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Farming and growing productivity and efficiency – a new perspective

Christopher Stopes and Roger Kerr

Summary

OF&G believes that it is essential to look at productivity and efficiency of the farming and food system from the perspective of the balance sheet as against a simple profit and loss approach. This would enable both cash and non-cash (e.g. natural capital) values to be simultaneously taken into account with external costs and benefits being represented within an assessment of performance. Whilst productivity and efficiency are critical a simple productivity and efficiency assessment based on only direct costs and outputs (P&L approach) misses the wider outcomes. Through a broader assessment of outputs beyond a simple yield/cost formula the full impacts of our food production system can be monitored, in simple terms if the overall balance sheet value is declining then the overall food production system is not sustainable.

If we are to establish a permanent and resilient business model for our farmers and growers, the starting point of our food system, then current and fixed assets must increase whilst liabilities reduce (or at least are held stable). At the same time, they must be efficient and productive, but where productivity and efficiency are considered in terms of stakeholder or equity value. This can then translate into public support (to deliver 'public goods for public money') and in the market.

The purpose of this paper is to review the definition of farming productivity and efficiency in the new context of public goods and food production, and the government's Public Value Framework[1].

1. Introduction

The current approach to agricultural economics is based on two drivers: growth in output and optimising internal farm inputs and labour. The context for this is input substitution: 'Can I grow more with the same or less inputs'. This simple input/output measurement of productivity and efficiency fails to take into account the external impacts ('externalities') arising from methods of farming and growing and of the food system overall. From the perspective of the environmental economist Kate Raworth, the outcome of this limited approach misses fundamental considerations. She says [2]: "We have transgressed at least four planetary boundaries, climate change, land conversion, nitrogen and phosphorus loading and biodiversity loss, … Growing sufficient nutritious food for all requires healthy nutrient rich soils, ample fresh water, biodiverse crops and a stable climate".

Dieter Helm, an advocate for natural capital, has said that the "economy exists and prospers as a result of the enormous amount of "stuff" that nature gives us for free."[3] If we are to address the current environmental, social and economic challenges, we need system change to ensure that interrelated issues are addressed – of biodiversity, soils, climate change, poor dietary health, low wages and waste, amongst many others. We need to effectively account for this "stuff".

We need practical and well-defined options. No single tool can possibly be 'the solution'. Sir Robert Watson, Chair of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)[4] and former Chair of the Intergovernmental Panel on Climate Change (IPCC) concludes[5] that "As policymakers around the world grapple with the twin threats of climate change and biodiversity loss, it is essential that they understand the linkages between the two so that their decisions and actions address both. The world needs to recognise that loss of biodiversity and human-induced climate change are not only environmental issues, but development, economic, social, security, equity and moral issues as well. The future of humanity depends on action now. If we do not act, our children and all future generations will never forgive us."

The key is to establish systems that effectively internalise hitherto external costs, providing public goods and benefits to consumers, citizens and policy makers, and enabling informed decisions about how the needs of society and the environment can be met now and in the future[6].

1 Royal Society of Arts (2019) Food Farming and Countryside Commission Our Future in the Land report (see pages 14-15). https://www.thersa.org/globalassets/reports/rsa-ffcc-our-future-in-the-land.pdf

2 Raworth, K (2017) Doughnut economics – Seven ways to think like a 21st-century economist. Random House.

3 Dieter Helm quoted in https://geographical.co.uk/nature/item/3111-natural-capital

4 IPBES – Science and Policy for People and Nature. See https://www.ipbes.net/

5 https://www.theguardian.com/commentisfree/2019/may/06/biodiversity-climate-change-mass-extinctions

6 OF&G (2017) An organic systems approach to the provision of public goods. OF&G Policy Paper 2, December 2017 https://ofgorganic.org/useful-info/downloads?q=&filter=policy-paper

OF&G
Old Estate Yard
Shrewsbury Road | Albrighton
Shrewsbury | Shropshire
SY4 3AG

01939 291 800
info@ofgorganic.org
ofgorganic.org
@ofgorganic
/organicfarmers

2. Current measures for productivity and efficiency do not include non-cash outcomes

The terms 'productivity' and 'efficiency' are currently primarily considered according to economic parameters **(see Box 1)** even though they have a much wider application and importance than a cash value alone can denote.

BOX 1

Definitions of productivity and efficiency

The definitions of productivity and efficiency in economic terms are precise . Productivity is an absolute measure, the productivity is X. It can be defined in two ways, partial productivity and global productivity. The global productivity takes all inputs together and computes the percentage increase in output (in economic terms) as a result of in an increase in the use of inputs. This is called Total Factor Productivity (TFP) by Defra.

