GREEN PAPER

A BUSINESS CASE

FOR THE

REDESIGN OF THE FOOD SYSTEM FROM THE GROUND UP

ONE FIELD, ONE FARMER AND ONE FAMILY AT A TIME

"We just kept on going on and on until, at last, the impossible became first feasible, then real, and finally inevitable." Albie Sachs

"If you think we can't change the world, it just means you're not one of those that will." Jacque Fresco

"It is not great men who change the world, but weak men in the hands of a great God." Brother Yun

"We cannot solve our problems with the same thinking we used when we created them." Einstein

"The task is not so much to see what no one has yet seen, but to think what no one has thought about what everybody sees." Arthur Schopenhauer

"All men dream but not equally. Those who dream by night in the dusty recesses of their minds wake in the day to find that it was vanity; but the dreamers of the day are dangerous men, for they may act their dream with open eyes to make it possible." T.E. Lawrence

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I have tried to make it flow. Where it doesn't, I am sorry. I know I will have missed some things and got others wrong. Please don't let either detract from the overriding purpose or message. Firstly, that the business case is, I hope, in spite of these errors and omissions, overwhelmingly made and, secondly, that we know everything we need to know about everything we need to know about in order to start, and start now, to change not just our worlds but to put ourselves on the path to a completely different world.

AUTHOR

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DISCLAIMER

Triage believes in the potential of the food system to solve the world's most intractable problems. This is its' foundation and its' platform. This Green Paper has been written by Triage to articulate the business case for the redesign of the food system in support of its' theory of change, i.e. that the redesign of the world's food system changes everything for everyone.

The Company has made it available to the wider community to contribute to thinking and discussion around food systems, and to catalyse systems change. The vast majority of its' contents represent the work of third parties, all of whom are acknowledged at the end of the Paper under "Background Reading". To the extent that any views are expressed, they represent the views of the author and do not necessarily represent the views of the authors or organisations of the background reading.

PREFACE

In January 2015 I moved to Brazil. It's a long story but, in short, I left everything and everyone behind, arriving here with a blank sheet of paper and what I thought were two very simple questions; "What am I doing (here)?", and, "What am I going to do?"

What seemed very straight forward turned out to be anything but, and the beginning of the most incredible journey.

I am an entrepreneur by nature and a businessman by necessity; we all have to grow up at some point. What I am really passionate about, however, is solving problems, in particular those that affect lots of people lots of the time. And it is this passion that led me to the food system.

The majority of the world's poor live in agricultural communities. These communities are poor because most farmers are poor. And most farmers are poor because they don't make a profit.

I have spent the past three years asking "why?", and I am still asking. I am also fascinated by "systems" and how they work, and so, back in 2015, I began to ask a second question; "how does the food system work?" These two questions, "why don't most farmers make a profit?", and, "how does the food system work?", or, more accurately, "why doesn't it work (for the benefit of all)?" were where I started. In the process of answering these two questions I began to ask more and, as in every aspect of my life, I now have more questions than I have answers, but one thing I am very clear on is that our food system needs to be redesigned, from the ground up, one relationship at a time.

This paper is an invitation to both a conversation and to begin a journey together, to coalesce not just the thoughts and ideas, science and research, stories and case studies, so we are speaking with one voice, but to mobilise an army of the great and the good, the bold and the brave. Or, to borrow the phrase of some new friends, Ralph Thurn and Bill Baue, "Positive Mavericks".

The working title of the Paper was given the same name as UNCTADs' 2013 Report, "Wake Up Before It's Too Late", because I'm not sure we have woken up. We continue to use language that "couches" the undeniable, and irrefutability of our situation, with "ifs", "buts" and "maybes".

It is also important to say that, as Paul Hawken says in his book, "Drawdown", in which he articulates a comprehensive plan to reverse global warming, *"We have not created or devised a plan. We do not have that capability or self-appointed mandate"*. Over the past three years we, like Paul, *"found a plan, a blueprint that already exists in the world in the form of humanity's collective wisdom made manifest in applied, hands-on practices and technologies",* of nature's own perfect plan that for centuries has sustained the planet and all life on it, and of a world that shouts of the wonder and awe of creation.

PROCESS

The Green Paper has been written, and is being published as such, to involve as many people as possible in presenting the case for a redesign of the food system, and to ensure that it is comprehensive, clear, coherent and compelling.

It is a discussion document intended to stimulate a conversation and to launch a process of consultation. The Green Paper will be followed by a White Paper, which, in turn, will become a blueprint and a roadmap for those either involved or with an interest in the food system. Early drafts of this Paper have already achieved as much.

Green papers are traditionally written in-house and then published. This Green Paper has been reviewed, commented upon, edited, amended and added to by a large group of people, and to whom I owe a huge debt of gratitude.

The Food System touches all of our lives. The issues identified in this paper, and by everyone everywhere, make the redesign of the food system the most urgent priority for us all. The question it asks us all is not, "what is the business case?" but, "what am I going to do about it?"

The redesign will affect all of us, whether we work in or are involved in the food system or not, so, right from the beginning, we wanted to include everyone.

WHAT IT ISN'T

This paper has not been written to make or prove a point. Any points that this paper does make have already been well made by those far better placed than me to make them. Neither is anything written here new. Many of those that have contributed to the Paper, by way of background reading and in providing incredibly valuable feedback throughout, have been talking and writing about the issues we face, and the solutions, for decades.

Finally, this paper is an invitation to a conversation and into a relationship. What has been interesting to observe during the process to date is the priority that others have given to relationship, and the basis on which people are choosing to be in relationship. We, so often, prioritise being right, but this journey has been marked by people committed more to getting it right, and who have not let difference of opinion to be the reason for not having one (a relationship). We value and share this commitment.

David Plummer

INTRODUCTION

One of the greatest achievements of the last 50 years is that advances in global food production have, largely, kept pace with global demand. Today, around 6 billion people are no longer hungry, up from about 2 billion 50 years ago, but with population growth and the increasing wealth of a strong and emerging middle class in many nations, the demand for food, and, critically, particular types of food, will continue to rise in coming decades.

Today's global food system has made food cheaper and more accessible than ever before. Food prices in nearly all major markets are at a historical low, and the majority of the world can access the widest possible variety of foods from virtually every corner of the globe.

The global food system, through the competitive nature of the market system, has also encouraged higher levels of production and efficiency from farms resulting in large scale plant and animal domestication, precision farming, and technological innovations, and it has driven down the costs of transport and communications, furthering the globalisation of the food system.

It has enhanced food security for many and freed up labour for other sectors that has helped countries grow their economies and raise living standards, but it is also the cause of rampant hunger, malnutrition, obesity and non-communicable disease, with the increasingly wealthy spending a large and growing amount of their food budget on a "richer" and more "globalised" diet (anything, anytime, anywhere) consisting of more meat and more processed foods, which are invariably higher in "empty calories".

It is the primary cause of biodiversity loss and greenhouse gas emissions, degrades our soils, poisons our water, is inefficient in the extreme, perpetuates social iniquity and neglects local cultures. Its' consequences have been, and continue to be, devastating. Nothing has a greater impact.

BACKGROUND

"Most of the people in the world are poor, so if we knew the economics of being poor we would know much of the economics that really matters. Most of the world's poor people earn their living from agriculture, so if we knew the economics of agriculture we would know much of the economics of being poor." Schulz

The majority of the world's' poor live in agricultural communities (80% of the extreme poor and 75% of the moderate poor). Out of the 2.5 billion people in poor countries living directly from the food and agriculture sector, 1.5 billion people live in smallholder households, many of whom are extremely poor. The relationship between the food system and poverty is hard wired.

Poverty is ingrained in agriculture with extreme poverty rates among agricultural workers more than four times higher than among non-agricultural workers, and consistent with the well-documented earnings penalty faced by agricultural labour. The share of workers in the agricultural sector is 65% among the extreme poor, 52% among the moderate poor and 20% among the non-poor, underlining the strong correlation between poverty status and primary occupation. The agricultural worker, including the smallholder, is, invariably, trapped.

The concept of a poverty trap, commonly understood as a self-reinforcing situation, has been very influential in describing the persistence of poverty and the relationship between poverty and sustainability. But the common understanding of, and thinking behind, a poverty trap, particularly in agriculture, is constrained for two reasons. Firstly, poverty arises from the complex interactions between a wide range of factors, e.g. social, ecological, environmental, cultural, etc. and, secondly, the concept of a poverty trap disempowers those in poverty.

The poor are hungry and their hunger traps them in poverty. Hunger is also the number one cause of death in the world, killing more people than HIV/AIDS, malaria and tuberculosis combined.

While food production has more than doubled and diets have become more varied, and often more energy-intense, the food system leaves over 815 million people hungry, up from 777 in 2015 and signifying a reversal of the progress we have made in past decades. Sub-Saharan Africa remains the region with the highest rate of undernourishment, affecting 22.7 percent of the population in 2016 with the situation especially urgent in Eastern Africa, where one-third of the population is estimated to be undernourished. Africa also has the highest levels of severe food insecurity, reaching 27.4 percent of the population in 2016, almost four times the level of any other region, and it is one of the regions where food insecurity is on the rise, particularly in sub-Saharan Africa.

In monitoring the progress towards the second Sustainable Development Goal (SDG 2), which calls on countries to *"end hunger, achieve food security and improved nutrition, and promote sustainable agriculture"* by 2030, these estimates are alarming.

The food system also leaves an additional 2 billion malnourished (suffering from micronutrient deficiencies, in particular of vitamin A, iodine, iron and zinc). Malnutrition is a term for a condition caused by improper diet or nutrition. It means "badly nourished," but is more than a measure of how much people eat or fail to eat. Malnutrition results from inadequate intake of protein, calories, or micronutrients and is characterised by frequent infections, disease, and reduced cognitive development.

Malnutrition is not only a consequence of poverty, food insecurity and disease, but also one of the reasons for the lack of progress in economic development. It has been proven to slow economic growth and deepens poverty through productivity losses from poor physical performance and cognitive capacity.

Conversely, and rather perversely, the incidence of obesity is rising in many countries with over 2.5 billion adults now deemed to be overweight. One of the greatest paradoxes of our time is the coexistence of the different faces of malnutrition within the same region, countries, and even the same household.

Non-communicable diseases or, more accurately, lifestyle related conditions associated with imbalanced diets have increased so rapidly as to have overtaken infectious diseases as the number one cause of global mortality. In addition, while food-borne illnesses persist in all types of markets, new scares affecting large numbers of people are emerging in increasingly globalised food markets, threatening to unravel the historical progress on food safety.

A globalised food trade, extensive production and complex supply chains are contributing towards an increased number of microbiological food safety outbreaks, outbreaks that cost the US economy c. $93.2 billion in 2015. Moreover, the volume of international food trade has grown exponentially. These factors, and others, are putting pressure on food companies to meet global demand in order to be competitive. This pressure could result in a major foodborne outbreak turning a local issue into an international crisis.

The risks of multiple breadbasket failures are at an all-time high with significant humanitarian, economic and political consequences. We are one harvest away from a global food crisis. Just as the 'democracies of bread' became a symbol of the Arab Spring, throughout history spikes in food prices have led to civil unrest.

The costs to society are enormous too with 22 negative environmental impacts, including greenhouse gas emissions, groundwater abstraction and waste generation, land conversion and habitat loss, wasteful water consumption, soil erosion and degradation, pollution, climate change, and genetic erosion, costing over $4.7 trillion every year. These costs do not take into account other real costs associated with our food system such as the loss of human potential and lives from malnutrition, the cost of humanitarian assistance to keep people alive ($22 billion in 2013 and before the costs of military support in delivering that assistance are taken into account), or global healthcare costs related to diseases associated with excess weight and obesity, e.g. diabetes, heart disease, cancer, etc. estimated at $2 trillion per annum, and losses due to NCD's of $7 trillion. The wider and ballooning costs of the health impacts of food systems include malnutrition ($3.5 trillion), antimicrobial resistance ($34 billion), endocrine disrupting chemicals ($557 billion), food borne illness ($14 billion), and occupational morbidity ($250 billion). At the same time, the economic returns from investing in nutrition are high; for every US$1 invested, US$16 is generated.

To measure the environmental impacts of human activity on our planet, environmental scientists developed a concept known as 'planetary boundaries'. The concept measures the boundaries for nine vital Earth system processes, e.g. biodiversity loss, climate change, etc. We have to stay within these boundaries if the planet is to sustain human life in the long term.

The planetary boundaries framework, which was proposed in 2009 by a group of Earth system and environmental scientists led by Johan Rockström from the Stockholm Resilience Centre and Will Steffen from the Australian National University, sought to define a safe operating space for humanity based on the intrinsic biophysical processes that regulate the stability of the Earth System. The framework has subsequently been revised and updated with a focus on the underpinning biophysical science based on targeted input from expert research communities and on more general scientific advances over the past 5 years.

Several of the boundaries now have a two-tier approach, reflecting the importance of cross-scale interactions and the regional-level heterogeneity of the processes that underpin the boundaries. Two core boundaries, climate change and biosphere integrity, have been identified, each of which has the potential on its own to drive the Earth System into a new state should they be substantially and persistently transgressed.

