HOLISTIC SOLUTIONS FOR FOOD SYSTEMS

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'For the last 60 years our global food systems have been focused on yields and productivity – but globally we have not solved food security and at the same time we have created widespread ecological crises. We need a renewed focus on holistic solutions and metrics, which account for the multitude of benefits that crops and livestock provide in the long term. This holistic approach may require a different mind-set, skills, methodology and produce fewer black and white results than we are used to, but they are necessary if we are to truly value ecological, human, and animal well-being.'

A straight-forward solution to any challenge is appealing. Our food systems and the complex ecosystems on which they depend however are anything but simple. In this article, I will consider the necessity of taking holistic approaches to implementing solutions to global challenges such as climate change, biodiversity loss, rising food insecurity and zoonotic pandemics, and the importance of holistic metrics to monitor progress and limit unintended or unconsidered consequences.

Food security – the problem with a singular focus on yield

The Green Revolution is used to describe the large-scale transfer and adoption of new technologies in the agricultural sector in the 1950's and 60's, particularly in developing countries. These technologies included chemical inputs (such as fertilisers and pesticides), irrigation technologies, farm mechanisation (such as tractors), and high-yielding rice, wheat, and maize seed varieties, which required fertilisers and pesticides to produce their high yields.

The focus of the research, innovations and policies of the Green Revolution was to address the problem of impending famine from a growing imbalance between population and food supply. Productivity was key and yield (amount of product harvested per unit of land) the predominant metric of success.

Since 1961, the average cereal yield has increased by 200 per cent, with a corresponding small increase in land expansion (Figure 1, below).

Alongside the high yield crop varieties came faster growing livestock breeds, supported by the availability of comparatively cheap animal feed crops, particularly pig, poultry and fed aquaculture, which could be reared in high numbers in a small area. The combination of population growth, rising per capita incomes, and urbanisation also created an unprecedented growth in demand for food animals. This growth has been termed a 'Livestock Revolution' by the FAO. Production of all major meat types has been increasing in absolute terms (Figure 2). In relative terms, the share of global meat types has changed significantly over the last