Partial productivity is defined as the amount of output due to an amount of a single input used. The elasticity of productivity is defined as the percentage change in output resulting from the increased use of one input. Positive values show the potential for change such that the outputs increase more than the inputs, a negative value shows the reverse.

The elasticity reveals the worth of deploying an input. In economic terms elasticity must be positive. In other words, one would not deploy an input that costs more than the cash return. There are however examples where this does not apply or where perverse outcomes arise. For example current farming and food systems currently require, on average, 10 calories of energy input to create one calorie of food energy output from our farming and food system . A 'unit-free' measure of partial productivity relates the percentage change of output as a result of a percentage change in input. A common productivity factor used is on the basis of labour input alone – this can lead to a drive for replacement of people by machines and lower employment.

Efficiency is a relative measure. It is the outcome of a productive system relative to some benchmark, in percentage terms, and defines the relationship between input and output. There are two efficiency measures: Technical Efficiency, which relates physical and economic outputs and inputs – yield per hectare, labour, profit or costs. Allocative Efficiency, which shows the response of the productive function to a change in input. In economic terms, the closer the production quantity in cash terms is to the optimum quantity of inputs, the higher the allocative efficiency (marginal costs per unit are higher than the per unit value of output).

Simply put, the cash cost of food paid by the final consumer is estimated to be the same as the external costs of the UK farming and food system[7]. Although all of these external costs can't be laid at the farmer's and grower's door, it seems self-evident that a much greater emphasis must be put on these externalities than economics and business practice currently allows. Systemic change is essential to overcome the diverse and linked challenges.

It is important to note that the relevant measures for productivity and efficiency of farming and growing food are distinct from those relevant to assessing the food system post farm gate, though both are closely associated; drivers of diet and causes of waste are shared. So for example we are living beyond ecosystem limits (planetary boundaries) as a result of consuming too much intensively reared meat & livestock products, and not enough fruit, vegetables, salads, pulses and nuts. This is contributing to a nitrogen surplus (by a factor of two), a detrimental climate change impact (GHGs likely to exceed safe limits), an attrition of biodiversity (10-100 times safe levels), and all with a high impact on human health.

If we get this right, we can have a food production system that provides a sufficient supply of food based on sustainable demand and consumption whilst reversing our impact on the environment and improving human health **(see Box 2)**. We would thereby create healthier soils, a more abundant and diverse mix of species, reduce the nutrient overload and stay within safe levels of greenhouse gas emissions.

BOX 2

Two organic farms where the system contributes to the 'planetary boundary' balance sheet

Mark Lea farms 223ha of organic land in Shropshire with a system built on the belief that sustainability requires diversity. The rotation is mixed with clover leys grazed by cattle and sheep, as well as producing red clover seed. Cropping includes milling oats, peas for human consumption grown for Hodmedods and this year 14 different milling wheats for direct sale to millers and bakers. They are food producers, adding value on the farm where they can, developing a relationship with customers. Companion cropping, diverse cover crops and agroforestry all contribute to the resilience of the farm. A green-waste composting enterprise receives 5000tpa of local kerbside garden waste, making compost used throughout the rotation to contribute to raising organic matter and improve the soil. This is their 20th year of being certified by OF&G, proving that the system is sustainable without synthetic inputs They are proud to farm in a way that contributes positively to biodiversity and soil, air and water quality whilst producing healthy food that is in genuine demand.

Polly Davies farms Slade Farm, a 300ha family run, organic mixed tenanted farm situated on the Glamorgan Heritage Coast. The farm has a sheep flock of 500 ewes, 55 cow suckler herd unit, 35 pigs and around 80-90ha of organic arable, on rotation round the farm, certified by OF&G. "Farming with Nature, we manage a range of habitats, improving the farmland bird populations as well as producing quality meat and organic cereals. Here at the farm we aim to be sustainable by not 'buying in' forage or feed cereals for our livestock, all our feed (including the protein) for the cattle, pigs and sheep, is grown here on the farm, reducing the farm's carbon footprint as well as providing a patchwork of habitats with cereals and grassland being grown across the farm" explained Polly.