For the social and economic spheres, social scientists have complemented these physical boundaries with social and economic boundaries that include income and work, education, gender equity, social equity, etc. the foundations of a healthy and thriving society. When both social foundations and environmental ceilings are respected, the world is a safe and just place, and humanity can thrive.

We are, however, deficient in every social dimension and have already exceeded four planetary boundaries; biodiversity loss, climate change, land conversion, nitrogen and phosphorous loading. The economic costs alone are staggering with a recent study by IFPRI estimating that the annual cost of land degradation due to "land use and cover change" (LUCC) was about $300 billion, not including any costs related to deterioration of ecosystem services which would increase the estimates significantly. The cost of completely rehabilitating lands degraded due to LUCC worldwide would be about $4.6 trillion over 6 years, but if action is not taken to rehabilitate degraded lands during this same period, the world will incur a loss of $14 trillion.

Notwithstanding the significant benefits so many of us enjoy, the food system fails the majority. Not only is it failing to sustain the people and planet on which it relies, it is trapping the poor, destroying the environment and harming human health.

In short, the food system has come to represent an existential threat to itself, the life of the planet and our lives on it.

SYSTEMIC RISK

Agriculture is the single largest employer in the world, providing livelihoods and jobs for 40% of the world's population. It is a fundamental component of the global food system. This system encompasses the numerous processes and infrastructure involved in feeding the world's population, from growing, processing and transporting of food products, to disposing of consumers' waste.

The primary goal of food systems, today, is to achieve food security, which exists only when all people at all times have access to enough safe and nutritious food to maintain a healthy and active life. There is sufficient global aggregate food production for everyone to be well fed but there remain marked differences in levels of nourishment across the globe. Despite international focus, around one in nine of the world's population is chronically hungry.

Most discussions of global food security have focused on the long-term pressures facing the global food system and the difficulty of matching supply to an ever-increasing demand. However, this chronic pressure on food supply heightens the system's vulnerability to acute supply shocks. Sudden disruptions to the food supply chain could reduce global food supply and trigger a spike in food prices, leading to substantial knock-on effects for businesses and societies. Crop production shocks could pose a systemic threat to food security if they were to impact any of the world's major breadbaskets, regions which produce a surplus of staple food crops considered vital for global society as a whole.

Closing the gap for the hungry must remain a priority for the world food system, but there is a pressing need to reduce the uncertainty surrounding the impacts of an extreme shock to the food supply. As the pressure on our global food supply rises, so too does its vulnerability to sudden and acute disruptions.

Although there is a large amount of uncertainty about exactly how climate change might impact world food production over the coming decades, there is a general consensus that the overall effect will be negative. Increases in the intensity and frequency of extreme weather events such as floods, droughts and wildfires, coupled with a rise in conditions amenable to the spread and persistence of agricultural pests and diseases, are expected to have a destabilising effect on world food production. This is further exacerbated by the growing issue of water scarcity, which is accelerating at such a pace that two-thirds of the world's population could live under water stress conditions by 2025.

The continued globalisation of modern food networks is introducing an unprecedented level of complexity to the global food system, bringing both significant benefits to many and systemic risks to us all. Disruptions at any one point in the system would be likely to reverberate throughout the food supply chain. Volatile food prices and increasing political instability are likely to magnify the impacts of food production shocks, causing a cascade of economic, social and political impacts across the globe.

Providing a growing global population with a healthy and nutritious diet is one of our greatest challenges but we also need to do so in ways that are within environmental and ecological limits.

Today's food systems have succeeded in supplying large volumes of foods to global markets but are generating negative outcomes on multiple fronts; widespread degradation of land, water and ecosystems, high global anthropogenic greenhouse gas (GHG) emissions, biodiversity losses, persistent hunger and micro-nutrient deficiencies alongside the rapid rise of obesity and diet-related diseases, and livelihood stresses for farmers around the world.

Food systems contribute about a third of all GHG emissions. Upstream of agriculture, major contributions are made by the fossil fuel-intensive production of chemical fertiliser and pesticides. Downstream, emissions arise from food processing and retail sectors that rely increasingly on abundant synthetic packaging and soaring 'food miles' in order to deliver the highly processed and unseasonal products to which consumers have become accustomed. Meanwhile, 70% of all water withdrawn from aquifers, streams and lakes is used for agriculture, often at unsustainable rates. The agricultural sector is responsible for nitrate, phosphorus, pesticide, soil sediment and pathogen pollution in soil and water. Furthermore, agricultural systems have contributed significantly to land degradation as well as to the destruction of natural habitats and losses of wild biodiversity around the world.

Many of these problems are linked specifically to 'industrial agriculture'; the input-intensive crop monocultures and industrial-scale feedlots that now dominate farming landscapes. The uniformity at the heart of these systems and their reliance on chemical fertilisers, pesticides and the misuse of antimicrobial drugs, including antibiotics, in livestock, aquaculture and crop production, leads systematically to negative outcomes and vulnerabilities, for example antibiotic and antimicrobial resistance (AMR).

Evidence is growing that animal-to-human spread of microbial-resistant bacteria reduces the human body's responsiveness to antibiotics. Antimicrobial resistance, where antimicrobial drugs, including antibiotics, no longer treat infections the way they are supposed to, has the potential to cause large global economic damage, causing low income countries to lose more than 5% of their GDP and push up to 28 million people, mostly in developing countries, into poverty by 2050.

Industrial agriculture and the industrial food systems that have developed around it are locked in place by a series of vicious cycles. For example, the way food systems are currently structured allows value to accrue to a limited number of actors concentrating knowledge and innovation, wealth and power among a few, very large global companies. The system has left

farmers highly dependent on third party support, reduced the range of options they feel they have and increased the cost of doing business exponentially.

WHAT'S REAL, WHAT'S REALLY GOING ON, AND WHAT REALLY MATTERS?

The current agriculture, farming and food narrative is awash with myth, for example the need to produce 70% more food by 2050. Multiple sources including Olivier de Schutter, the former UN Special Rapporteur on the Right to Food, have stated that we already produce enough food to feed our current population and the projected 2050 population. In fact, global food production continues to increase at a rate faster than population growth. We produce 17% more food per person today than we did 30 years ago; more than enough to feed over 10 billion people.

It's not just myths that need to be challenged. We also need to challenge vested interests and polarised positions on all sides. Hilal Elver, the current UN Special Rapporteur on the Right to Food, stated that political will is needed to re-evaluate and challenge the (vested) interests, incentives and power relations that keep industrial agrochemical dependent farming in place.

The World Health Organisation (WHO), in their 2017 report on ten years in public health, stressed the need for governments "to make bold political choices that take on powerful economic operators, like the food and soda industries . . . *The interests of the public must be prioritised over those of corporations"*. Multi-national companies like Unilever are torn between doing well and doing good, and have a vested interest in maintaining the status quo, but they're not the only ones, and these companies and organisations have immense political influence that they use to influence policymakers and regulators, and to obstruct reforms. They are also able to shape the narratives (the myths) that entrench this status quo, for example, that industrial agriculture gives us cheap food and is vital to feed the world.

And we need to acknowledge that the search for answers and solutions doesn't begin in Silicon Valley's food-tech labs, or anyone else's for that matter, but with smallholders and individual farmers wherever they are.

WHAT THE EXPERTS ARE SAYING

In 2008 a commission that convened over 400 experts unveiled a series of reports calling for an end to business-as-usual and a paradigm shift in agriculture concluding that agroecology and locally-based food economies, rather than the global market, were the best strategies for combating poverty and hunger (IAASTD, International Assessment of Agricultural Knowledge, Science and Technology for Development).

The body of evidence and wealth of scientific support for regenerative farming, which includes agroecological, conservation and sustainable farming systems, has demonstrated that these practices can comfortably feed the growing human population, all while repairing our damaged ecosystem. This scientific support led the United Nations Commission on Trade and Development (UNCTAD) to issue the report, "Wake Up Before It's Too Late", calling for a fundamental transformation of agriculture that takes into account systemic considerations. It also identified governance, the power asymmetry problems with input and output markets, as well as current trade rules as significant challenges.

The International Panel of Experts in Sustainable Food Systems (IPES) stated in their 2016 report, "From Uniformity to Diversity", that we need a fundamentally different model of agriculture and to shift the centre of gravity. They also stressed the need to transition to agroecological production systems stating, *"This transition is viable and necessary whether the starting point is highly specialised industrial agriculture or forms of subsistence farming in poor, developing countries"*.

Bioversity, in their 2016 report on mainstreaming biodiversity concluded, *"Food systems need to be reformed so that they nourish people while nurturing the environment. Agricultural biodiversity is a source of nutritious foods that are culturally acceptable and often adapted to local and low-input agricultural systems. It is also a source of important traits for breeding resilient, nutritious crops and animal breeds"*.

UNEP's 2017 "Food Systems and Natural Resources" paper, called for, *"A fundamental transformation of our food systems . . . if we are to meet future demands of food and quality of life for present and future generations"*.

The United Nations Food and Agriculture Organisation stated in their 2017 report on the future of food and agriculture, *"High-input, resource-intensive farming systems, which have caused massive deforestation, water scarcities, soil depletion and high levels of greenhouse gas emissions, cannot deliver sustainable food and agricultural production. We need innovative systems that protect and enhance the natural resource base, while increasing productivity. We also need a transformative process towards 'holistic' approaches, such as agroecology, agro-forestry, climate-smart agriculture and conservation agriculture, and which also build upon indigenous and traditional knowledge"*.

The World Economic Forum's (WEF) 2017 report, "Shaping the Future of Global Food Systems: A Scenarios Analysis", mapped out four potential future worlds; 1) Survival of the Richest, 2) Unchecked Consumption, 3) Open-Source Sustainability, and 4) Local is the New Global, concluding that any of these scenarios was possible and that, together, they demonstrate that today's food systems require a fundamental transformation to meet human needs within planetary boundaries in 2030.

IPES most recent report, "Unravelling the Food – Health Nexus", published in October 2017, stressed the urgency of reforming food and farming systems on the grounds of protecting human health stating that, *"The health impacts of food systems are interconnected, self-reinforcing, and complex, but we know enough to act"*.

Finally, a report presented to a meeting of the G20 Agriculture Deputies in March 2018 stated that, *"Meeting the growing demand for food with existing farming practices is likely to lead to more intense competition for natural resources, increased greenhouse gas emissions, and further deforestation and land degradation. In the current context of massive deforestation, water scarcities, soil depletion and high levels of greenhouse gas emissions, high-input, resource-intensive farming systems cannot deliver sustainable food and agricultural production. Innovative systems that protect and enhance the natural resource base, while increasing productivity, are needed. Farming methods will need to embrace technological improvements and production systems that use fewer inputs to achieve a given output and move towards 'holistic' approaches that can contribute to sustainable productivity growth, such as agroecology, agro-forestry, climate-smart agriculture and conservation agriculture, which also build upon indigenous and traditional knowledge".*

The message is consistent and clear; our food system needs to be redesigned. Are we listening, and have we heard what has been said?

WHAT ARE WE PLAYING FOR?

Every system has a 'genetic' potential; the theoretical maximum production or performance that might be achieved when the system is performing optimally. It is not possible, today, to quantify the genetic potential of the food system but it is possible to quantify many of the benefits that derive from a healthy and thriving one. These include but are by no means limited to:

- **Zero hunger**; hunger is caused by poverty and inequality, not scarcity. To end hunger, we must end poverty and inequality. The FAO has put the cost of ending hunger at $267 billion a year. The economist Jeffrey Sachs has put the cost of ending extreme poverty at $175 billion a year for 20 years ($3.5 trillion). The value of eliminating both is upwards of $400 billion a year, or $8 trillion over the same period.
- **An end to poverty**; producing food locally for local markets reduces local poverty levels 7x more than general agriculture, and investing in small scale agriculture is 3.5x more effective at reducing poverty.
- Thriving economies; increased agricultural productivity is the single most important determinant of economic growth and poverty reduction, and growth in agricultural income is essential to stimulate growth in the overall economy, including the non-farm sectors. Thriving economies are better able to support initiatives such as the 'living wage'. If workers were paid a living wage then, and based on an African median living wage of $9.00 per day (the lowest regional average), at least $12 trillion would be added to workers' wages.
- **More**; locally produced food increases per capita income whereby general ag decreases it, increases grower income by as much as 5x, creates 4.5x more jobs, and has an economic multiplier of at least 2.5x.
- **Public health**; local food enables consumers to obtain food items with superior quality characteristics, e.g. freshness, flavour, ripeness, enhanced shelf life, and teaches consumers about farming practices used (often directly from growers) which, in turn, engenders trust in the integrity and quality of the food they purchase. Connecting people with the source of their food through local food initiatives has been shown to lead to healthier diets. Also, poly-cultures are better for balancing diets and reducing risk, and can thrive without agrochemicals. The cost of global healthcare costs related to diseases associated with excess weight and obesity (diabetes, heart disease, cancer, etc.), is estimated to be $2 trillion per annum. According to the Union of Concerned Scientists, if Americans consumed the USDA recommended levels of fruit and vegetables it would also save 127,000 lives with total economic savings of up to $11 trillion. And that's just in the United States.
- **Transformation of entire continents**; localising production of Africa's projected food import bill for 2025 ($110 billion) would add at least $275 billion to its' economy, and investing in Africa's food system could turn it into a $1 trillion powerhouse.
- **Climate smart**; regenerative production systems are more resilient to adverse weather and more resource efficient.
- **Strengthen resilience**; building soil carbon and microbial activity underpins higher yields and profits.
- **Reverse climate change**; production systems that build soil health maximise carbon fixation whilst minimising the loss of that carbon once returned to the soil, reversing the greenhouse effect. A global move to regenerative farming could sequester more than 100% of current annual CO2 emissions. The UNDP estimates the cost of global warming to be upwards of $12 trillion per annum.
- **Environmental benefits**; regenerative farming can deliver environmental benefits per acre of one metric tonne of sequestered carbon, a reduction in up to 8 kgs of leached nutrients, reduce soil erosion by 3 tonnes and save 7000 cubic feet of water. These environmental benefits translate to economic value of up to $264 per acre, $ trillions globally.
- **Stay within our planetary boundaries**; 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.
- **Biodiversity**; regenerative farming delivers other ecosystems services including support of wildlife habitat and crop pollination, and preserves wild land, e.g. forests and wetlands;

- **Peace and security**; there is a startling similarity between todays ecological and food security hotspots and Western governments' list of places prone to civil unrest and violent regime change, places where the cost of intervening measures in the tens of billions in aid and military intervention (the cost of managing security related violence globally is 13% of global GDP, or c. $10 trillion in 2016).

