Sustainable Yield Growth – a gamechanger for SDGs?

Synopsis

Global Agrifood Challenge

- Population growth, rising incomes, and increasing urbanisation mean food demand will continue to grow and change over the coming decades.
- Already, an estimated 2 billion people suffer from moderate or severe levels of food insecurity, and most of this new demand will be from regions already experiencing hunger, malnutrition, and poor access to food – mainly in SE Asia and Sub-Saharan Africa.
- In meeting all of this food demand, the biodiversity and climate change challenges must also be addressed. Food production must become more environmentally sustainable and climate neutral.
- Actual demand for food, and the environmental costs of its production, can be reduced somewhat by reducing food losses and waste, and by dietary change. On their own, however, they're insufficient to meet the challenge.
- The challenge is urgent, and transformational pathways that can ensure food demands are fully met in an environmentally sustainable way need to be developed.
- This global agrifood transition is essential to meeting both the UN Sustainable Development Goals (SDG) and the Paris GHG targets, which, without new cutting-edge solutions, will be missed.

Sustainable Yield Growth

- Increasing agricultural yields sustainably provides one of the most promising avenues in the near term for making substantial progress with the agrifood transition; it provides a breakthrough solution to meeting the challenges of hunger, climate change, biodiversity loss and ecosystem damage. Importantly, it catalyses real progress toward both a number of the SDGs and the Paris targets.
- More practically, sustainably increasing yields means the development and application of the wide range of new technologies and food production techniques that provide pathways to the regenerative farming systems that underpin the SDGs
- Only profitable businesses can deliver the new food systems needed to meet the challenges of the agrifood transition. A greater focus on the business case for change is perhaps the single most effective way of accelerating the uptake of new agrifood production methods.

DG WILKINSON – SEPTEMBER 2022

Sustainable Yield Growth – a gamechanger for SDGs?

One of the greatest challenges of the first half of the 21st century is to reengineer agrifood systems around the world. This "agrifood transition" (AFT) entails a revolutionary realignment of agrifood systems to address a complex web of interconnected challenges affecting the whole food chain from farm to fork; it entails not only how we produce food, but also what we produce, where it's produced, and who gets what.

Agrifood Transition – Key Issues:

Addressing this agrifood challenge means delivering real change across six key sets of inter-related issues:

- ***Food production*** – increasing population and wealth mean that global demand for food will increase by an estimated 70% by 2050
- ***Biodiversity and Ecosystems*** – food production depends fundamentally on healthy ecosystems; food systems must significantly reduce its impact on biodiversity and ecosystems, and be more environmentally sustainable
- ***Climate Change*** – agrifood chains are a major source of GHG emissions, and climate change is expected to substantially reduce agricultural production
- ***Food Losses and Waste*** – by reducing food losses and waste, demand for food will be reduced and less food needs to be produced
- ***Health and Diet*** – changing what foods are produced can have major benefits for both environmental and health concerns
- ***Food Equity*** – food is increasingly seen as fundamentally different to all other goods; that people have a basic right to access adequate supplies of nutritious food

While there is no simple or silver bullet solutions to any of these challenges, sustainably increasing yields can make significant contributions to all of them, and thereby catalyse and accelerate the agrifood transition, and make real progress toward the UN Sustainable Development Goals (SDG) and Paris targets by 2030.