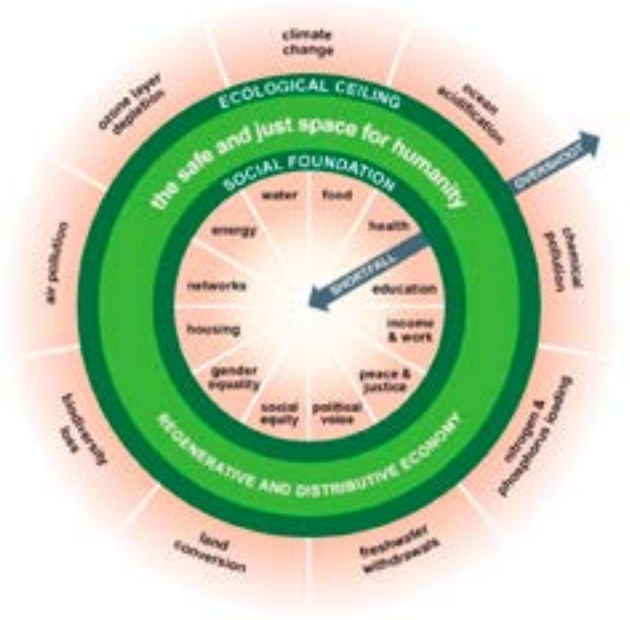
7 Sustainable Food Trust (2017) The hidden cost of UK food. Report by SFT November 2017 http://sustainablefoodtrust.org/wp-content/uploads/2013/04/HCOF-Report-online-version-1.pdf

3. Financial performance of farms – broadening business objectives.

The economic prosperity of farmers and growers, as well as the health of society and of the environment, depend in part on how we farm. The productivity measure that must be our focus is a newly defined total productivity, where a wider range of both inputs and outputs are included, more than merely economic - often these inputs and outputs will not have a cash value.

Productivity and efficiency are key concepts in defining the success of the efforts that farmers and growers make to provide our food. They are the key drivers determining the business performance. Prevalent 'economic' criteria for assessing the productivity and efficiency of farming (for example on the basis of labour, cash profit, gross margin or yield) fail to sufficiently address the crucial 'environmental' pillar of sustainability. These criteria also fail to address the 'social' pillar, resulting, for example, in poor health and nutrition, whilst insufficient attention is paid to the ethical treatment of animals. These critical failures show that the current economic assessment alone is inadequate when guiding future policy and farming practice towards productivity and efficiency within planetary boundaries. We must operate in what Kate Raworth defines as the "safe and just space for humanity" (Figure 1).

Figure 1: Ecological ceiling and social foundation – the safe and just space for humanity (Raworth K, 2015 p. 44)



Many people understand what a P&L account is, but find it much trickier when it comes to a balance sheet. A balance sheet represents a business's overall financial strength, this differs from the P&L account, which details the income, costs and profit (or loss) of the business.

A balance sheet **(see Box 3)** represents the business assets and its liabilities, giving an overall 'net asset' position – seen in the first section of the balance sheet. The bottom section shows how the financial position has been attained, through a combination of cumulative retained profit and equity (shareholder and stakeholder value).

BOX 3

Balance Sheet

The elements that make up a balance sheet are:

- Fixed assets

  Fixed assets are assets held that typically have a useful life beyond a year.

  In a business example, these could be computer and office equipment purchases that have been booked to the balance sheet. In the context of food production by farmers and growers the fixed assets are, for example land and buildings but should also include soil carbon content and soil functionality, pollinators, biodiversity, trees and agricultural landscapes.

- Current assets

  Current assets are day-to-day assets held by the business; for example, trade debtors, stock and cash. From the point of view of the food production system these should include, for example, farm animal welfare and health, rural vitality and resilience to flooding.

- Current liabilities

  The opposite of current assets are day-to-day liabilities. In a business these could include trade creditors and VAT. When considering the liabilities of a food production system then we need to consider climate change stability, water quality and availability and air quality, for example. These are aspects that, without proper consideration, can and will have significant deleterious public as well as private effects (and require significant financial investment to mitigate them) if they continue to decline. This is particularly important if the concept of Natural Capital and the delivery of public goods is acknowledged.

- Net assets

  The net assets are then the total of fixed assets plus current assets less current liabilities.

  This represents the amount of retained value that is left if all liabilities are met and the value of assets calculated.

- Capital and reserves

  The bottom section of the balance sheet shows the same total as the net assets figure, but it is broken down by:

  - Profit and loss reserves – in a business this is the running cash profit/loss position. In a farming system this can be seen as the amount of food produced.
  - Stakeholder value – how much external funds have been put in. This rises or falls based on the net assets and the P&L.

The farmer's and grower's aspiration to produce more with less is a valid one, we all want to be more productive and efficient. But we inhabit a finite environment, so it is critical to assess the relative value of both the inputs used that result in profit and the 'assets' accumulated (or dissipated) on the balance sheet. Whilst aiming to achieve higher productivity and efficiency, account must be taken of any consequential deleterious outcomes that increase our balance sheet liabilities. It is essential to evaluate the "total

system productivity and efficiency" of the farming and growing practices on both the P&L and the balance sheet.