The business case for a redesign of the food system from the ground up is comprehensive, clear, coherent and compelling, delivering trillions of dollars of annual savings and generating multiples thereof in value to individuals, families, communities, society, the environment and the economy. We have everything to play for.

SUSTAINABLE DEVELOPMENT GOALS

Food systems are at the heart of the United Nations 2030 Agenda for Sustainable Development. The 17 Sustainable Development Goals (SDGs) set ambitious benchmarks for promoting economic prosperity, enhancing social inclusion and ensuring environmental sustainability. The Goals recognise the central role of food, from what we grow and harvest to where we grow it and by whom, how we process, trade, transport, store, sell and consume, and that it is the essential connecting thread between people, prosperity, and our planet.

As a result, the world now has a framework for action towards a "sustainable" food system, but we have lacked a clear understanding of what success might look like or how we might get there; until now.

A redesign of the food system from the ground up will deliver a blueprint for success and a road map on how we get there including a detailed plan of action with clear indicators as to precisely what good will look like. Moreover, it provides a picture of a healthy, flourishing and prosperous world, a world in which the potential of the food system to solve the world's' most intractable problems has been realised.

REDESIGN OF THE FOOD SYSTEM . . .

The future of agriculture is not simply a debate of one production system versus another. Not only does this over simplify what is already very complex but it also ignores local wisdom and underutilises the ingenuity of farmers.

The hallmark of a truly sustainable system is its ability to regenerate itself. The key to sustainable agriculture is healthy soil and the microbes that live in it. Microbes are central to all life on Earth due to their huge diversity in form and function, with complex microbial communities driving many of the things we depend upon including soil fertility, plant health and nutrition, animal immune systems, and ours too. The soil is not just the foundation for present and future growth, it is the foundation for all life.

A redesigned system would build on this foundation, prioritise local needs, improve local markets and create thriving local economies. An emphasis on local needs would bring communities together, promoting farmer-to-farmer learning, sharing and extension, co-creation and innovation. Local farmers would be the source of knowledge and would coordinate with scientists, businesses, investors, government agencies and NGOs to combine traditional knowledge, the rich history of farmers and human ingenuity with modern developments and cutting edge technological understanding; a marriage of agroecology, agrotech and digital that combines ancient wisdom, modern science and the information age.

Fresh, local food is a vision that unites food sovereignty activists, environmentalists, slow food enthusiasts and the majority of the world's' farmers. Supporting or rebuilding local food systems to bring fresh and culturally relevant food from local producers to local consumers catalyses community and regional development in both the global North and the global South. Producing and marketing local food is a cornerstone to a redesigned food system, but building these local food systems also requires rethinking the role of trade and the institutions that promote it.

. . . FROM THE GROUND UP

Agroecology's principles are strongly rooted in both science and the knowledge and practice of smallholder farmers, but the most successful (movements) have transcended technological approaches by putting agroecology at the heart of wider social change, forging new pathways for food sovereignty, local autonomy, and community control of land, water, and agrobiodiversity.

This is important because agroecology is sometimes removed from its political context and defined solely as a science, a practice of applying ecological principles to the design and management of sustainable farms. This simplification invites a variety of competing narratives, such as integrated pest management, organic farming, conservation agriculture, regenerative agriculture, ecological intensification, and climate-smart agriculture, which structurally de-centre agroecology.

The starting point of any conversation about the redesign of the food system are the very systems that traditional farmers have developed over centuries. Such complex farming systems, adapted to local conditions, have, so often, helped smallholders farm sustainably in harsh environments, meeting their subsistence needs without depending on mechanisation, chemical fertilisers, pesticides, or other modern agricultural technologies. Guided by an intimate knowledge of nature, many traditional farmers have nurtured biologically and genetically diverse farming systems with robustness and built-in resilience. These traits are essential if agriculture is going to adapt to a rapidly changing environment (climate, pests, and diseases).

These systems help smallholders cope with volatile global markets, technological monopolisation, and corporate concentration.

One of the many benefits of a "Ground Up" approach is the ability to tap into these skills, knowledge and experience, of proven and tested practices deployed in the form of polycultures, agroforestry, and other complex farming systems that strike a balance between farm-level productivity, resilience, agroecosystem health, individual livelihoods and community health. Perhaps most importantly, however, a "Ground Up" approach is open, democratic and decentralised.

HISTORICAL CONTEXT

One of our major challenges is how we explain the evolution of a global food system where distant social actors, ecologies, and places have complex, and often contradictory, relations. In particular, we face the difficult task of providing an account of food system change that is at once theoretically sophisticated, historically grounded, and holistic in its perspective. A leading example of this type of approach is food regimes analysis, which is anchored in the political economy. The food regimes approach views agriculture and food in relation to the development of capitalism on a global scale and argues that social change is brought about by struggles among social movements, capital, and states.

The concept of food regimes was introduced by Harriet Friedmann and Philip McMichael in an article in which they addressed the changing role of food and agriculture in the development of global capitalism since 1870. Friedman and McMichael argued that, like many problems in the global South, global food system issues can be traced back to a colonial history. They described two key periods where the structure of the global food system enabled the uptake of Western-style capitalism and consumerism; the Diasporic-Colonial food regime of 1870 to 1914 and the Mercantile-Industrial food regime of 1947 to 1973. Friedmann went on to describe a potential third regime that we might find ourselves in now, the "Corporate-Environmental" regime. The concepts and their descriptors were heavily politicised, but the points well made.

Critically, the third regime, Corporate-Environmental, follows globally powerful food retailers and agro-food companies who have, in many cases, selectively adopted the language and goals of environmental and social movements, and food chains that promote their organic food aisles separately from their regular and, invariably, more affordable foodstuffs. This new regime is arguably a response to the environmental critique of industrial agriculture but is often removed from the context in which these products are produced.

In the last decades of the previous century the green revolution and industrial agriculture simplified agricultural methods to increase the yields of staple crops. This was often done in the name of famine prevention but it also marginalised rural communities and eroded agricultural biodiversity, soil fertility and indigenous knowledge.

Social movement responses have been wide ranging with movements like Slow Food, which was established over 30 years ago, working to prevent the disappearance of local food cultures and traditions, and to combat people's dwindling interest in the food they eat, where it comes from, and how food choices affect the world around us. And La Via Campesina, an international movement that has brought together millions of farmers and their communities around the world, defending their right to food sovereignty by promoting social justice and dignity through sustainable agriculture and the local food system promoted by organisations like Slow Food.

SYSTEMS THINKING

"There is no such thing as a single-issue struggle because we do not live single-issue lives." Audre Lorde

"Most of our business and political leaders are unable to 'connect the dots', to use a popular phrase. They fail to see how the major problems of our time are all interrelated. Their so-called "solutions" tend to focus on a single issue, thereby simply shifting the problem to another part of the system. Moreover, they refuse to recognise how their piecemeal solutions effect future generations." Fritjof Capra

"Let's face it. The universe is messy. It is nonlinear, turbulent, and chaotic. It is dynamic. It spends its time in transient behaviour on its way to somewhere else, not in mathematically neat equilibria. It self-organises and evolves. It creates diversity, not uniformity. That's what makes the world interesting, that's what makes it beautiful, and that's what makes it work." Donella H. Meadows

Systems theory is the interdisciplinary study of systems, a system being a cohesive conglomeration of interrelated and interdependent parts. Its' goal is to systematically discover a system's dynamics, constraints, conditions and the principles that can be applied to any system and in any context, in order to achieve its' potential.

In 2008 Michael Pollan, professor of journalism at UC Berkeley and an award-winning journalist and writer who has been writing books and articles about the places where nature and culture intersect (on our plates, in our farms and gardens, and in the built environment) for the past 25 years, wrote an open letter in the New York Times Magazine to the then President-Elect, Barack Obama, entitled "Farmer in Chief; what the next president can and should do to remake the way we grow and eat our food". In it he chronicles the successes, failures, challenges and opportunities of the US food system and the industrial model. He applies systems theory to society's growing problems with the current system, the unintended consequences and negative externalities, and offers some solutions.

He also describes the power of existing models, models that have existed for centuries, for example cleverly designed polycultures that produce large amounts of food from little more than soil, water and sunlight, and shows that what he is advocating is not some ideological nirvana but what has already been proven, not only by small-scale, "alternative", farmers in the United States and other places around the world, but also by large rice-and-fish farmers in China, and giant-scale operations of up to 6,000 hectares in places like Argentina where farmers have traditionally employed an ingenious eight-year rotation of perennial pasture and annual crops. These successes are not isolated instances but the tip of the iceberg. All around the world farmers are using their knowledge, experience and skills to solve complex, systemic problems in context.

The most recent example of what can be achieved by taking a systems approach at scale is from China where, over a 15 year period (2001 – 2015), an integrated soil-crop system (ISSM) trial involving nearly 21 million smallholder farmers and c. 38 million hectares increased annual yield by 32 million tonnes (18.3% - 21.8% across maize, wheat and rice), reduced the use of N by 1.2 million tonnes (8.5% - 15.6%), reduced N losses by 0.3 million tonnes (22.9% - 34.9%), GHG by 15 million tonnes (18.6% - 29.1%) and increased farmer income by US $12.3 billion.

The Pollan essay is a brilliant application of systems theory and thinking to the challenges we face, but, in order to redesign a system, any system, we need to address the issue of "purpose". As Pollan rightly points out, the current system has been spectacularly successful in keeping food prices low and providing a burgeoning and global middle class with a plentiful supply of food, in particular Western style food, anywhere and at any time. But at what cost?

The purpose of the food system has to be redefined; a universal statement of purpose, not just at a global level, but nationally, regionally, and locally.

STARTER FOR TEN

The Food System is highly complex, highly interrelated and highly interdependent, from soil health and fertility to the microbiome (soil, plant, animal, human, etc.), on farm performance through processing, to production, distribution, retail, consumption and waste.

A food systems approach gathers all of these vital elements and activities, and the outputs of these activities; economic, environmental, social, cultural and nutritional outcomes, positive and negative.

IPES, the International Panel of Experts in Sustainable Food Systems, has put forward five interdependent points of leverage for building healthier systems but we need to establish more than just the leverage points. We need to know what we are building on and what we're building with.

KEY ELEMENTS OF A REDESIGNED FOOD SYSTEM

THE SOIL

"A nation that destroys its soils destroys itself." Franklin D. Roosevelt

"Essentially, all life depends upon the soil … There can be no life without soil and no soil without life; they have evolved together." Charles E. Kellogg

"We must look at our present civilisation as a whole and realise once and for all the great principle that the activities of homosapiens, which have created the machine age in which we are now living, are based on a very insecure basis, i.e. the surplus food made available by the plunder of the stores of soil fertility which are not ours but the property of generations yet to come." Sir Albert Howard

Soil is the living, breathing skin of our planet. Soil is the result of the interactions between the atmosphere (as governed by climate), the biosphere (local vegetation, animal activities, including those of humans) and the geosphere (the rocks and sediments that form the upper few metres of the Earth's solid crust). Soil makes up the outermost layer of our planet, while topsoil is the most productive and biologically active soil layer.

A typical mineral soil sample is 45% minerals, 25% water, 25% air and 5% organic matter. It is estimated that 5 - 10 tonnes of animal life can be found in one hectare of temperate grassland soil. Soils are generally around 1 - 2m deep, however, some soils are very shallow, just a few centimetres, while soils found on old, stable, land surfaces are much, much deeper, for example, the Phillipi Peatland in Greece which is reputed to be 190m deep.

Soils are an important factor in addressing micronutrient deficiency as most essential nutrients and minerals, e.g. zinc, iron, iodine, etc. cannot be derived from biosynthesis and must, therefore, be obtained by plants from the soil. These micronutrients are, in turn, then acquired by humans through the food they consume. Soil degradation leads to huge losses of productivity and fertile land, further compounding the challenge of soil quality, land availability and food security. There are also negative impacts on water quality as the sediments and nutrients from erosion are deposed in water bodies, with this increased pollution causing declines in fish and other species.