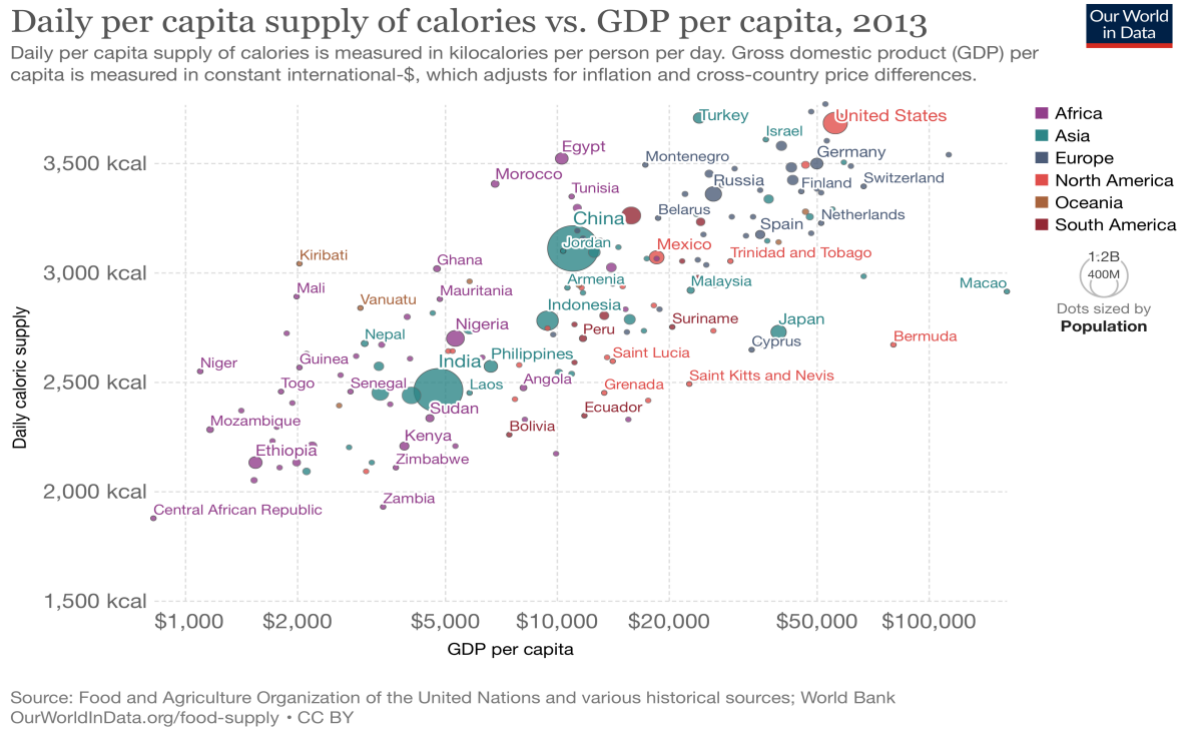
Growing Food Demand

According to the UN Population Fund, on November 15, 2022, in the middle of COP 27, world population is forecast to reach 8 billion.[1] By 2030 there will be another 500 million people, and by 2050 world population will be over 10 billion. At the same time as population growth increases global food demand, growing wealth and urbanisation will also change the types of food demanded. Typically, as wealth increases, demand shifts away from staples and plant-based foods toward more consumption of meat and dairy products,

[1] *World Population Prospects 2022: Summary of Results*

while increasing urbanisation shifts food demand toward more highly processed foods. Both of these changes entail increased use of environmental resources and GHG emissions.

Currently, over 900 million people suffer from hunger and malnutrition due to lack of access to affordable food, mainly in SE Asia and Sub-Saharan Africa. A further billion suffer from moderate food insecurity, bringing the total number of food insecure people to over two billion. Tragically, most of the additional 2 billion people that will be born over the next 25 years will be in countries already suffering from food insecurity. At the same time, over a billion people in the richer countries suffer from a range of adverse health effects from over consumption and mal-consumption of foods.



Source: Food and Agriculture Organization of the United Nations and various historical sources; World Bank
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As a result of increasing global population, income growth, and urbanisation, the World Bank estimate that global demand for food will increase by 70% by 2050, and that at least US$80 billion annual investments will be needed to meet this demand.

WRI suggest that meeting this historic challenge could mean producing some 56% more crop calories by 2050 than was available in 2010, and that nearly 600 million more hectares of agricultural land will be needed – over three times the total EU agricultural area! If we are to avoid net land-use expansion,

> *"absent efforts to reduce growth in food demand, the amount of absolute growth in annual food production that will be needed each year from 2010 to 2050 is larger*

than the increase in food production that was achieved each year in the previous 50 years." (p.148)

Environmental Constraints

In meeting the growing demand for food over the next few decades, agricultural production, and the whole agri-food chain, needs to become environmentally sustainable and climate-neutral.

Biodiversity and Ecosystems: Food production, like all aspects of human life, is critically dependent on a robust and resilient natural environment yet, alongside the dramatic increases in food production over the last century, biodiversity and ecosystems health have deteriorated dramatically. According to the IPBES Global Assessment Report on Biodiversity and Ecosystem Services, over the past 50 years a wide range of biodiversity and ecosystem health indicators have declined, that a million species are at risk of extinction, and that this "loss of diversity, including genetic diversity, poses a serious risk to global food security by undermining the resilience of many agricultural systems to threats such as pests, pathogens and climate change". The OECD report similarly: "Since 1970, one-tenth of the world's terrestrial biodiversity and one third of freshwater biodiversity have been lost, and we are on course to lose another 10% of terrestrial species by 2050.