To focus solely on productivity and efficiency in terms of cash P&L without considering the overall position of assets and liabilities (the balance sheet), does not make sound business sense. Go into any large corporation and the performance of the organisation is not measured by profit, gross margin, or labour productivity, but by the Company's share price: is it 'worth' more today than it was yesterday? If we want a resilient business model for farming and growing, then we need to factor in the whole farming system business balance sheet in to our farming business and understand the impact of different measures of productivity and efficiency.

If you were to draw a line under the business at the balance sheet date, the net asset would be the amount of money and other assets left within the business once all positions were settled. A strong business will have a positive and growing net asset position as this will mean it has reserves to support future development. It makes the business more resilient. Clearly if the profit is good but the overall net asset value is falling then this will impact on shareholder value. While current mainstream methods of farming are providing a cash surplus, the negative impacts on biodiversity, soils, water quality, finite resources and climate, means that the balance sheet is rapidly declining year-on-year. If UK agriculture was a PLC then the shareholders would undoubtedly be demanding the senior management team (SMT) provide a rescue package that reverses continuing year on year declines.

Table 1 shows an example of a whole system balance sheet comparing two farming systems. Each element would be defined and evaluated according to a clear set of parameters that allow both success and failure to be recorded. This approach allows for assessing continuous improvement towards a range of defined targets that may not be directly comparable: an increase in soil carbon is not directly comparable with an increase in biodiversity, nor will the targets necessarily have a known cash value, for example animal welfare and biodiversity.

Table 1: A whole system balance sheet

	Key indicator	Good system	Poor system
Fixed assets	Soil carbon content	+1	-1
	Pollinators	+1	-1
	Biodiversity	+1	-1
Current assets	Animal Welfare	+1	0
	Resilience to flooding	+1	-1
Current liabilities	Climate change mitigation	+1	0
	Water quality	+1	-1
	Air quality	+1	-1
Overall		+8	-6
P&L	Yield	-1	+1
Overall balance sheet		+7	-5
+ = positive impact | - = negative impact | 0 = no change			

4. How organic production contributes to a positive balance sheet.

Organic production standards prohibit the use of inputs that are associated with impacts on the environment. These inputs include synthetic pesticides, herbicides and nitrogen fertiliser. Their avoidance by organic farmers means that system redesign is required. In this regard, organic producers grow a wide range of crops in a long rotation, typically including diverse fertility building pastures used for livestock production. Although this may result in a lower yield per hectare compared to non-organic production, the extent of the yield reduction varies widely in different locations and with different crops.

More extensive and health promoting livestock production is a requirement of organic standards. These define, amongst other things, veterinary treatment (minimising antibiotic use), what the animals may eat and their housing. This has a climate change impact whilst contributing to animal welfare (one of Defra's public goods). Animal welfare is included as a current asset in the balance sheet above.

Organic standards legally define the production system and this is verified through annual inspection. There is a positive impact on biodiversity, pollution, climate change and animal welfare, and this is coupled with a high level of integrity – relevant to consumers, citizens and policy makers.

At the current level of organic production in the UK, OF&G estimates[8] that around 300,000kg of synthetic pesticide active ingredients and 40,000 tonnes of artificial nitrogen are avoided on Britain's half a million hectares of organic farmland. Given the significant amount of natural gas needed to produce artificial nitrogen, organic production is better able to avoid the need for fossil fuels and consequently, evidence suggests, results in a lower emission of greenhouse gases per hectare[9]. However, the use of fossil fuels by organic farmers, for example in mechanical weeding, must also be taken into account in any assessment, although there are more tractor passes over a field for frequent spraying of pesticides and spreading of fertilisers.

Whilst yields and premiums fluctuate in both organic and non-organic production, variable costs and working capital requirements of organic systems can be less than comparable non-organic systems. Organic producers can achieve a reasonable and resilient financial return, without the use of the inputs that have led to exceeding planetary boundaries like artificial fertilisers and pesticides and the resultant intensification of farming systems. To achieve an improving overall balance sheet position, internal and external elements need to be addressed simultaneously, and organic whole-systems thinking can help move towards that.

8 OF&G Press Release: More farmers seizing the potential of growing demand for organic, stats reveal. 17 May 2018. Based on calculations made using Defra organic statistics, taking account of area, crop type and application rates of pesticides and fertilisers to these crop types.