The Foundation of All Life

Soil is one of nature's most complex ecosystems and the most diverse habitat on earth containing a myriad of different organisms that interact and contribute to the global cycles that make all life possible. In fact, nowhere in nature are species so densely packed as in soil communities, with over 1,000 species of invertebrates found in a single m^2 of forest soil.

A healthy soil is a living soil, but soil health doesn't just underpin our food system, with around 95% of food production reliant on soil, it also regulates water, carbon and nitrogen cycles and performs several globally important functions.

Healthy soil is the foundation and cornerstone of life. Biological diversity, food production, the quality and volume of our water and carbon storage are all immediate and obvious benefits that flow from it, but healthy soil is also one of the keys to national security. Food and water security are tied to political stability on a global scale. Degraded soils are associated with reduced quantity and quality of food, water supplies, and environmental health. Increasing risks of food insecurity are also related to higher global energy demand, and any decline in crop yields and agronomic production exacerbate the food insecurity that currently affects over 850 million people globally.

Healthy Soils, Healthy People

A healthy soil functions as a vital living ecosystem that sustains plants, animals and humans. Soils host a quarter of the world's biodiversity and have provided tools for medicines and antibiotics. Soil is both the source of and a means to eliminate disease. Exploration of the life cycle and management of soil-borne pathogens can help reduce food contamination and improve human health, yet only a small fraction of soil microbial communities has been studied. And there is a need to harness the microbial diversity in our soils, for example, for the development of new pharmaceuticals.

The Business Case for Soil

Up until recently soil - it's value, it's role and its centrality - has been overlooked by almost everyone from farmers to policy makers, business leaders to the consumer. Soil health, along with water supply, is the most valuable resource for humans, as human life depends on the soil's generosity.

The current situation, from an agricultural production, natural resources, soil degradation, land use, and environmental perspective, has been extensively documented, including the interconnected and interdependent nature between each.

The 68th UN General Assembly declared 2015 the International Year of Soils stating that *"... soils constitute the foundation for agricultural development, essential ecosystem functions and food security and hence are key to sustaining life on Earth"*. The same document goes one, *"The sustainability of soils is key to addressing the pressures of a growing population. The sustainable management of soils can contribute to healthy soils and thus to a food-secure world and to stable and sustainably used ecosystems. Good land management is of economic and social significance, and this includes soil management, particularly for its contribution towards economic growth, biodiversity, sustainable agriculture and food security, which in turn are key to eradicating poverty and allowing women's empowerment. It is urgent to address issues such as climate change, water availability, desertification, land degradation and drought, as they pose global challenges"*. And, *"there is an urgent need at all levels to raise awareness and to promote sustainable use of our limited soil resources using the best available scientific information and building on all dimensions of sustainable development"*.

José Graziano da Silva, FAO Director-General, has rightly pointed out that, *"the multiple roles of soils often go unnoticed. Soils don't have a voice, and few people speak out for them"*. And he has said, *"They are our silent ally in food production"*, but they are not just our silent ally in food production. They are our silent ally in almost everything.

Buried Treasure

Soil's invisibility is not unsurprising. Soil is only now becoming mainstream with various programs such as France's "4 per 1000 initiative, soils for food security and climate", government plans such as the USDA's "Roadmap to Soil Health", and the FAO's Global Soil Partnership. The work of writers such as David Montgomery have also brought the role, function and capacity of soil to prominence. Indeed, the writer of this paper owes a huge debt to David. His books, "The Hidden Half of Nature: The Microbial Roots of Life and Health", which he wrote with his partner, Anne Bikle, "Dirt: The Erosion of Civilisations", and "Growing A Revolution: Bringing Our Soils Back To Life", were the source and inspiration of his own rekindled interest in, and fascination with, the soil.

Soil Organic Carbon

Soil organic carbon (SOC) is the carbon that remains in the soil after partial decomposition of any material produced by living organisms. It constitutes a key element of the global carbon cycle through atmosphere, vegetation, soil, rivers and the ocean.

SOC is the main component of soil organic matter (SOM) and as such constitutes the fuel of any soil. SOM supports key soil functions as it is critical for the stabilisation of soil structure, retention and release of plant nutrients, and allowing water infiltration and storage in soil. It is therefore essential to ensuring soil health, fertility and food production. The loss of SOC indicates a certain degree of soil degradation.

Soils represent the largest terrestrial organic carbon reservoir. Depending on local geology, climatic conditions and land use and management, amongst other environmental factors, soils hold different amounts of SOC. The largest amounts of SOC have been estimated to be stored in the northern permafrost region with around 190 Pg C (1 Pg is 1 billion tonnes) in the first 30 cm of the soil, mostly in peat soils. There, carbon accumulates in soils in huge quantities due to the low temperatures leading to low biological activity and slow SOM decomposition. The corresponding soil type is called Histosol and is characterised by a SOC content of between 12% and 18%. In contrast, in dry and hot regions such as the Sahara Desert, plant growth is naturally scarce and only very little carbon enters the soil. Arenosols, the typical soils of these areas, invariably have less than 0.6% SOC. Black soils, such as Chernozems, are inherently fertile because of their relatively high SOC content (over 1%) and optimal plant growth conditions in terms of nutrient exchange capacity and a well-developed structure enabling sufficient water provision. Unsustainable management practices such as excessive irrigation or leaving the soil bare endanger these soils, causing SOC loss and massive erosion. Increasing the SOC they contain can be achieved through sustainable soil management, including mulching, planting cover crops, judicious fertilisation and moderate irrigation. Loss of SOC negatively affects not only soil health and food production, but also exacerbates climate change. When SOM is decomposed, carbon-based greenhouse gases are emitted to the atmosphere. If this occurs at too high rates, soils can contribute to warming our planet. On the flip side, many soils have the potential to increase their SOC stocks, thus mitigating climate change by reducing the atmospheric CO2 concentration.

THE MICROBIOME

Some scientists believe the microbiome crisis is of similar proportions to the climate change (crisis) but it gets much less coverage. Microbes are disappearing from our bodies and this is a major problem as not only do trillions of microbes (bacteria, fungi, viruses, protists) live on every surface of our bodies as well as inside our mouths, other orifices and gut, they also make up the majority of our body's cells.

Few people are aware of how these microbes and their genes directly affect the functioning of our bodies. The human genome found in the nuclei of our cells contains roughly 20,000 genes, but the microbiome, the sum total of genetic material in the microorganisms that live in and on us, contains as many as 20 million genes, all of which are directly or indirectly interacting with and, at times, even controlling our genes.

Our microbial genes are critical to the regulation of our metabolism, to the ability of our immune system to fight off infection and to the production of the neurotransmitters that power our brain and nervous system.

The main issue is the modern diet. Our hunter-gatherer ancestors mostly ate a plant-based and fibre-rich diet, which sustained a diverse microbial population in our guts that could produce all the metabolites our bodies and brains needed to grow and flourish. By contrast, most modern humans rely on a narrow, nutritionally impoverished and fibre-poor diet. This starves large parts of our microbiome and disrupts our health through typical "diseases of modernity" such as obesity and diabetes. The microbial diversity found in the guts of contemporary hunter and gatherer societies, such as the Hadza people in Tanzania or the Yanomami of South America, is roughly twice as high as the one found in the average European or American gut, independent of ethnicity. The good news is that in most cases, if we return to a diverse, fibre-rich diet before essential microbes are lost, some of the diversity of our gut's microbial population can be restored.

PRODUCTION SYSTEMS

Industrial production systems and its big brother, the industrial food system, dominate in the developed world for several reasons. For example, they make food cheaper, can enhance food security and free up labour for other sectors that can help countries grow their economies and raise living standards. However, they consolidate power in such a way as to deeply embed themselves into the biophysical, social and economic landscapes; they are "locked in". This has made them very resilient, which is particularly problematic when the way they work traps the poor, is harmful to human health and destructive to the environment.

Food production relies on soils as a key natural resource; nutritious food and animal fodder can only be produced if our soils are healthy. A healthy living soil is therefore a crucial ally to food security and nutrition. Numerous and diverse farming approaches promote some principles of sustainable soil management with the goal of improving productivity and protecting soils and the environment, for instance: agroecology, conservation agriculture, organic farming, minimum or zero tillage farming, and agroforestry.

Agroecology uses ecological theory to study and manage agricultural systems in order to make them both more productive and better at conserving natural resources. This whole systems approach to agriculture and food systems development is based on a wide variety of technologies, practices and innovations, including local and traditional knowledge as well as modern science. By understanding and working with the interactions between plants, animals, humans and the environment within agricultural systems, agroecology encompasses multiple dimensions of the food system, including ecological, economic and social.

Organic farming is agricultural production without the use of synthetic chemicals or genetically modified organisms, growth regulators, and livestock feed additives. It also emphasises a holistic farm management approach where rotations and animals play an integral role to the system.

Conservation agriculture practices have significantly improved soil conditions, reduced land degradation and boosted yields in many parts of the world by following three principles; minimal soil disturbance, permanent soil cover and crop rotations. To be sustainable in the long term, the loss of organic matter in any agricultural system must never exceed the rate of soil formation. In most agro-ecosystems, that is not possible if the soil is mechanically disturbed. One of the tenets, therefore, of conservation agriculture is limiting the use of mechanical soil disturbance, or tilling, in the farming process.

Zero tillage is one of a set of techniques used in conservation agriculture. Essentially, it maintains a permanent or semi-permanent organic soil cover, e.g. a growing crop or dead mulch, that protects the soil from sun, rain and wind, and allows soil microorganisms and fauna to take on the task of tilling and soil nutrient balancing, natural processes that are disturbed by mechanical tillage. The application of modern biotechnology in agriculture has resulted in facilitation of zero-tillage systems for some crops. However, environmental benefits are heavily dependent on thoughtful management practices as the use of herbicides on herbicide-tolerant varieties can compromise soil biodiversity.

Agroforestry systems include both traditional and modern land-use systems where trees are managed together with crops and / or animal production systems in agricultural settings. The combination of trees, crops and livestock mitigates environmental risk, creates a permanent soil cover against erosion, minimises damage from flooding and acts as water storage, benefitting crops and pastures.

SUSTAINABLE INTENSIFICATION

There has been, and continues to be, a lot of talk about "sustainable intensification". Talking is something we are very good at.

The goal of sustainable intensification is to increase food production from existing farmland while minimising pressure on the environment. It is a response to the challenges of increasing demand for food from a growing global population in a world where land, water, energy and other inputs are in short supply, overexploited and unsustainably used.

The desire for agriculture to produce more food without harming the environment, or even positive contributions to natural and social capital, has been reflected in recent calls for a wide range of different types of more sustainable agriculture, from a doubly green revolution to an evergreen one, agroecological intensification to green food systems, and many more. Most draw on earlier traditions and innovations such as permaculture, natural farming and the one-straw revolution, and biodynamic agriculture, but all centre on the proposition that agricultural and uncultivated systems should no longer be conceived of as separate from each other.

We define sustainable intensification (SI) as a process or system where yields are increased without adverse environmental impact and without the cultivation of more land. The concept is thus relatively open in that it does not articulate or privilege any particular vision of agricultural production. It emphasises ends rather than means, and does not predetermine technologies, species mix, or particular design components. Sustainable Intensification can be distinguished from former conceptions of agricultural intensification by its explicit emphasis on a wider set of drivers, priorities and goals, than solely productivity-enhancement. This open and inclusive approach is essential if we are to meet people where they are and avoid both excluding some and losing others along the way.

SYSTEMS APPROACH

"From an early age we are taught to break apart problems, to fragment the world. This apparently makes complex tasks and subjects more manageable, but we pay a hidden, enormous price. We can no longer see the consequences of our actions; we lose our intrinsic sense of connection to a larger whole." Peter Senge

The challenges we face are deeply interconnected (indivisible and not hierarchical), multidimensional and mutually reinforcing.

The current approach to solving these challenges, and the majority of investment in research and innovation, tends to focus on the symptomatic, neglecting the real needs (and opportunities), failing to address root issues, underlying causes, mal-design and / or mismanagement of problems. Current approaches also tend to over focus on measuring problems, a key strategy used for postponing action by those who benefit from the status quo. The proposed solutions then over focus on efficiency and substitution strategies, e.g. improved application of pesticides and finding less poisonous substitutes.

We get stuck in activities pathologically designed to postpone change, particularly measuring problems (monitoring our extinction), endless over collection of data often justified by a need for 'evidence-based [vs. responsible] approaches', hearings, committee meetings, report-writing, etc. with little to no follow through and usually only leading to more of the same.

Postponing pathologies or strategies must be recognised, exposed, contradicted and addressed. We need a new approach to solving complex, systemic, problems. We need access to all of the relevant data and we need to stop wasting millions (of dollars, pounds, reals, euros, rands, etc.) unnecessarily repeating studies in new locations, or in the same locations by different people, or those with mischievous intentions, often related to perceived threats to existing commercial advantage.