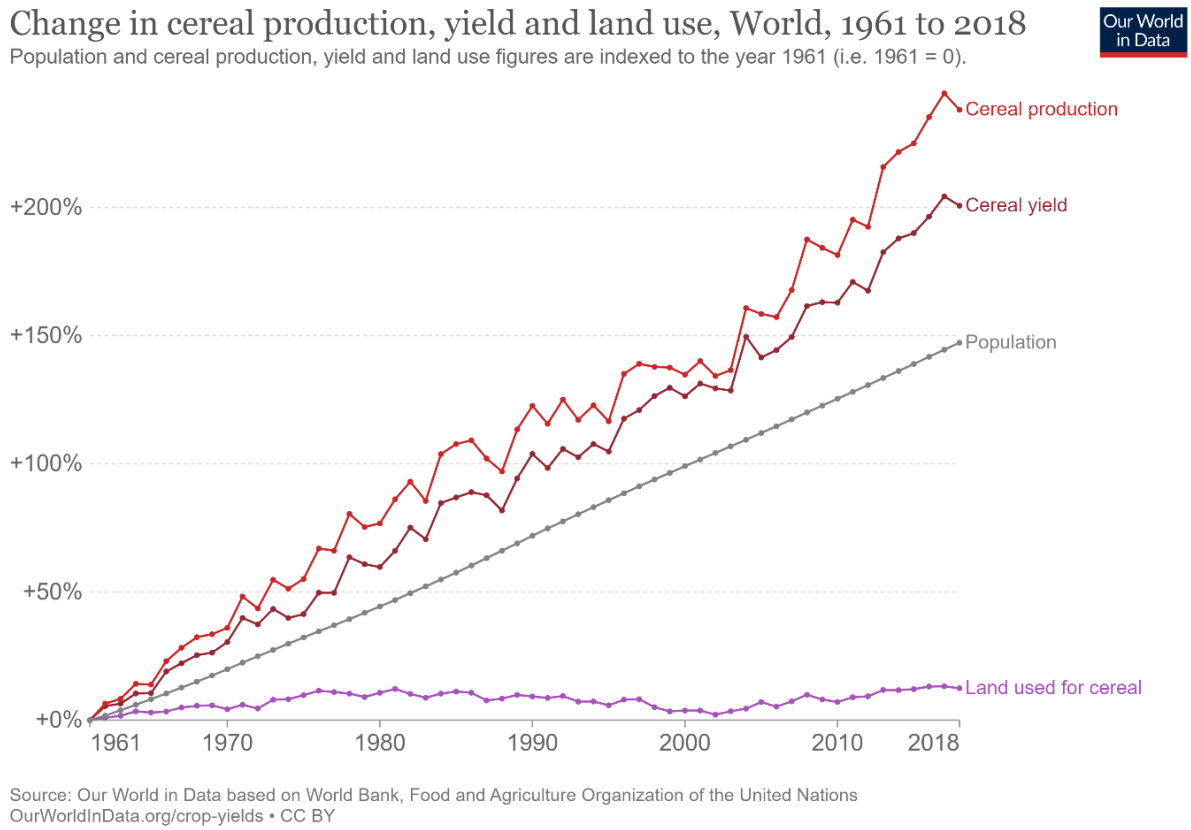

Figure 1. Change in cereal production, yield and land use, World, 1961 to 2018 (Ritchie, 2017).

50 years. In 1961, poultry meat accounted for only 12 per cent of global meat production; by 2013 its share has approximately tripled to around 35 per cent.

Like crops, the focus of food animal production is yield; 'feed conversion ratio' (FCR), is the weight of feed administered over the lifetime of an animal divided by weight gained and is a key metric for comparison and 'efficiency'. Fed aquaculture and chicken have the lowest FCR's, and ruminants such as sheep and cattle, the highest. More 'efficient' systems are often considered to have the lowest FCRs.

The end result of all this focus on yield is that globally, we produce more than enough food to sufficiently meet energy and nutrition requirements of the global population. But we have not solved food security issues. Food security is about more than there simply being enough food to go around: access (i.e. affordability, equitable trade and distribution networks) and utilisation (food waste) is also critical. According to the latest SDG progress report, even before the COVID-19 pandemic, the number of people experiencing hunger globally and suffering from food insecurity had been rising gradually since 2014.

We have also created other problems. The spread of Green Revolution hybrids resulted in the cultivation of fewer varieties of crops, the large-scale loss of indigenous varieties (reduced agricultural biodiversity) and farmers who are often more susceptible to crop failure. The FAO's 2019 report State of the World's Biodiversity for Food and Agriculture concluded that while more than 6000 plant species have been cultivated for food, fewer than 200 make substantial contributions to global food output, with only nine accounting for 66 per cent of total crop production in 2014. The world's livestock production is based on about 40 animal species, with only a handful providing most of the global output of meat, milk, and eggs.