9 There is a trade-off between greenhouse gas emissions per hectare or per unit of production and the health and welfare of livestock – a priority in organic standards

5. Achieving change through organic land management.

Organic production, with its closely defined production and processing standards, aims to define a whole system. It does so effectively when considering the global challenges. But to make sense, the uptake of organic and agro-ecological approaches to production must be accompanied by a reduction in intensive meat consumption and a significant reduction in food waste (estimated currently to be around one third of all food produced). If this were to be achieved, then recent estimates based on global modelling suggest that "organic agriculture can contribute to providing sufficient food and improving environmental impacts, only if adequately high proportions of legumes are produced and with significant reductions of food-competing feed use, livestock product quantities, and food wastage.[10]"

Measuring productivity in terms of yield per unit of input (land, labour, capital etc.) and efficiency in percentage cash terms, against a limited benchmark, tend to result in exceeding ecological limits whilst failing to achieve the social foundation **(see Box 4)**.

There is little or no evidence[11] that intensification in the use of inputs and maximisation of yields brings about positive impacts on either ecosystem services (the ecological ceiling), or on human well-being (the social foundation) in the UK. Single economic production functions and economic efficiency maximised for cash output are failing. They do not guide our food and farming system towards a safe space.

There is much talk of the need to feed a growing world population however the more immediate issue, in the face of climate change, the sixth mass extinction and the exponential rise worldwide in childhood obesity, is how we continue to feed the existing world population without further exceeding our planetary boundaries.

Farming should be seen within the context of the fixed and variable assets which we aim to enhance or conserve and the liabilities we seek to mitigate. This whole system/balance sheet thinking helps to address the inherent deficiency of simple economic measures by bringing all three elements of sustainability (economic, social and environmental) more effectively together. Organic producers already use this thinking.[12]

BOX 4

Genetic Modification – why GM technology may not be the best way to improve productivity or efficiency of farming systems.

Choice -

From a recent YouGov survey for the Agricultural Biotechnology Council, 57% of people rejected GM. So, why would UK agriculture want to exclude almost 6 out of 10 consumers?

Contamination (Co-existence) -

With the increase of GM, the whole of UK agriculture will be seen as GM with the level of adventitious contamination of non-GM increasing and in some cases being unavoidable. This will have implications across the whole sector whether a farmer grows GM or not and will consequently create additional costs, not least with increased testing, impacting on producer returns.

Research shows coexistence with non-GM in the event of widespread adoption of GM in the UK would be almost impossible.

Gross margin -

A United States Geographical Survey showed that following the introduction of herbicide resistant GM there was a 33% reduction in fungicides and insecticides, but a 21% increase in herbicides. Over the same period in the EU, where GM is not allowed, insecticide and fungicide use fell by 65% and herbicide use by 36%.

Feed the world -

There's a common fallacy that we need GM to produce more food so we can feed the growing world population, which is anticipated to be 9.7bn by 2050. But around half the food we produce is currently wasted, so if policies were found to avoid waste, we could feed 9.7bn now. Feeding the world is political problem not an agricultural one.

The real challenge is how do we feed the current world population in the face of mass extinctions of animal and plant life and significant climate change.

GM is effectively 'business as usual', something which everyone (including the UN and the IPCC) agree is no longer an option. It is a solution in search of a problem!

OF&G recommends that this broader balance sheet approach be adopted to fairly assess the productivity and efficiency of our agricultural systems. This could help define the future shape of farming, and allow for measurement to check we are operating within planetary boundaries. With Environmental Land Management schemes under development and the Agriculture Bill continuing to make progress, now is the chance to design and implement policies relevant to increasing the level of organic farm production in the UK by re-thinking our measures of productivity and efficiency.

10 Muller A, Schader C, Nadia El-Hage Scialabba N E, Brüggemann J, Isensee A, Erb K, Smith P, Klocke P, Leiber F, Stolze M, Niggli U (2017) Strategies for feeding the world more sustainably with organic agriculture. Nature Communications 8:1290 https://www.nature.com/articles/s41467-017-01410-w.pdf

11 Rasmussen LV, Coolsaet B, Martin A, Mertz O, Pascual U, Corbera E, Dawson N, Fisher JA, Franks P, Ryan CMI (2018) Social-ecological outcomes of agricultural intensification Nature Sustainability volume 1, pages275–282 https://www.nature.com/articles/s41893-018-0070-8

12 OF&G (2017) An organic systems approach to the provision of public goods. OF&G Policy Paper 2, December 2017 https://ofgorganic.org/useful-info/downloads?q=&filter=policy-paper