We need genuine trans-disciplinary, multi-competency and multi-experience teams, able to access disciplinary and specialised knowledge as needed. We also need to include competencies relating to holistic approaches to design, sustainability, well-being, meaningful and effective change processes.

These teams must come alongside those most affected by any changes as primary collaborators and facilitators, from beginning to end. This approach enables ownership, relevance, achievability, ongoing improvement and openness to unplanned / unintended benefits.

We need to be much better at recognising, valuing and involving the wisest and most experienced in our society, and not be so obsessed with 'cleverness'. Wisdom enables us to work with the 'known' and the 'unknown'. Cleverness limits us to working with the miniscule that is known. We must therefore be prepared to engage with the unknown.

SUSTAINABILITY

"To think that their present circumstances and their present societal arrangements might be sustained. That is an unsustainable thought for the majority of the world's people." Peter Marcuse

The problem for most of the world's poor and, indeed, the rest of us, is not that their conditions cannot be sustained but that they should not be (sustained). Programmes and policies can be sustainable and socially just, but they can also be sustainable and unjust. We therefore need to rethink what we mean by sustainability.

Sustainability is not a goal for most activities and programmes, but a constraint. It suggests the possibility of conflict-free consensus whereas, in fact, vital interests do conflict. It will take more than simply better knowledge and a clearer understanding to produce change.

Sustainability is both an honourable goal and a camouflaged trap (for the well-intentioned unwary). As a concept and a slogan, it has an honourable pedigree, at least in principle. In practice, severe conflicts of interest still beset efforts to establish specific standards. Few, these days, would contest that sustainability is something desirable in environmental terms. Sustainability is, therefore, at best, one criterion among others; not a goal. Whilst the lure of universal acceptance is a powerful attraction, sustainability is, in fact, a trap. Sustainability as a goal in itself, if we are to take the term's ordinary meaning, is the preservation of the status quo, and I've yet to meet anyone who thinks that maintaining it is a good idea.

SUSTAINABILITY REPORTING

What currently passes for "sustainability reports" typically amount to ESG (environmental, social and governance) reports on incremental progress in the right direction but fall short of assessing the degree and rate of progress needed to achieve sustainability. In other words, a reductionist interpretation of sustainability. 20 years into the development of the Global Reporting Initiative (GRI), 25 years after the first Rio Conference, and 45 years after Rachel Carson's Silent Spring, Earth Overshoot Day arrives earlier each year as testament to the increasingly unsustainable nature of our current system. It is also worth noting that there is no sustainable business in an unsustainable world.

REGENERATIVE SYSTEMS

A regenerative system cares for the planet and it cares for life in the awareness that this is the most effective way to create a thriving future for humanity. We are participants in a complex dynamic eco-psycho-social system that is subject to certain biophysical limits. The best way to learn how to participate appropriately is to pay more attention to systemic relationships and interactions, to aim to support the resilience and health of the whole system, to foster diversity and redundancies at multiple scales, and to facilitate positive emergence through paying attention to the quality of connections and information flows in the system.

REGENERATIVE DESIGN

The redesign of the food system from the ground up must create an underlying pattern of health, resilience and adaptability that maintains our planet in a condition where life as a whole can flourish. But this isn't the planet that we currently inhabit.

Regenerative design is a concept based on process-oriented systems theory. The word "regenerate" means "to create again." A regenerative system makes no waste, its' output is equal to or greater than its input, and part or all of this output goes toward creating further output. In other words, it uses as input what in other systems would become waste.

A regenerative approach uses biomimicry, or the study of ecological systems to find solutions to human problems, to model patterns for industry, agriculture, and human habitats. Just as in nature, organic and synthetic materials are not only metabolised (used) but also metamorphosed (changed) into another vital element of a closed system.

One element of biomimicry is the use of all species within a system. Much of environmental action today focuses on preservation by segregating wild areas from human habitation. A better system is conservation, recognising that humans are a part of the ecosystem and need to be incorporated into it.

This is closely related to permaculture, another model that relies on synergy or the idea of separate components forming a whole that is greater than the sum of its parts. It emphasises patterns and groupings that occur naturally. Food crops are not only sustainably grown, but part of the harvest can be used to support the next year's crop. A holistic farm model uses the outputs from one crop or animal to grow another; one crop need not necessarily be self-recreating, but the farm as a whole would require no additional input, nor would it generate any waste products. Permaculture relies on polyculture, or the use of

multiple crops instead of a single crop, in imitation of natural biodiversity. It is permanent, or continually renewing, agriculture. In addition, the crops themselves and the materials used to build the farm would already exist in the area and would therefore be ideally suited to the climate and environment.

REGENERATIVE AGRICULTURE

The concept and definition of regenerative agriculture is an evolving one but, in short, it is farming in a way that increases biodiversity, enriches soils, improves watersheds, and enhances the environment through the provision of a range of ecosystems services. It is drawn from decades of scientific and applied research around the world, as well as the practices and experiences of millions of farmers.

Regenerative farming systems outperform conventional ones in years of drought, build rather than deplete soil organic matter, use 45% less energy and are more efficient, produce 40% less greenhouse gases and are more profitable than conventional (systems). Olivier de Schutter said in 2011, *"Today's scientific evidence demonstrates that agro-ecological methods out-perform the use of chemical fertilisers in boosting food production where the hungry live, especially in unfavorable environments. Recent projects conducted in 20 African countries demonstrated a doubling of crop yields over a period of 3-10 years. We won't solve hunger and stop climate change with industrial farming on large plantations. The solution lies in supporting small-scale farmers' knowledge and experimentation, and in raising incomes of smallholders so as to contribute to rural development".*

SMALL FARMERS

More than 90% of the world's 570 million farms are managed by an individual or a family and rely primarily on family labour. They make up 98% of farm holdings, produce more than 80% of the world's food in value terms and manage up to 75% of its' farming land, confirming family farming's central importance in global food security today and for future generations. Of these, some 74% of all farms are in Asia (35% are in China, and 24% in India), 9% in Sub-Saharan Africa, 7% in Central Europe and Central Asia, 3% in Latin America and the Caribbean, 3% in Middle East and North Africa, and only 4% in the industrialised and affluent countries.

About 500 million farms are less than two hectares with c. 410 million, almost three-quarters of all farms worldwide, smaller than one hectare. We need to recognise the diversity and complexity of the challenges faced by small farmers, and that family farms are key to ending hunger and achieving inclusive and efficient agricultural and food systems.

MAKING GLOBAL GOALS MORE THAN JUST LOCAL BUSINESS

"If you are trying to transform a brutalised society into one where people can live in dignity and hope, you begin with the empowering of the most powerless. You build from the ground up." Adrienne Rich

The UN Global Compact's "Making Global Goals Local Business" campaign sets out an impressive roadmap for business and the SDGs, and has already achieved a tremendous amount since its launch in 2016; 9,500+ companies, 3,000+ non business stakeholders, 165 countries, 65+ million employees working in Global Compact companies. It's founding mission is more important than ever as the world faces a complicated web of multi-dimensional, interconnected, systemic challenges, including rising protectionism and inequality. But making globalisation more inclusive, human, and respectful will do little more for the 4 billion or so at the base of the pyramid unless we start at the base, and with them. Retrofitting a globalised, "corporate", multi stakeholder and, predominantly, Western world view is not the answer. Both governments and global companies have already discovered this as they hit a "glass floor" (the opposite of a glass ceiling) as they try and do everything from unlock the potential of the small farmer to sustainable development, and move from doing "less bad" to doing "real good". If black is the new white, then local is the new global.

MAKING THE GLOBAL GOALS PERSONAL

"Relationships aren't everything, they're the only thing." David Plummer

From "trickle down" economics to leading corporate, political or social change, development to sustainability, top down does not work. This is not to say that there haven't been beneficial outcomes, there have been many, but the potential of any system can only be realised by approaching it from the perspective of those on the ground, one relationship at a time.

THE RULES HAVE CHANGED

Entire markets can be disrupted overnight by numerous factors, be it a new technology or a sudden lack of natural resources. New markets are emerging rapidly due to megatrends such as population growth, resource scarcity and global health risks. The markets are melting pots of new risks and new opportunities, developing at an ever-increasing speed. Meanwhile, consumers and investors are better informed than ever before and they want businesses to take responsibility for the pressure our planet and its population are under. There is growing understanding, especially by business leaders and investors ahead of the curve, that it is not enough for companies to concern themselves only with short-term profits because natural disasters, social unrest or economic disparity damage long-term prosperity. We need look no further than the $4.8 trillion of assets under management by supporters of the Coller Foundations FAIRR initiative, or the $3.5+ trillion represented by faith groups who

collectively own 8% of the planet and feed billions of people every day through their programs, for examples of what good really looks like.

These changes profoundly affect the way we organise our societies, live our lives and run our businesses. The old models are outdated and the old rules no longer apply.

For companies to navigate the critical developments of the new millennium, it takes a keen sense of emerging trends, a grounding in ethics and values that consumers and other stakeholders are increasingly invested in, and sustainable operations from start to finish, and in every part of the value chain. The businesses that understand this challenge and take action will be a step ahead. But we must start at the bottom if we want to achieve our goals and deliver the Goals.

THE BASE OF THE PYRAMID

The book, "Next Generation Business Strategies for the Base of the Pyramid (BoP): New Approaches for Building Mutual Value", co-authored by Ted London and Stuart Hart, provides one of the best narratives for anyone seeking to navigate the world of the 4 billion plus people who comprise the world's poor. Critically, it moves on from the idea of "making a fortune from the base of the pyramid" to "creating a fortune with (the base of the pyramid)", and, somewhat prophetically, states that the next generation of entrepreneurs will develop distributed, small scale, small-footprint products and services that are more appropriate to the BoP context, and that these models may well point the way toward better models for the rest of us.

It advises of the need to think differently, and of how to meet the needs of a market that doesn't yet realise it has any (market creation). Most importantly it makes the case that the BoP can only be understood at the ground level, from the bottom up, and that in the one-to-one interactional marketplaces at the BoP, the boundaries between "human" and "economic" issues tend to get blurred, where long-term relationships tend to trump short-term ones, and "rich networks" make up for resource constraints. Opportunities must be concretised, localised and socialised.

CITIZENS VS. CONSUMERS

We live in an age, time and culture (s) where we think, as Descartes put it, that *"we are the masters and possessors of nature"*. But we are not. We cannot even master ourselves. Many of us need look no further than our waistlines, or the fact that over one third of the global population is overweight, for evidence of the same.

The Consumer Mindset is a way of thinking that says people are best understood as Consumers. The role of the individual is to consume (food) and the only action available to us is to choose between products and services.

The language of the "Consumer" is pervasive in our food system, which is understandable as the most basic interaction we all have with food is to consume it, but language matters. It carries unspoken values and norms within it which shape our behaviour as individuals, and which add up to mindsets that in turn shape entire human systems.

The work of the New Citizenship Project in the UK has explored the impact of consumer language and norms through a number of social psychology experiments. The results show that everything from our motivation to participate in our local community to our concern for others and the environment can be reduced by priming the Consumer Mindset. Even subconscious exposure to the word "consumer" can trigger this effect. To think of ourselves and each other as consumers is to tell ourselves a story of humanity as fundamentally selfish. This story is both partial and belittling. Academic fields from economics, for example in the Nobel Prize winning work of Elinor Ostrom, to animal behaviour, led by Frans de Waal, increasingly emphasise that we are, by nature, collaborative, empathic creatures who want to work together and help one another. When "consumer" becomes a mindset, it is deeply destructive and, when we use this language in our organisations, we reinforce these ideas, and this impact plays out through the systems we create around our lives, including the food system.

Now conscious of the consumer as a mindset, we can start to see many of the problems currently manifest in our food system as symptoms of this deeper cause, shaping the relationships in the system such that negative outcomes are inevitable.

It starts with the "Value-Action Gap", a term often used to describe the fact that greater numbers of people say they will, for example, purchase healthier or more ethical products than do so in practice, where drivers of price and convenience take over. This is generally taken as evidence that people are fundamentally selfish on the basis that our actual behaviour is a better reflection of our values than what we claim we will do.

Accepting the Value-Action Gap at face value has all sorts of consequences, leading to brand strategies like healthier or more sustainable choices such as Fairtrade and "Organic" being marketed as luxury to justify a price premium. This ultimately restricts these products to niche audiences and undermines their influence in creating widespread change. It creates intense price pressure on producers from brands who are simply referring "what the consumer wants" up the supply chain, and disconnection of the public from producers; food production becomes sanitised and idealised, as consumers are protected from any unpleasant realities they do not want to know about.

It justifies one-dimensional, short-term pressure from shareholders on businesses throughout the system as they prioritise price and convenience as "what the consumer wants", with Governments withdrawing their influence, seeing consumption behaviour as a better reflection of the public priorities they should be serving than any other considerations; following the consumer rather than leading for future society. Finally, it limits the strategies available for change with everyone from the

farm gate believing, or sometimes justifying, that they have to work within the bounds of narrow self-interest and that they are working against the guiding story of the system when they try to challenge the status quo or influence change.

This analysis does not identify any one organisation as culpable for the current situation, or, indeed, any one role in our food system. Instead, what is to blame is a mindset in which so many of us are complicit. A mindset that leaves us struggling for good outcomes against our apparently selfish natures, fighting more battles, and with no hope of winning the war.