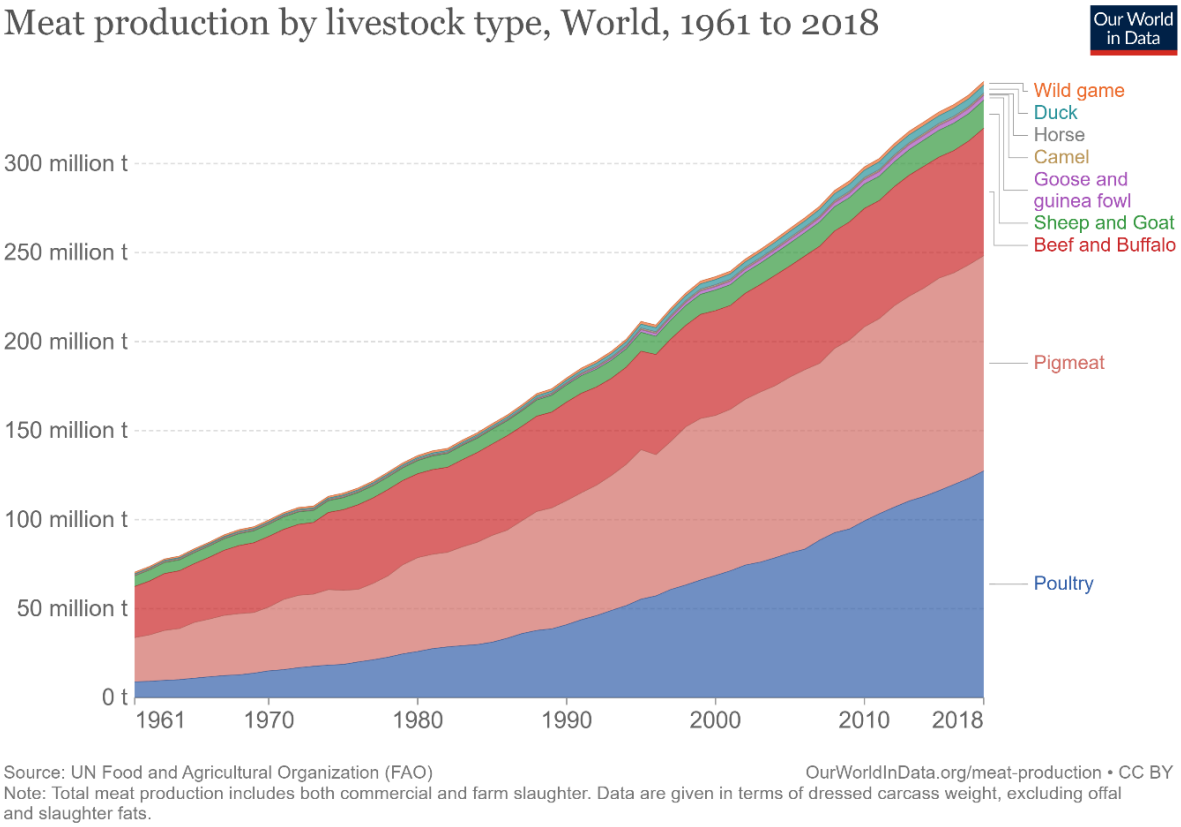

Figure 2. Meat production by livestock type, World 1961 to 2018(Ritchie & Roser, 2019)

Appropriate research and policies to incentivise judicious use of chemicals such as pesticides and inorganic fertilisers, which these new high yielding cultivars required, were largely lacking during the Green Revolution Furthermore, techniques such as irrigation, mono-cropping and repetition of the crop cycle for increased crop production depletes the soil's nutrients and water table. The high concentration of livestock in a small area requires intensive energy and water use and creates large amounts of animal waste that need to be disposed of. Unintended consequences from soil degradation, pollution from chemical runoff, animal effluent, biodiversity loss and unprecedented rates of freshwater withdrawals have had serious environmental impacts and degraded the resource base on which our food production depends.

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Climate change – and the problem with a singular focus on carbon sequestration

In recent years, there has been increasing focus on the role of tree planting to address climate change through the removal of large amounts of carbon dioxide from the atmosphere. Some researchers argue that tree restoration is the most effective climate-change solution we have available and an expansion of plantation forestry — growing trees of a limited variety of ages and species (for example, in monoculture plantations) is taking place in certain parts of the world.

For example, a 2021 study in New Zealand by Orme et al., found that between 1 January 2017 and 31 December 2020, 92,118 ha of beef and sheep farmland were sold into exotic forestry plantation (2017 = 7,004 ha: 2018 = 27,567 ha; 2019 = 38,502 ha; 2020 = 19,045 ha). Of this 92,118 ha, it is estimated that approximately 34 per cent of these land sales were to carbon farming companies.

The researchers argue that this focus on carbon is likely to have knock-on effects on food production: 64 per cent of the proposed planting in the New Zealand study is on low-erosion or moderate erosion land, which is often highly productive hill country. Beef & Lamb New Zealand (the industry organisation representing NZ beef and lamb farmers) estimate that the intended transitioning of productive land to exotic forestry over the last three years will result in a reduction of ~700,000 sheep, with downstream implications for processing companies and supplying services. There are other threats and risks from substantial increases in exotic plantation forest, such as physical and social impacts on local communities, biodiversity impacts from wilding species, exposure to fire risk and reduced water flows in drought areas.

There are also concerns that new forestry plantations are distracting from the need to rapidly phase out use of fossil fuels and protect existing intact ecosystems. Without limits on forestry offsets (i.e. how many carbon credits can be purchased to offset emissions), the more likely outcome according to Beef & Lamb NZ is an even faster increase in the sale of sheep and beef farms into forestry, with little or no change in fossil fuel emissions behaviour or commitment to real climate action from large emitters.

The way forward – holistic solutions and metrics

Nature Based Solutions – Defined by the International Union for the Conservation of Nature (IUCN), Nature-based Solutions (NbS) are 'actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.' Through the work of organisations like the IUCN and The University of Oxford's Nature Based Solutions Initiative (Figure 3), NbS have gained popularity as an approach to address climate change and biodiversity loss while supporting a wide range of sustainable development goals.