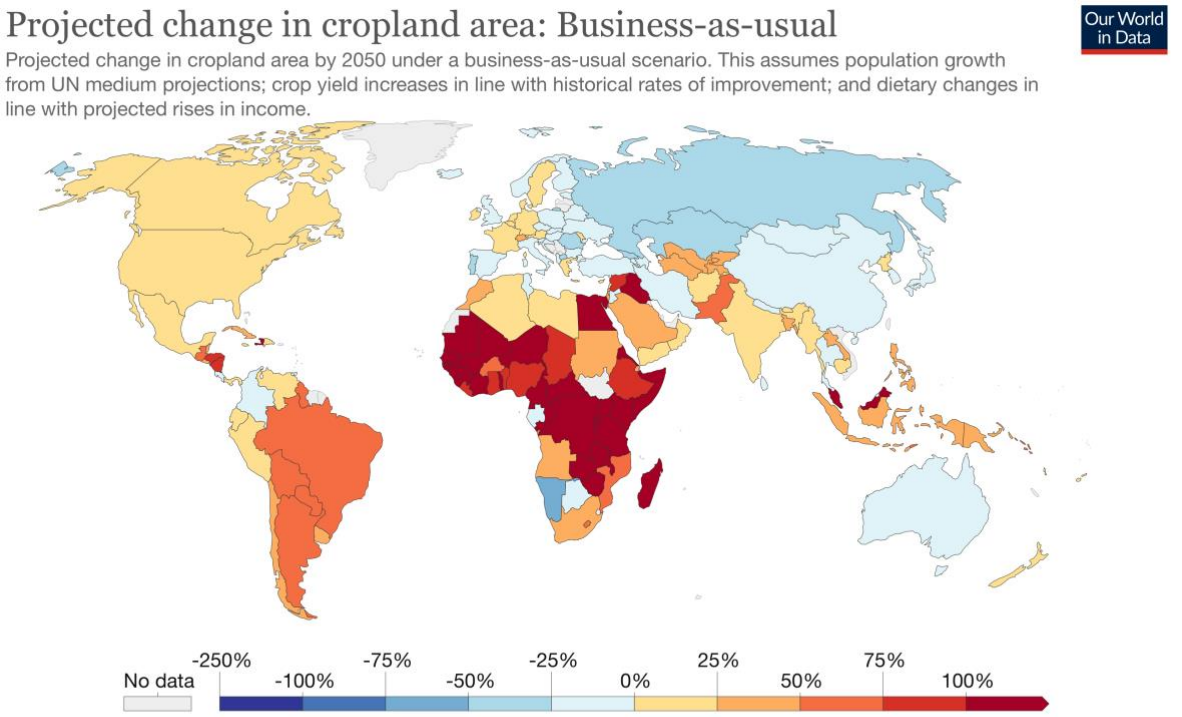
The expansion of global cropland, especially in Africa, is currently accelerating – from 5m Ha per year to 9m Ha per year over the past 20 years, and nearly half of it is at the expense of natural ecosystems.[2] Reversing this trend must be at the heart of efforts to meet the growing demand for food in these regions.

Climate Change: Agrifood systems are a major source of GHG emissions, and need to play a commensurate role in addressing the climate change challenge. According to the IPCC, agriculture, forestry and land use change account for an estimated 23% of global GHG emissions. If emissions from the whole food chain are included, this rises to an estimated 37%.

At the same time, the anticipated effects of climate change, including more extreme weather events, droughts, and floods, while they vary from region to region around the world, all impair agricultural production. Most studies[3], including the IPPC Special Report on Climate Change and Land, suggest that yields of crops such as wheat, maize, and soya, could fall substantially over the next few decades as a result of climate change, with the worst consequences felt in the most food-insecure regions of sub-Saharan Africa and South Asia. These regions are also those that will

[2] See WRI - 5 Takeaways on Cropland Expansion and What It Means for People and the Planet
[3] For a review of such studies, see WRI, Creating a Sustainable Food Future, 2019

face the greatest pressures to expand farmlands, with potentially catastrophic implications for biodiversity and ecosystems health.