The Citizen mindset is a way of thinking rooted in a belief that people are best understood as "Citizens". When given meaningful opportunities, we can and want to shape what the choices are and not just choose between them, seeking the best outcome for all and not just our own, narrow, self-interest. The great opportunity is that if we change our starting point and allow ourselves to see a bigger truth of human nature, we can change everything. This is because we draw on more of ourselves, tapping into the broader resources identified by scholars of human nature from de Waal and Ostrom to Ken Robinson and Yuval Noah Harari; our natural desire to learn, our inherent capacity to be creative, and the unique ability to collaborate and act collectively that have driven our success as a species to date.

Enabled by the dawning digital age, we can see this bigger story already finding expression in the wider world beyond the food system, across nations and in every sector from the bubbling of participatory democracy initiatives like Better Reykjavik in Iceland and Todos in Chile, which seek to harness citizens as ongoing participants in democracy rather than consumers who choose who to vote for once every few years, to the rise of business movements like B Corp, whose members see their organisations as purpose-focused corporate citizens, not just profit maximising consumers of their supply chains.

What might it look like to reimagine each of the key organisational roles in the system through the lens of a citizen mindset? Just as with the wider world, what becomes clear when we look from that conceptual shift out into the world is that there are early signals that this is already starting to happen. There are new ideas, initiatives and organisations forming that explicitly and implicitly challenge the consumer mindset. Once we name the "Citizen Mindset", we can see these not just as distinct and isolated from one another, but as coherent and growing waves of change.

SOCIAL EQUITY

Social equity issues, including gender, are major concerns in agriculture as they relate to poverty, hunger, nutrition, health, natural resource management and the environment, and which are affected by various factors resulting in greater or lesser degrees of equity. Because the majority of the world's poor and hungry live in rural settings and are directly dependent on agriculture for their livelihoods, political, economic, cultural and technological factors contribute to mitigating or reinforcing inequality.

Women and men have differing roles and responsibilities in productive households but gender-based patterns are context-specific. A persistent feature, however, is that women have a key role in agricultural activities yet have limited access to, and control of, productive resources such as land, labour, credit and capital. Agricultural development sometimes strengthens patterns that are unfavorable to women, such as male bias of the agricultural extension system in many countries, and these patterns and behaviours need to be addressed.

BIODIVERSITY

The biodiversity of smallholder systems who keep many rustic and climate-resilient varieties and breeds alive are critical to food security; 75% of the world's food is generated from only 12 plants and 5 animal species making the global food system highly vulnerable to shocks.

Diverse farming is the backbone of sustainable agricultural intensification, for example, agroforestry, home gardens, integrated crop-livestock systems, mosaic land uses, intercropping, cover crops, integrated pest management and crop rotations all typically benefit from using agricultural biodiversity. It is also a rich resource for year-round healthy and diverse diets by providing nutrient-rich species and varieties that are well adapted to local conditions. Increasing the number of food groups grown on farms is associated with greater diversity on the plate. Households that grow a diverse set of crops are less likely to be poor than households that specialise in their crop production. Additionally, crop diversity reduces the probability that a non-poor household will fall into poverty and the probability that a poor household will remain in poverty. While agricultural biodiversity is by no means the only component needed in a sustainable food system, a sustainable food system cannot exist without agricultural biodiversity.

LOCAL FOOD

Food sovereignty is the right of peoples to healthy and culturally appropriate food produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems. It puts the aspirations and needs of those who produce, distribute and consume food at the heart of food systems and policies rather than the demands of markets and corporations. It defends the interests and inclusion of the next generation. It offers a strategy to resist and dismantle the current corporate trade and food regime, providing direction for food, farming, pastoral and fisheries systems determined by local producers and users.

Food sovereignty prioritises local and national economies, and markets, and empowers peasant and family farmer-driven agriculture, artisanal fishing, pastoralist-led grazing, food production, distribution and consumption based on environmental, social and economic sustainability. Food sovereignty promotes transparent trade that guarantees just incomes to all peoples as well as the rights of consumers to control their food and nutrition. It ensures that the rights to use and manage lands, territories, waters, seeds, livestock and biodiversity are in the hands of those who produce food. Food sovereignty implies new social relations free of oppression and inequality between men and women, peoples, racial groups, social and economic classes, and generations.

DIET AND NUTRITION

Healthy, high-quality diets should include a diversity of foods that are safe and provide levels of energy appropriate to age, sex, disease status and physical activity as well as essential micronutrients. The World Health Organisation's (WHO) definition of a healthy diet emphasises the importance of starting healthy eating habits in early life and limiting the intake of free sugars and salt. It advises people to eat plenty of fruits and vegetables, wholegrains, fibre, nuts and seeds, while limiting free sugars, sugary snacks and beverages, processed meats and salt, and replacing saturated and industrial trans fats with unsaturated fats.

All parts of the food system must work together to deliver high-quality diets. This means thinking well beyond the farm gate to also consider the many processes and activities involved in food production, processing, storage, transportation, trade, transformation and retailing. This amounts to a change in mindset, and a fundamental shift in approach.

WASTE

Each year, an estimated one-third of all food produced for human consumption is lost or wasted world-wide. Food loss and waste (FLW) occurs throughout the supply chain, from primary production to final household consumption. It has direct and significant implications for food availability and nutrition, natural resources, and climate change.

In middle and high-income countries, food is wasted and lost mainly at later stages in the supply chain, with more than 40% of this waste occurring at retail and consumer levels. Food waste is recognised as being distinct to food loss because the drivers that generate it, and therefore the approaches to tackling it, are quite different.

In low-income countries, FLW occurs mainly at the early and middle stages of the food supply chain with lower levels of waste at consumer level. FLW can be traced back to financial, managerial and technical constraints in harvesting techniques as well as storage and cooling facilities, with an estimated 40% of losses occurring at post-harvest and processing levels. These translate into lost income for small farmers and higher prices for poor consumers. Strengthening the supply chain through investments in infrastructure, transportation and farmers' capacities, as well as in an expansion of the food and packaging industry could help to reduce losses. In addition, pests and diseases, lack of rainfall, and lack of appropriate harvesting techniques are also important causes of post-harvest losses at the farm level. Promoting improved and climate-smart farming practices is, therefore, also important in reducing food loss.

PRECISION AGRICULTURE

Precision agriculture (PA) is first and foremost a way of thinking, an approach, and a set of principles. Examples of farmers utilising farming practices that do exactly what machines do are widespread, with one of the best examples being those of farmers in Zimbabwe that follow a very simple yet precise process doing everything on time, to standard, without waste and with joy. With joy? The farmer and organisation that developed this model understands that not only does all change start with an individual, but that in order to really change we must first have a change of heart.

Technology led PA and its suite of information technologies, such as soil and yield mapping using a global positioning system (GPS), GPS tractor guidance systems, and variable-rate input application, allow farmers to fine tune their production practices. Access to detailed, in field, information can decrease input costs and increase yields.

How and whether farmers decide to adopt new technologies is complex, but most account for the full costs and benefits of the proposed investment as PA technologies often require a significant investment of capital and time and, historically, the scale rule has applied, i.e. the economics only work at scale.

TECHNOLOGY

In the context of increasing digitalisation of the economy, and of society as a whole, Information and Communication Technologies (ICTs) are crucial in assessing and managing natural resources, and in providing accurate and timely information / feedback.

Farmers in developed countries have been using ICTs in large scale farming for PA including soil analysis, irrigation, farming equipment, weather forecasting, and more. The fast pace of technological development, which allows for increasing data storage and analytics, and progressively lower costs, has helped support these farming advances.

While the main incentive to adopt PA methods is to maximise profitability, it can also reduce the environmental impacts of farming practices. The approach is mainly used by large arable farms in Central and Northern Europe, the USA, Canada and

Australia, but it is growing, both geographically and in the scale of farmer that is using it. A successful example of the application of this method is the use of Controlled Traffic Farming, which reduces crop damage and soil compaction as it confines field vehicles to the minimal area of permanent traffic lanes with the aid of GNSS technology and decision support systems, with farmers in Australia and the UK reducing machinery and input costs, and increasing crop yields.

In many developing countries, however, the digital divide is nowhere more evident than in agriculture. This is not only due to the extent to which digital technologies have penetrated rural areas across the developed economies and the developing world, but also due to different farm structures. Open access resources, particularly mobile phone applications, are vital in the provision of information and knowledge.

Technologies such as Digital Soil Mapping (DSM) and soil sensors allow for innovative bottom-up approaches to characterise soils. Such technology can be utilised to support efficient and precise decision making on the farm and is key to advancing soil research and providing location specific advice by extension services to adopt best practices. ICTs can also provide digital platforms for cooperation and collaboration between scientists and other stakeholders that would improve agricultural practices and soil conservation, and the design and implementation of environmental policies can utilise these technologies to monitor soil erosion, SOC, nutrient balances and other agri-environmental performance indicators with better targeted policy and legislation on environmental practices in different locations.

ACCESS TO KNOWLEDGE, SKILLS AND TECHNOLOGY

Food systems knowledge, skills and technology play a key role in shaping the quality and quantity of natural, human and other resources, as well as access to them. They are also crucial in supporting the efforts of actors at every level to reduce poverty and hunger, as well as improve rural livelihoods and the environment in order to ensure equitable and environmentally, socially and economically sustainable development.

KNOWLEDGE

"Knowledge, not capital, is the key to sustained economic growth and improvements in human well-being." The World Bank

The choices that families and farmers have regarding the food that they consume and the crops they produce and sell at markets have a direct bearing on economic and nutritional outcomes. Good nutrition contributes to cognitive development, better opportunities for children to realise their potential, and higher earnings later in life, which in turn support macroeconomic and societal growth. Poor nutrition, on the other hand, impairs productivity, and acts as an impediment to personal and national growth.

Enhancing knowledge and skills has never been so vital for the creation of inclusive and sustainable societies as in today's globalised, knowledge-oriented world. It is a key to eradicating poverty, promoting equitable economic and social development, human rights, creating global citizens, combating inequality and sustaining our environment.

Knowledge can be divided into two parts; knowledge about technology, called technical knowledge or simply know-how, and knowledge about attributes, that is, knowledge about products, processes, or institutions. The unequal distribution of know-how (knowledge gaps) across and within countries, and the difficulties posed by having incomplete knowledge of attributes (information problems) are major contributory factors to the redesign of the food system. There are steps we must take to narrow knowledge gaps; acquiring knowledge, absorbing knowledge, and communicating knowledge. But we must also listen.

We also need to focus on the young, and how young people see their learning and lives, a perspective often overlooked in rethinking and enhancing knowledge exchange and learning. In particular we need to immerse ourselves in the realities experienced by young people in rural areas where schooling and other forms of learning, agriculture and rural livelihoods, social identities, social change and rural transformation, are all closely connected.

We must acknowledge that young people, rural or otherwise, and like the rest of the world, are not homogeneous. There is no "one size fits all". Young people arrange their learning, livelihoods and social practices according to their needs, lifestyles, traditions and evolving environments. Future farmers learn from their parents and role models. Even with limited literacy skills, young people find ways to benefit from mobile phones to obtain information that they need. When it comes to knowledge and skills for agriculture and rural livelihoods, for many of these young people, schooling plays a relatively minor role. Rather it is valued as a means to pave the way for employment in the formal sector, and to develop their social status and image.

In this era of stark disparities, it is essential to increase access to relevant knowledge and skills, through formal, non-formal and informal learning.

SKILLS (AND JOBS)

In addition to the above, the availability of educated, skilled and experienced people is a major challenge for economies worldwide, and even more so for the developing world. This trend also impacts agricultural producers, processors, service providers and governments alike. Analysts have called this shortage in skilled labour, "the talent blackout". The Public and Private sectors must join efforts and invest in general and specific education urgently.

Countries like the UK, New Zealand, the US and Canada have openly stated their leadership ambitions in food acknowledging that the key to making this happen is to secure the appropriate skills and capability, and to attract the right talent and expertise into the industry.

African agriculture is also facing an existential crisis with a rapidly aging population of farmers. Unless something is done, and done urgently, Africa will have no farmers left within 20 years.

Africa's youth is facing the same crisis. There are 200 million young people in Africa (400 million by 2045) of whom 70% live in rural areas. They represent 40% of the working population yet 60% of them are unemployed. In fact, less than 20% of African youth are in wage-paying work.

Africa is nearing the end of the African Union's (AU) "Youth Decade Plan of Action" (2009-2018) yet it is not creating enough opportunities for the 10-12 million young people that enter the world of work every year. The World Economic Forums' Global Risks report, 2016, identified disenfranchised youth as a threat to political stability stating, *"Properly managing the demographic youth bulge in Africa will be critical for security outcomes, implying major investments in skills building and job creation".*

INNOVATION

"Innovation is a bottoms-up, decentralised, and unpredictable thing, but that doesn't mean it cannot be managed." Eric Ries

Innovation is a major driver of both productivity growth and sustainability. Examples include the adoption of input-saving technology and production practices, such as low-tillage, modern buildings allowing energy savings, machinery for precision agriculture, better management of risks, and changes in marketing practices. ICTs contribute to reducing input use, for example labour, energy, fertiliser and pesticides through precision agriculture, and thus improve productivity and sustainability performances. ICTs also facilitate sharing of information, participation and traceability along the global value chains and, increasingly, connect small farmers to markets, reducing transaction costs, and raising food system efficiencies, sustainability and inclusion.