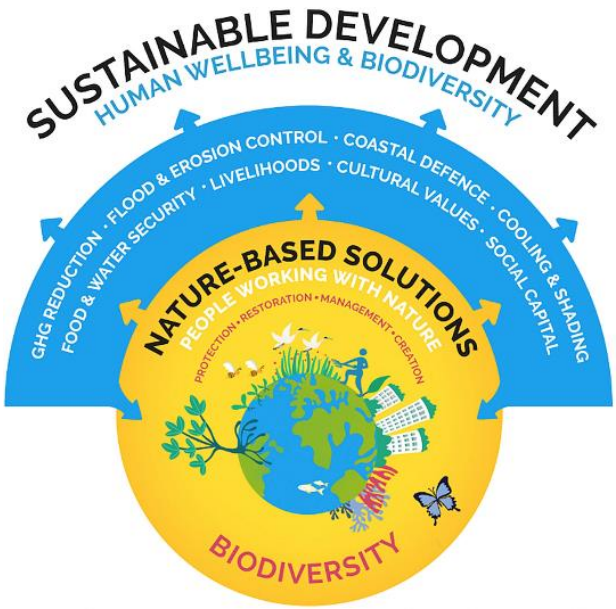

Figure 3. Conceptual diagram of nature-based solutions. People and nature, together (yellow circle), co-produce a variety of outcomes (ecosystem services or Nature's Contributions to People, blue band) which benefit society; these benefits can, in turn, support ecosystem health (blue arrows(Seddon et al., 2021).

NbS have become prominent in international policy and business discussion on climate change. For example, they were highlighted in a recent landmark synthesis report in 2019 by The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). IPBES described NbS and 'nature- friendly' solutions as cost-effective ways of meeting the Sustainable Development Goals. The first draft of the post-2020 global biodiversity framework, as set out by the UN Convention on Biological Diversity (CBD), include NbS such as restoring peatlands and adopting regenerative agriculture contributing at least 10 GtCO2e (gigatonnes of equivalent carbon dioxide) a year to global climate crisis mitigation efforts. This is around a third of the 32 GtCO2e annual emission reductions needed according to UNEP, while ensuring there are no negative impacts on biodiversity.

A 2020 review by Chausson et al., mapped global evidence on the effectiveness of nature-based interventions for addressing the impacts of climate change and other extreme weather events, which was followed by the launch of an online evidenced-based platform: naturebasedsolutionsevidence.info

Much work has also been done to improve the understanding and conceptualisation of NbS, including development of a Global Standard for NbS by the International Union for the Conservation of Nature (IUCN) and work by a consortium of conservation and development organisations and research institutions led by The Nature Based Solutions Initiative to develop four high-level guidelines on how to develop successful NbS. (1) NbS are not a substitute for the rapid phase out of fossil fuels; (2) NbS involve a wide range of ecosystems on land and in the sea, not just forests; (3) NbS are implemented with the full engagement and consent of Indigenous Peoples and local communities in a way that respects their cultural and ecological rights; and (4) NbS should be explicitly designed to provide measurable benefits for biodiversity.

Alongside the planning and implementation of NbS are metrics. *NbS activities need to be evaluated and monitored with the right metrics, to account for the multitude of benefits they provide in the long term.*

Global Farm Metric - The Global Farm Metric (GFM) is a measure of on-farm sustainability developed by the Sustainable Food Trust that can be used by land-

Figure 4. The Global Farm Metric; 11 categories of sustainability and associated measures(Sustainable Food Trust, 2021)

managers to monitor their impacts (positive and negative) on the environment, economy, and society to inform sustainable decision making.

The GFM comprises eleven sustainability categories each with multiple measures which land managers carry out on their land and then input to produce a sustainability score for each category (Figure 4). This gives a clear and holistic indication of the areas where they are performing well and where they need to improve.

The GFM is designed to be adaptable to different climates, cultures and contexts, no matter the size, scale and income of the land. 'A farmer in India can then have a conversation with a farmer in North America about how they're doing on their soil indicators in a way which is genuinely comparable and meaningful to them both.' While the GFM is still in the development phase, and further work is being undertaken on metric and digital development and trialling on-farm, such an adaptable and universally comparable tool is crucial if we are to make informed global decisions about sustainability actions.

Summary

There is an urgent need to shift our focus away from silver-bullet solutions such as monoculture forest plantations to offset carbon emissions or ever-increasing crop yields to improve food security – they are unsuited to the stark *whole ecosystem* challenges we face.

Approaches such as NBs can inform the planning and implementation of sustainability actions and metric frameworks such as the GFM can evaluate the outcome of those actions through a holistic lens. They may require a different mind-set, skills, methodology and produce fewer black and white results than we are used to, but they are necessary if we are to truly value ecological, human, and animal well-being.

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