Reducing Food Demand

The drivers of growing demand for food are largely ineluctable. Policies to reduce fertility rates will be helpful but will have little effect in the shorter term. The UN estimate that "two-thirds of the projected increase in global population through 2050 will be driven by the momentum of past growth that is embedded in the youthful age structure of the current population."[4]

Although most of the population growth over the coming decades is "baked in", there are countervailing measures that can reduce the effective demand for food.

***Food Losses and Waste (FLW)*:** Reducing food losses and waste holds great potential in the short term for addressing the increased demand for foods that will inevitably

[4] World Population Prospects 2022: Summary of Results

arise over the coming years. The FAO estimate that as much as 30% of food production is lost or wasted, and that "reducing food loss and waste is a significant lever for broader improvements of our food systems toward improving food security, food safety, quality and sustainability and increasing efficiency".

Modelling by WRI and others suggest that reducing FLW can significantly reduce GHG emissions and the agricultural area otherwise needed to meet the increased food demand by 2050.

While over half of all FLW occur in the richer regions, the specific challenges of reducing food losses and waste vary significantly between the richer and poorer regions, and the remedies needed vary accordingly. In the most food insecure regions, like sub-Saharan Africa, around 75% of all such losses occurring in the primary production and food handling and storage phases of the supply chain. By contrast, in richer regions, like North America, some 60% are associated with food consumption.[5]

Shortening supply chains and greater reliance on local food supplies is sometimes proposed as a contributory solution. While this tends to favour smaller producers, which is most of the world's farmers, it can also impair food security by reducing the diversity of food suppliers. With agricultural output especially vulnerable to the increased extreme weather events and outbreaks of plant and animal diseases expected as a result of climate change, localising food supplies will increase vulnerability to disruptions of supplies, and maintaining robust and resilient food supply chains will remain vital to food security.

Dietary Change: The land use and GHG impacts of producing different foods varies substantially, with livestock products the most intensive. It is suggested, therefore, that increased food demands can be met without expanding production; that if people shift their dietary preferences away from animal based products and towards more plant based and synthetic foods, we have ample farmland and food , it would improve human health and well-being, and it would reduce the environmental burden of food production. As the Global Nutrition Report suggests "our diets are increasingly harming our health and the planet."

The Sustainable Food Trust, which advocates such a realignment of diets to "improve our health, protect nature, and combat climate change", conclude that

> "shifting to sustainable farming practices will likely increase food prices, as is already being experienced in the energy sector. To protect against food

[5] WRI, p. 55, Table 5.3

> poverty and ensure access to high-quality food for lower income groups, government intervention will be essential."[6]
>
> While this may be a plausible route for richer countries, it is far from clear how such essential interventions could be provided at the global level.
>
> When the problem is seen as calories of food or as nutrients, which is the primary purpose of food, a case may be made for there being enough food for everybody. However, food also has deep psychological and socio-cultural meanings as well, which suggest that such fundamental change will be neither easy nor quick; while changing the dietary preferences of people at a global scale, may make an important contribution over the longer term, it is unlikely to contribute much over the next few years, or even decades.

Regardless, however food demand may evolve, more environmentally sustainable agrifood production systems will need to be developed and adopted at scale if the biodiversity and climate challenges are to be met. While efforts to reduce and/or change food demand are important, modelling by the WRI suggest that "boosting yield growth and cropping intensity (at least for lands that are already regularly cropped) is critical to achieving a sustainable food future." [7]

At the same time, agrifood systems must be resilient to new unforeseeable challenges like the Corona virus pandemic and the conflict in the Ukraine, which have greatly impaired global food systems and progress toward the SDGs and Paris targets.[8]

Identifying the Transformational Pathways

UN Deputy Secretary-General Amina Mohammed said recently: "let us be frank; we are off track on both the SDGs and the Paris goals", and "we must come together to rescue the SDGs and the Paris goals before it is too late." [9]

To identify the pathways that are most likely to transform agri-food systems, a simple two-step evaluation procedure may be useful.

The first step is to develop sustainable investment impact reporting criteria and metrics to evaluate the effectiveness of proposals for improving sustainability and alignment with net-zero targets. Such estimates could be quantified as percentages of the proposals aims achieved per year. Obviously they cannot be precise but, if well done, they can provide

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[6] SFT, "Feeding Britain from the Ground Up", p. 9

[7] WRI - Creating a Sustainable Food Future, p. 222,

[8] As the US Global Leadership Coalition suggest, "the COVID-19 pandemic increased global food insecurity in almost every country by reducing incomes and disrupting food supply chains—conditions worsened worldwide by Russia's unprovoked invasion of Ukraine."