Advances in exponential technologies are enabling better, faster and cheaper decision-making by large and small-scale farmers around the world

Companies are providing farmers with in-field sensors to collect information on things like soil nutrition and acidity, air quality, crop maturity, and weather (including humidity and temperature). These sensors are becoming more precise, cheaper and easily accessible, even for farmers in developing countries who can power them with inexpensive solar panels.

The data generated by these field sensors is then processed by control centres, who often also use satellite images and / or drones to collect a well-rounded overview of all the factors that will lead to a successful crop, and then provide real-time updates back to farmers.

Due to imperfect mobile phone and Wifi coverage in rural areas, it can be difficult and costly to get the data back to the farmers. That's why companies are experimenting with using "white space", UHF and VHF radio frequencies that are normally used to broadcast television shows. This space is typically unlicensed in developing countries so can be easily picked up as additional bandwidth for mobile phone plans. Farmers are setting up data transmission sheds on their farms using TV aerials to receive signals through a transceiver.

As more farm information is collected, the overall data pool grows, and, as farmers analyse this data and use platforms to share information with each other, the overall knowledge pool grows. By integrating sophisticated algorithms which can then leverage machine learning and AI technologies, more and more people can make better decisions more quickly.

Companies are also employing AI to help analyse the data they gather, and using data to provide a type of "concierge service" for farmers, matching farmers with the right service providers that can help to boost their production and sustainability.

It's not all digital data. Peer platforms that enable farmers to "talk" to other farmers and / or experts can make decision making just as real time, contextual and personalised. Interesting crowd-sourcing solutions are also taking shape where farmers can take a picture of a crop with their phone and upload it to a database where an expert can assess the maturity of the crop based on its coloring and other properties. Farmers can provide their own reading on temperature and humidity and this would be a substitute for sensor data if none was available.

More generally, new technology is already shaping how agricultural value chains are organised, offering the potential to accelerate innovation and new opportunities for income gains, entrepreneurship, and higher skilled jobs in the food system. Emerging technologies driven by the Fourth Industrial Revolution include big data and artificial intelligence, new physical systems such as automation, robotics, and additive manufacturing, and advances in science such as new energy technologies and next generation biotechnologies and genomics, all offering significant opportunities for the food system. Solar power is providing new job opportunities for agro-processing in off-grid areas. Remote sensing technologies are being used to offer mechanised and extension services in some African countries. Digital finance is increasing financial inclusion in many regions

and facilitating micro-entrepreneurship. E-commerce platforms are linking small entrepreneurs in rural areas with national and global markets.

Improving cross country supply of innovations and cross border technology transfer is crucial to increase productivity growth and address transboundary issues such as contagious diseases, climate change mitigation and adaptation, and the sustainability of water resources.

Unexpected new minds are entering this domain and delivering breakthrough ideas

Precision agriculture has opened the floodgates, bringing surprising and innovative new minds to help solve the challenges of farming. Talent from various disciplines outside of the traditional agricultural domain are applying their knowledge to the field, from coders and analysts to data scientists, software developers, hardware engineers and entrepreneurs.

Even space exploration companies are now setting their sights closer to home by using their satellites to provide specific data on how to optimise crop yields, for example, the Ceres constellation provides weekly hyperspectral and midwave infrared data for any spot on Earth. This means we can access new levels of actionable, crop-specific, intelligence that will maximise yields and reduce input costs.

Then there's computer technology bigwigs who are entering agriculture with innovations that could potentially change the 'how' of farming, for example, autopilot programs for drones that choose the most efficient flight route and reduce the time it would take a drone to cover an entire farm by 25%, and "hyper-local" weather forecasts that predict weather conditions at much more accurate and specific time increments and locations than traditional weather systems, helping farmers save water and increase production.

Precision agriculture is enabling surprisingly low-tech solutions

Precision ag isn't just for high-tech farmers in developed markets. Farmers in developing countries are also able to take advantage of this approach. To collect and make use of data and information, all you really need is a mobile phone. And not even a smartphone. Talk and text is enough with companies disseminating climate information via text message, connecting farmers with other members of the agriculture ecosystem like financial services, NGOs and veterinarians, and daily updates on other useful areas such as crop nutrition and general market updates. These digital extension programs can also include WhatsApp chat groups, videos, audios, and other apps.

Productivity and sustainability outcomes also depend on other important drivers, for example innovation and structural change. Productivity can be improved through economies of scale and the adoption of more efficient existent technologies and practices but long-term productivity growth depends on a continuous process of technical progress and social and business innovations. Innovation needs to (increasingly) move from a linear (lab-to-field) approach to a demand driven network connecting farmers, industry, consumers and research.

DIGITAL

Digital technologies are no silver bullet, for agriculture, farming and food nor, indeed, anyone else. When they are connected, and when they connect, however, they can drive profound economic, environmental and social transformation.

The velocity and intensity of change in the sector is unprecedented. New players, business and funding models, societal expectations, demographic shifts, globalisation and technology are rapidly changing the face of the sector.

In time, every economy will be a digital economy with the combined value of digital transformation to industry and society estimated to be $100 trillion over the next decade. Today, there is an opportunity to move beyond digital point solutions to an interwoven market of digital solutions and economies. This can accelerate impact, development and growth beyond the initial intervention because digital is about more than the innovation of solutions themselves. It is about how they reimagine the way people live and work.

Emerging technologies driven by the Fourth Industrial Revolution are disrupting many industries, bringing rapid and large-scale change. These include:

- Digital building blocks such as big data, the Internet of Things (IoT), artificial intelligence, deep learning, machine learning and blockchain;
- New physical systems such as autonomous vehicles, advanced robotics, additive manufacturing, advanced materials and nanotechnologies; and
- Advances in science such as next-generation biotechnologies and genomics, and new energy technologies.

Agriculture, farming and food has been slow to harness the power of these technologies, attracting significantly lower levels of investment and inspiring fewer technology start-ups than other sectors. For example, research by Accenture revealed that $14 billion had been invested in 1,000 food systems-focused start-ups since 2010, while healthcare attracted $145 billion in investment in 18,000 start-ups during the same period. This has to change.

BLOCKCHAIN

Blockchain technology is basically a decentralised record-keeping system. Blockchain's main virtues are security and instant verification, as is the idea of decentralisation that shifts the "power" from entities like governments, banks and companies, and democratising trust.

Blockchain (technology) uses networks of computers, all working together, to keep and verify all sorts of records. Each computer stores a "block," basically a chunk of time-stamped data, which is linked to the next computer, where another block is stored. This forms a chain. Each of those blocks are cryptographically locked, which means that the only people who can access it are the original data owners and anyone those owners allow to have access.

Another benefit of the blockchain is that it's updated in real-time. In a traditional transaction, there's usually a linear order to the process; you complete a form, the other party in your transaction completes a form, and then you both mail or otherwise send those forms to a third party like a bank or a lawyer to verify the information, but in a blockchain transaction that third party isn't necessary because the blockchain itself, securely locked and impartial, can do the verifications on its own. And it can do this in real time so both sides of the transaction are completed at the same time.

Blockchain technology has huge potential to decentralise and democratise trust in supply chains and bring measurable benefits and value to the food system.

OPPORTUNITIES FOR DISRUPTION IN FOOD SYSTEMS

In 2017, the World Economic Forum developed a set of scenarios (mentioned earlier). Technological innovation is one of the elements that will help to shape global food systems.

The potential impacts of such disruptive technologies are wide ranging. Fourth Industrial Revolution technologies have the potential to help revolutionise food systems, dramatically changing the shape of demand, improving value-chain linkages and creating more effective production systems. At the same time, however, they are likely to introduce new challenges. They raise concerns pertaining to health and safety, the environment, privacy and ethics. They can create unintended consequences, which must be considered and explored in advance. In addition, their positive effects may be unevenly distributed, potentially deepening the divide between rich and poor. Harnessing the positive impacts of technology innovation and avoiding potential downfalls will require deliberate, intentional and coordinated efforts by investors, innovators and policy-makers.

DATA; BIG, SMALL AND OPEN

Open Data

People around the world use data to make everyday decisions every day. For example, when heading out of town, most of us check the forecast before packing our bags. If the forecast calls for rain, we pack an umbrella and a raincoat. If it is going to be cold, perhaps we pack gloves and a hat. How much data does a service like weather forecasting require? The US National Centers for Environmental Information (NCEI) is an open government data source that has enabled global weather forecasting providing public access to one of the most significant archives of environmental data on Planet. The NCEI provides over 25 petabytes of comprehensive global atmospheric, coastal, oceanic and geophysical data.

We haven't always had the luxury of detailed weather forecasting at the tip of our fingers. Only in the last 10-15 years has technology enabled us to consume the information produced from this vast data source through smart phone weather applications and yet today, when we travel, we often find ourselves packing food in our suitcase because we don't know what may be available when we arrive. A farmer may not know the best market to sell her products at or the best price to sell them for. A parent may not have access to nutritious food for their child or have the tools or knowledge to make better choices in selecting nutritious food within what is available.

We have a global, comprehensive, open data set that enables weather forecasting, but we do not have a global, comprehensive data ecosystem that spans the global farm to fork spectrum.

If we are going to unlock the potential of the food system to solve any problem, let alone the world's most intractable ones, then we need open data policies to enable decision making based on facts and evidence. Taking a global perspective will both help identify existing data, and gaps in that data, and sharpen the focus on how open data can foster innovation and collaboration.

We need more organisations like the Global Open Data for Agriculture and Nutrition (GODAN) initiative, who focus on opening agriculture and nutrition data as a mechanism to support sustainable development and solve long-standing global food security challenges, and the Global Partnership for Sustainable Development Data, who are bringing together governments, the private sector, and civil society organisations dedicated to using the data revolution to achieve the Sustainable Development Goals.

Over 800 million people go to bed hungry every night. If the situation does not improve and population grows as predicted, the number of people that go hungry every night will dramatically increase. By making data open and building capacity for open data

use by all stakeholders, we stimulate economic growth and support farmers, scientists, companies, entrepreneurs and consumers working to address critical challenges such as food security, public health, climate change and the environment.

If we can forecast the weather around the world utilising today's available data and technologies, we have the capabilities and capacities we need to solve global food insecurity, and everything else.

Big Data

The Big Data band wagon has rolled on and, much like a high stakes poker game, has seen companies and government's doubling down on the path to "deep insights" and "actionable intelligence".

Data production rates through new sources of data, such as the geometric growth of device adoption and now commonly aggregated as the "Internet of Things", and the opening up of vast data sets by companies and governments, have led to an explosion of information. We have to deal with vast amounts of data in the world in which we live. But how?

The three V's of Big Data - volume, velocity and variability - is a definition that was coined by a data analyst in 2002. The amount of data, rate of data and variety of data are all increasing exponentially. Two further V's have subsequently been added; veracity, the accuracy of data, and value; the only one that really matters.

Value

Data of any type - big, small or open - is only relevant to the extent to which it enables us to unlock or create value and, so often, that value lies in that which cannot scale, which is unique to here, value that is embodied, shared, trusted and alive.

What Data Misses

Data, in particular Big Data, all too often misses the analogue, the disconnected, the local, the small, the individual and the deeply personal. It also misses the out of sight and out of mind knowledge, for example the negative externalities of activities such as mining for rare earth metals (that we need for our devices).

The OECD has estimated that up to 80% of people work in the informal economy. How do we measure informal situations, and the informal economy? What about social knowledge, i.e. life that isn't recorded, embodied knowledge, intelligence, ecological knowledge, and hormonal knowledge?

So How Much Data Do We Need?

The answer is very simple; enough. If we get value by using small amounts of data, then great. If we need to analyse mountains of data, that's ok too. Either way we have to start with the value that we are trying to unlock, or a problem we are trying to solve.

The same is broadly true for types of analysis, which can be broken down into descriptive, predictive and prescriptive analytics. We only need to go far enough to solve the problem and / or get at the value we believe is there. Just think of the tremendous insight an individual derives from seeing a simple descriptive snapshot of themselves; counts, averages and other aggregates. Now apply that to a farm, a community, a company, even a country; not complicated, but incredibly valuable.

COUNTING EVERYTHING THAT SHOULD BE COUNTED

"Sustainability requires contextualisation within thresholds. That's what sustainability is all about. But to this day in the reporting world, Sustainability Context is incipient, uneven, and occasional. We don't have decades to get serious about Context in light of the ecological and social perils that lie ahead. I think the time for procrastination has passed and the time for aggressive movement is upon us." Allen White, co-founder of GRI

There should be no doubt that cheap food costs dear. The case has been well made by many organisations, like the Sustainable Food Trust, Food Tank, TEEB (the Economics of Ecosystems and Biodiversity), True Cost Accounting and McKinsey, but who's counting, what are we counting and are we counting everything?

"Agriculture is, arguably, the highest policy priority on today's global political agenda, in recognition of its widespread impacts on food security, employment, climate change, human health, and severe environmental degradation." This is not a new statement but one that has been made repeatedly. Are we ready to count everything that should be counted so that we can measure and value everything that is valuable?