[9] https://press.un.org/en/2022/dsgsm1769.doc.htm

useful relative orders of magnitude, and allow proposals to be ranked. Syngenta Group's criteria for sustainable investing in the Good Growth plan provide a good start.

The next step is to triage potential solutions by *when* they can be implemented.

1. *What can be done now?* – these include what can be done immediately, and includes incentivising and de-risking greater uptake and scaling of existing and emerging technologies, along with the development of both public and private payments for ecosystem services.
2. *What might be done soon?* – these are the actions that are realistically possible within, say 2- 3 years, and include incentivising focussed R&D of technologies, products, services and organisational structures.
3. *What is going to take longest to do* – these are proposals that are unlikely to play a significant role before 2030, including changing human preferences and behaviours.

Prioritising pathways according to how effective they are and how quickly they can be implemented should help target resources to those actions and investments that can deliver the greatest transformations most quickly, and help accelerate the agrifood transition.

Because equitable access to foods is largely a function of complex and deep seated economic and social inequalities, it will be neither easily nor quickly ameliorated. Similarly, while, theoretically, changes to dietary preferences could substantially address many aspects of the agrifood challenge, it is unlikely to do so in the short term to the extent that would be needed to have a significant impact on the volume, composition or environmental costs of food production. These are both important issues, but to make the urgent progress needed to meet the SDGs additional routes to more sustainable agrifood systems are needed.

Sustainable Yield Growth

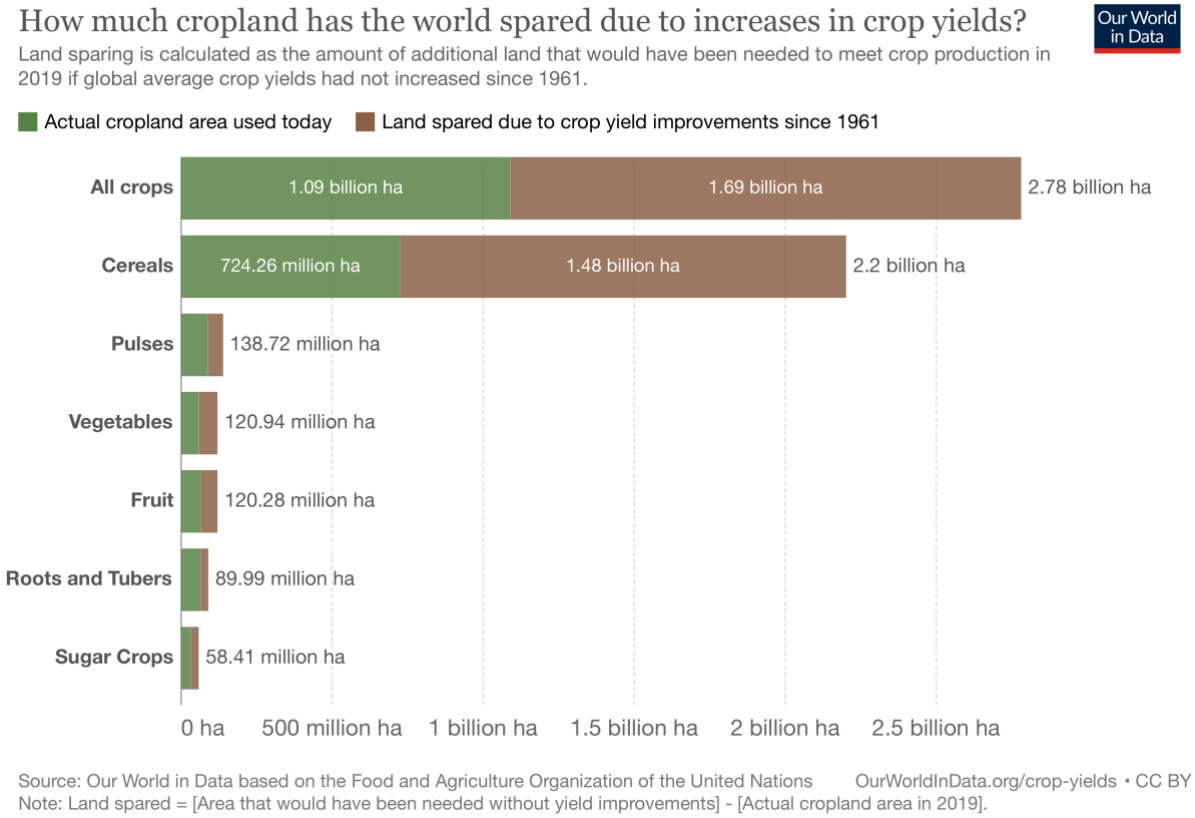
Increasing agricultural yields sustainably provides one of the most promising avenues for making substantial progress with the agrifood transition in the near term; it provides a breakthrough solution to meeting the challenges of hunger, biodiversity loss and ecosystem damage, and climate change. Importantly, it catalyses progress toward a number of the SDGs that were agreed in 2015, especially SDG 2 Zero Hunger.[10]

Over the coming years, as WRI suggest, "absent efforts to reduce growth in food demand, the amount of absolute growth in annual food production that will be needed each year from 2010 to 2050 is larger than the increase in food production that was achieved each year in the previous 50 years", and that "both crop output per hectare and milk and meat

[10] *SDG 2.4 by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality UN SDGs*

output from ruminants per hectare must grow each year more than they did historically if we are to avoid net land-use expansion." (p.148)

Sustainable yield growth can also make an important contribution to the biodiversity and ecosystems challenges by sparing land that would be otherwise needed for food production. Over the past 60 years, while world population has grown by 5 billion and income per capita increased nearly 4-fold, yield growth has provided over 3 times as much crops and 50% more calories per capita,[11] while saving some 1.7 billion hectares of land from cropping. Provided this spared farmland is set aside for nature, Balmford, et al suggests that high yield farming can provide a wide range of critical environmental benefits.



Unfortunately, as the FAO observe,

> *"the fact is that globally the rate of growth in yields of the major cereal crops has been steadily declining, it dropped from 3.2 percent per year in 1960 to 1.5 percent in 2000. The challenge for technology is to reverse this decline, since a continuous linear increase in yields at a global level following the pattern established over the past five decades will not be sufficient to meet food needs."*[12]

[11] McDougall, Phillips, "Evolution of the Crop Protection Industry since 1960", 2018
[12] *How to Feed the World in 2050*

As a result, according to a recent analysis from the Bill and Melinda Gates Foundation, "all the 17 development goals set by world leaders in 2015 would be missed unless cutting-edge solutions emerged."[13] Achieving these sustainable development goals requires an acceleration of investment in to R&D and implementation of new technologies and techniques that increase agricultural yields in an environmentally sustainable way. *FAO, Principles for Responsible Investment in Agriculture and Food Systems* provides guidance on what such investments should achieve:

> *"Responsible investment in agriculture and food systems refers to the creation of productive assets and capital formation, which may comprise physical, human or intangible capital, oriented to support the realisation of food security, nutrition and sustainable development, including increased production and productivity"*[14]

The OECD-FAO Agricultural Outlook 2022-2031 agrees:

> *"following a business-as-usual path, SDG 2 on Zero Hunger would not be achieved by 2030 and GHG emissions from agriculture would continue to increase. To achieve the Zero Hunger target while simultaneously keeping agricultural emissions on track to reach the Paris Agreement targets, average global agricultural productivity would need to increase by 28% over the next decade... Comprehensive action to boost agricultural investment and innovation and to enable the transfer of knowledge, technology, and skills are urgently required in order to put the agricultural sector on the necessary trajectory for sustainable productivity growth and the transformation towards sustainable food systems. Additional efforts to reduce food loss and waste and limit excess calorie and protein intakes, particularly from animal sources, would also be necessary."*[15]

Sustainable Yield Growth in Action

Sustainable yield growth contributes to a diverse range of agricultural production systems[16]. More practically, it means the development and application of the wide portfolio of new technologies and food production techniques that provide pathways to the regenerative farming systems underpinning the SDGs. These include:

- ***reclaiming and rejuvenating land and water resources.*** Repairing damage is as important as preventing it, and the UN's Global Land Outlook estimates up to 40% of

[13] The Future of Progress,
[14] FAO, Principles for Responsible Investment in Agriculture and Food Systems, p.3
[15] OECD-FAO Agricultural Outlook 2022-2031, p. 19
[16] See, for example, Syngenta Public Policy Position on Diverse Agricultural Systems

the world's land area is degraded[17]. The IPBES estimate that currently "land degradation has reduced productivity in 23 per cent of the global terrestrial area".[18]