The escalating crisis in our food system that is trapping the poor, damaging the environment, degrading natural resources and contributing to soaring levels of diet-related ill health must be the number one priority for all of us. It is, after all, our world.

One of the challenges we all face is the distorted economic system which takes account of the direct costs of production, such as land, feed, seeds, labour and farming equipment, but fails to include the many externalised costs including the social, cultural, nutritional and, environmental impacts. This system results in a situation where food produced intensively appears to be cheaper to consumers and more profitable to producers than food produced that is sensitive to, and positively impacts across, all five dimensions of "profit"; the four already mentioned and the economic.

The external costs of this system are ultimately paid for by us, the consumers or, should I say, the citizens, either individually or as part of society, even though we rarely realise this. A number of organisations have developed reporting standards that seek to capture the true cost of a particular system or activity, from organisations like True Cost Accounting and B Corporation, to GIIN's IRIS and the GRI (Global Reporting Initiative). They are all doing important work but none has gone far enough. We have to count everything that can be counted so that we can measure and value everything that is valuable.

One of the critical issues is the "context gap". The term "context gap" was first coined in reporting circles by Reporting 3.0 and is so named after the overwhelming lack of adherence to the Sustainability Context Principle, which was first introduced in GRI's second generation of reporting guidelines published in 2002. It states that, "Many aspects of sustainability reporting draw significant meaning from the larger context of how performance at the organisational level affects economic, environmental and social capital formation and depletion at a local, regional or global level. In such cases, simply reporting on the trend in individual performance (or the efficiency of the organisation) leaves open the question of an organisation's contribution to the total amount of these different types of capital… Placing performance information in the broader biophysical, social, and economic context lies at the heart of sustainability reporting… This will involve discussing the performance of the organisation in the context of the limits and demands placed on economic, environmental, or social resources at a macro-level".

Companies are increasingly being encouraged to frame their sustainability activities and communication around ecological limits, as captured by concepts such as planetary boundaries, climate tipping points or regenerative capacity, but a systematic review of 40,000 corporate responsibility reports published between 2000 and 2014 showed that fewer than 5% referred to ecological limits in any one year, and that only 31 companies planned to align performance or products to limits. Thirty-one!! This is quite a gap.

We need to close this gap by making what Reporting 3.0 calls the "micro-macro link" between company impacts and the health of the ecological and societal systems they operate within.

FROM INTEGRATED TO INTEGRAL THINKING

Integrated thinking, a concept advanced by the International Integrated Reporting Council (IIRC), advocates for assessing interlinkages between the multiple capitals, e.g. financial, natural, social, human, etc. and cross-pollination between business disciplines (first and foremost, financial disclosure and sustainability reporting). This is a good start but it is not enough as it falls short of truly integral thinking, i.e. thinking that takes a holistic approach.

Integral thinking calls for closing the micro-macro gap by assessing activity (micro-level) impacts in the context of the carrying capacities of the capitals (at the macro-level), which in turn triggers the economic system design transformation necessary for bona fide sustainability to emerge. In other words, an integral approach not only includes value creation, as advocated by IIRC, but it also transcends this by integrating both shared value, which builds social capital in the service of growing financial capital, and what the Future Fit Business Benchmark calls "system value", which enhances all capitals.

BEWARE OF THE PRECAUTIONARY PRINCIPLE

One proposal for guiding action in the face of dynamic complexity and "not knowing" is to apply the Precautionary Principle as a framework that aims to avoid, as far as possible, actions that will negatively impact on environmental and human health in the future. From the United Nation's "World Charter for Nature" in 1982, to the Montreal Protocol on Health in 1987, to the Rio Declaration in 1992, the Kyoto Protocol, and Rio+20 in 2012, we have committed to applying the Precautionary Principle over and over again.

The Principle puts the burden of proof that a certain action is not harmful on those proposing and taking the action, yet general practice continues to allow all actions that have not been proven to have potentially harmful effects to go ahead unscrutinised. In a nutshell, the Precautionary Principle can be summarised as, "practice precaution in the face of uncertainty".

While high-level UN groups and many national governments have repeatedly considered the Precautionary Principle as a prudent way to guide actions, day-to-day practice shows that it is very hard to implement, as there will always be some degree of uncertainty. The Precautionary Principle can also hinder innovation and discovery, and block highly beneficial new technologies on the basis that it cannot be proven with certainty that these technologies will not result in unexpected future side-effects that could be detrimental to human or environmental health.

We should evaluate proposed actions on their positive, life-sustaining, restorative and regenerative potential, and limit the scale of implementation of any innovation to local and regional levels until proof of its positive impact is unequivocally demonstrated. A "from the ground up" approach enables precisely this.

ROLE OF GOVERNMENTS

Governments can stimulate and enable private actors to undertake more effective actions. In many countries, a large number of laws, financial, trade agreements and other regulations exist that are "implicitly" influencing food systems and the use of natural resources. Aligning these policies in such a way that they contribute to more sustainable food systems is thus an

important mission for authorities at various levels of government. Governments could implement a wide range of policies including, but not limited to:

- Elimination of subsidies, or tax arrangements, that encourage unsustainable production or practices;
- Creation of adequate legal frameworks to secure property rights and land tenure and regulate access to and use of water, biodiversity and ecosystems services;
- Creation of adequate legal frameworks to regulate environmental impacts from food systems, for example to prevent nutrient losses at all stages, especially in the livestock sector;
- Investment in technology and research development for locally suitable seeds and breeds (with proper infrastructure, distribution system, quality assurance and certification schemes);
- Attraction of investment in rural infrastructure, small enterprise development, e.g. inputs, local storage and processing facilities, logistic and transport;
- Facilitation of links between different food system actors, e.g. cooperation agreements among retailers to establish marketing codes of conduct;
- Use of cities as innovation incubators where ideas on sustainable food systems are tested (urban farming, education campaigns, sustainable sourcing, food environment regulations, etc.);
- Adoption of consumption-oriented policies to stimulate healthy and sustainable eating patterns, for example the creation of a healthy food environment;
- Comprehensive monitoring of the status of the natural resources needed in food systems, as well as of environmental impacts; and
- Development of education programmes on the links between natural resources, consumption patterns, and health.

INCLUSIVE, OPEN AND BOTTOM UP

We are trapped in dominant paradigms and tinkering with the flawed and failing won't change anything. We must include everyone, especially the different and the difficult, and not just the usual, so called, experts.

The majority of change, and development, is done to people or for them, and fails. The redesign of the food system must be done with and by the very people it most affects, incorporating fresh ideas and local knowledge.

We must start with values and beliefs, worldviews and new paradigms; *"if we always do what we've always done, we will always get what we've always got"*.

The design must be holistic, pluralistic, contextual and subjective, reflecting not just the whole but that the whole exists in context; a context rich in history, culture, experience and wisdom.

The design must extend our philosophy beyond yield to the most profitable use of our land; nutritionally, economically, environmentally, socially and culturally. We must design and maintain whole systems that are problem-proof and enable wellbeing for all. The design must be adaptable to the local environment and culturally relevant, utilising farmer knowledge and local resources, serving local markets and building the local economy first.

We must regenerate and restore soil health and biodiversity with complex cropping systems and with non-crop biota considered, and support ecological processes, ecosystem services and closed cycles. And we must use 'natural' ecosystems as models, emphasising integration, resilience and sustainability.

Finally, we must explicitly consider human and social ecology, especially psychology, personal and cultural change.

DESIGN PROCESS

The process must support the:

- **Personal**: spontaneity, curiosity and engagement, empowerment, awareness, respect of the unknown, creative visioning, values and worldviews clarification, acquisition of essential literacies and competencies, building and maintaining vitality, health and wellbeing, caring, loving, responsible, negentropic relationships, lifelong personal development and responsibility;
- **Socio political and cultural**: building and maintaining trust, access, collaborative, life-affirming community structures and processes, reflexive, critical, imaginative, celebratory attitudes, cultural diversity and respectful, mutualistic relationships, cultural development and psychosocial co-evolution;
- **Environmental**: enabling life-supporting ecological processes, conserving habitats and functional high biodiversity, ecosystem development and co-evolutionary change; and

- **General**: proactive, whole system design / redesign for wellbeing, small / doable actions, meaningful, collaborative initiatives, windows of change and use of integrator-indicators, attentive to all outcomes and feedback.

Homogeneity and heterogeneity, the uniformity of a substance or circumstance, must also be looked for.

EFFICIENCY, SUBSTITUTION AND REDESIGN

In the 1980s, Stuart Hill of the radical Hawkesbury College in Sydney, then of McGill University, developed a new concept of change in agricultural systems, and one that helps plot steps towards new and more effective systems, as well as setting a scale for ambition. Hill observed, *"there is something seriously wrong with a society that requires one to argue for sustainability",* and suggested there were three critical stages:

1. Efficiency;
2. Substitution; and
3. Redesign.

This ESR progression framework is helpful in understanding what we have achieved on a path towards sustainability in agricultural and food systems, and how the focus should now be on systemic redesign. Hill also distinguishes between deep (eco-design and redesign based) and shallow (substitution-based systems).

The first step, "Efficiency", focuses on making best use of resources within existing system configurations. Why waste costly inputs or resources? These can be argued to be brilliant basics, and they should be done by all diligent farmers, but they don't result in system change.

The second step is "Substitution". This step focuses on the use of new technologies and practices to replace existing ones that may be less effective on both productivity and sustainability grounds. Substitution implies an increasing intensification of resources, making better use of existing resources, e.g. land, water, biodiversity, etc. and technologies. Substitution approaches can also result in compellingly different outcomes but they, too, don't result in system change.

The third step, "Redesign", centres on the design of agro-ecosystems to deliver the optimum amount of ecosystem services to aid food, feed, fibre, fuel and f (ph) arma production whilst ensuring that agricultural production processes improve natural capital. Redesign harnesses agroecological processes such as nutrient cycling, biological nitrogen fixation, allelopathy, predation and parasitism. The aim is to minimise the impacts of agroecosystem management on externalities such as greenhouse gas emissions, clean water, carbon sequestration, biodiversity, and dispersal of pests, pathogens and weeds. Redesign is, fundamentally, a social challenge as there is a need to make productive use of human capital in the form of knowledge and capacity to adapt and innovate, and social capital to resolve common landscape-scale or system-wide problems such as water, pest or soil management.

Redesign is the game changer, setting agriculture on a journey that never ends but with a clear sense of multiple targets and wide social benefits. Hill does, however, note a paradox, indicating why it has been so hard to achieve deep redesign. The more effective any efficiency and substitution initiatives are, the more likely they are to protect and perpetuate the design characteristics of the system that is the root cause of the problem (s).

EXITING THE AGE OF INCREMENTALISM AND PREDATORY DELAY

Brendan Leblanc, a partner at EY and who also serves as EY's representative on the International Integrated Reporting Council (IIRC) Working Group, Sustainability Accounting Standards Board (SASB) Advisory Board, Global Reporting Initiative (GRI) - North America Organizational Stakeholder Group, and is a World Business Council for Sustainable Development (WBCSD) Liaison Delegate calls our current state, with its gaping Context Gap, the "Age of Incrementalism", a period when we continue to tweak business-as-usual while the evidence is abundantly clear that transformative change is necessary.

We are also suffering from what one writer calls "predatory delay", which applies not only to denialists but also to incrementalists. There once was a time when steady incremental actions could have staved off planetary catastrophe, but that time has passed. This hasn't been the been the case since at least the mid-1990s and, as the years have passed, this vision of slow climate action without large scale transformation has gone from unworkable to an outright and dangerous delusion.

CONCLUSION

Today really is the most critical moment in the history and psychosocial development of our species. We stand at a threshold and a moment of profound choice. What choice will you make?

INVITATION

As mentioned in the Preface, this Paper is an invitation to a conversation and into a relationship, with those who have not just kept going but who have seen beyond what can be seen to all that there is to see, who have dreamt with open eyes to make their dreams become possible, and for whom the impossible has already become the inevitable.

NEXT STEPS

Every relationship starts with a conversation. If you'd like to start one then we'd love to talk to you. Please call David Plummer on +44 (0) 7770 866235, or email him at david.plummer@triage.ag.

ABOUT TRIAGE

We believe in the potential of the food system to solve the world's most intractable problems, from hunger and poverty to the economy and the environment. Our work focuses on unlocking this potential.

We work throughout the food system with individuals, farmers, producers, agri food companies, development organisations, governments and investors.

We help our clients build the capacity and capabilities they need to grow, and to drive growth, development and impact through everything they do. This means we do everything from recruitment to projects, strategic advisory to innovation and growth consulting.

Over the past three years, we've worked with everyone from farmers in Africa and Latin America, to data companies in Silicon Valley and Silicon Fen, development agencies and agri food businesses in Sub Saharan Africa to investors working everywhere.

We know that things happen, or don't, because of the people involved. We also know that what you do, why you do it, how you do it and who you do it for are all both deeply personal and highly contextual. Finally, we know that the best context for anything is a relationship that is built on trust. This is why we say, *"Relationships aren't everything, they're the only thing"*.

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