- ***increasing agricultural production with fewer inputs and a lower environmental burden.*** The suite of precision farming technologies, including satellite monitoring and telemetry, robotics, as well as seed improvements, green fertilisers and biologics, and glasshouse production, provide just a few of the ways by which food production is being increased with less environmental impact.
- ***reducing GHG emissions.*** Agricultural GHG emissions are being reduced by a number of new technologies including feed additives to reduce methane emissions, improved slurry management to reduce runoff of nitrates, new fertiliser products and application techniques are also reducing emissions of nitrates, and new land management methods are helping to sequester carbon in soils and flora.
- ***improving resilience to weather extremes and disease***. As a recent report by the Royal Society argued, "Biotechnology is seeing a particularly rapid acceleration in the use of science and innovation to improve quality and yields as well as resistance to pests, diseases, heat and drought at a time of climate change."[19] While these losses vary by crop and livestock, as well as by region, as an FAO study concluded, even with modern pesticides, "annually up to 40 percent of global crop production is lost to pests."[20]

When yield is understood in terms of the amount of food actually available to consumers, sustainable yield increases also contribute to reducing food losses and waste by

- ***reducing spoiling during storage, and make a significant contribution to food supplies***. This is especially important for the less food secure regions where around three quarters of all FLW is at the production, and at the handling and storage stages of the food supply chain. By way of example, biotech developments that extend the shelf life for cassava – a staple for many of the world's poorest people - from 2-3 days to around 18 months, will play an important role in reducing food losses, and therefore the need to increase food production.

Sustainable yield growth builds upon and accelerates an impressive record of successful innovation and improved environmental sustainability. In the US, for example, over the past 60 years, corn "yields have nearly tripled on average, while crop protection usage as grams per hectare have reduced by 95%".[21] At the same time, the relative human and environmental safety of the products has improved.

Innovation and sustainable yield growth can address a significant share of the anticipated increased demand for food over the coming years. However, as suggested by Chatham

[17] p.5
[18] p. xv
[19] p. 1
[20] FAO, Scientific Review of the Effect of Climate Change on Plant Pests
[21] Thomas, Shane, "Regenerative Agriculture Doesn't Have to be Contentious".

House, WRI, and others, there is a risk that sustainable yield growth alone could lead to an increase in utilised agricultural land as farming becomes more profitable in some crops and/or regions. For this reason, complementary policies and measures may be needed to reduce shifts in the location of agricultural production, avoid conversion of the most biodiverse and carbon-rich lands, and to actively restore lands that are abandoned as farm production adjusts. Balmford, et al suggest several ways of "explicitly linking yield growth to improved environmental performance - including strict land-use zoning; strategic deployment of yield-enhancing loans, expertise or infrastructure; conditional access to markets; and restructured rural subsidies." (p.480)

Accelerating Change

As well as being environmentally sustainable, sustainable yield growth must also be commercially sustainable. If agrifood businesses are not profitable and do not provide a living for the producers, the transition to more sustainable agrifood systems will not happen, and the environmental improvements needed will not be made. Putting more emphasis on the business case for proposed new technologies and production techniques will greatly accelerate their take-up by farmers and others in the agrifood chain.

As the *FAO* suggest,

> *"In the past, [sustainability] had been defined primarily along environmental criteria. If the soil was bad, or if water was not managed well, then a farm might have been considered unsustainable. In recent years, however, there has been a realization that being sustainable reaches much further, to include economic and social dimensions, and putting farmers in the center. If a farm is not economically sound or not resilient to external shocks, or if the well-being of those working on a farm are not considered, then a farm cannot be sustainable."*

Sustainable yield growth means sustainable income growth for food producers, which is the essential foundation for achieving most SDGs. By way of illustration, DroughtTEGO, is a new drought-resistant variety of maize grown in Kenya that produces 60% more grain than more traditional varieties, and increases farm incomes by 75%! This extra income enables people to invest in better housing, water and sanitation, as well as health care and education.

Conclusions

There are no easy or "silver bullet" solutions, but sustainable yield growth provides a powerful pathway to meeting the growing food needs of billions of hungry people, while protecting biodiversity and improving the health of the ecosystems on which we all rely. If real progress is to be made toward the SDGs and Paris targets, the technical and

technological innovations at the heart of sustainable yield growth must be given the highest priority.