



The magazine of the Food Ethics Council

Sustainable intensification

Unravelling the rhetoric

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Food Ethics, the magazine of the Food Ethics Council, seeks to challenge accepted opinion and spark fruitful debate about key issues and developments in food and farming. Distributed quarterly to subscribers, each issue features independent comment and analysis.

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Sustainable intensification: unravelling the rhetoric

Everyone agrees that action is needed to build sustainable, resilient and fair food systems. Feeding a predicted global population of 9bn by 2050 healthily and equitably while halting the devastating environmental impacts from our current food and farming systems, means business as usual is not an option. But what does a food system that is healthy and fair to people, planet and animals look like? One solution currently receiving attention from scientists, politicians and agri-business is 'sustainable intensification' – two words whose juxtaposition is causing much debate and disagreement.

In this issue of *Food Ethics* magazine we unravel the rhetoric, assumptions and differing viewpoints and values that lie behind this new phrase. Alongside our contributors, we ask: what does this controversial term mean, in theory and in practice? And does it help or hinder the task of transforming the way we produce, distribute and consume food, here in the UK and globally?

Defining terms

Sustainable intensification appears to mean different things to different people. To John Beddington, the Government's Chief Scientific Advisor, 'sustainably intensifying' production is 'increasing yields whilst reducing negative environmental effects' (p16). The Foresight report he commissioned, *The Future of Food and Farming*, brought the phrase firmly into the mainstream of food security policy, arguing sustainable intensification must be a priority domestically and abroad. Professor Tim Benton, the UK's Food Security Advisor argues that land is the limiting factor (p9). Therefore, producing more food with no more (possibly less) land requires further intensification with fewer inputs, and minimising or mitigating environmental costs.

To others, the term is an oxymoron or, as Jonathon Porritt puts it, 'dishonest' (p16). Big farming interests and agrochemical companies have hijacked it to describe the same old model of intensive farming, but with the added gloss of 'sustainability'. Part of the problem with the term, says Colin Tudge (p14), is that it has not been properly defined and could mean more or less anything. As Tara Garnett and Charles Godfrey point out (p7), much of the controversy stems from its critics and some of its advocates presupposing that it refers to particular systems of production. However, their work to try and navigate a way through competing food system priorities concludes that sustainable intensification is unlikely to resemble anything we have today, though will certainly adopt elements from the broad range of production systems, whether 'intensive' or 'agro-ecological', that currently exist.

Its proponents argue that sustainable intensification is key to feeding a growing global population estimated to increase to nine billion by 2050, requiring an increase in food production by 50%. But Bunker (p4) and Hird (p18) challenge this 'productionist' agenda. They point out that globally we already produce more than enough food to feed everyone – the reasons for hunger are social and economic; not absolute food shortage.

Efficiency or sufficiency?

There is more agreement on the need to produce food more efficiently. Precision farming – applying the right amount of chemicals (pesticides and fertilisers) at the right time, being more water efficient, and promoting greater resource use efficiency – can produce food with fewer inputs. But contributors to this magazine differ on what kind of production system, and what levels of technology can offer efficiency. Beddington and Benton say bigger is better, but Bunker (p6) and Tudge (p14) say small and medium mixed farming can be just as efficient. Owen (p16) suggests it's 'bonkers' that we're applying precision fertilisers to grow feed for cows on land that could feed people, rather than working with the natural food-fertiliser cycle farmers have been employing for millennia. Added to this are the animal welfare concerns of 'mega farms' or intensive production systems, argue Bond and Lewis-Brown (p26). Hothersall (p 23) calls for more research into livestock production systems, based on "the behavioural, welfare and ethical implications of future agricultural systems. The Royal Society's 2009 report (Reaping the benefits: Science and the sustainable intensification of agriculture) says we shouldn't rule out any options. Decisions being made about where we put the emphasis on limited research funding belies this approach. Hird (p18) points out that expensive technologies like GM receive disproportionate funding and political attention when cheaper and simpler alternatives which can be low cost, low input diverse and high yield systems. These low cost systems are largely feeding the world today: small scale farmers can double food production in critical areas using low input high output methods – the original concept of 'sustainable intensification'.

The way forward?

Garnett and Godfrey (p7) argue for an equitable balance between 'sustainable' and 'intensification'. They propose a more useful assumption to underpin the term: tackling hunger requires getting to grips with supply, demand, waste, efficiency and population – the more successful we are in these areas, the less we will need to increase yields. DEFRA's Green Food Project has been examining what sustainable intensification means for the future of UK food and farming and is due to report in July 2012. What's clear, as Bunker points out, is that developing more sustainable agricultural systems and supporting other countries to do the same will require a suite of policies including trade reform, ending subsidies that unfairly disadvantage developing countries and sharing knowledge and expertise. Whether the language of sustainable intensification helps or hinders, this debate makes explicit the need for transformation not only of our agricultural production – but also of our whole food system, including the ways in which we consume, the priorities we give to land and feeding people fairly. Behind the language lie differing views and assumptions, but focusing the debate on the linguistics misses a golden opportunity to truly understand the challenges and explore the choices we can make to ensure a food system that is fair for people, animals and the planet.

Sue Dibb is Executive Director of the Food Ethics Council

Challenges for the food system

Putting sustainable intensification into context



Food and food security is high on the political agenda, writes **Abi Bunker** of the RSPB, and the phrase sustainable intensification is increasingly referenced by policy makers and politicians alike. But what sustainable intensification might really mean in practice, and how useful it is, is up for debate.

Globally, 925 million people suffer hunger and another one billion lack vital micronutrients in their diets. Meanwhile, one billion people are over-consuming, leading to chronic health problems.¹ The world population will probably increase until at least mid-century and per capita consumption is on the rise. The spread of the 'western-style' fat and sugar rich diet is already having significant health impacts in developing countries.²

But that's not all. Our production and consumption of food continues to have significant negative impacts on the natural environment in the UK and globally – and it is the natural environment that underpins food production, water quality and availability and indeed all human existence and prosperity.³ Numerous reports and papers highlight these mounting problems: the UK's National Ecosystem Assessment, the European Nitrogen Assessment 2011,⁴ Agriculture at a Crossroads⁵ and the Foresight report The Future of Food and Farming. These last two conclude that to end hunger and build a more sustainable food system, action is needed on many fronts simultaneously – tackling biodiversity losses, natural resource depletion, climate change, poverty, food system governance, health and nutrition, equity, investment in agricultural R&D and cutting waste.

Foresight recommended that one part of the response to these challenges should be "sustainable intensification": "the pursuit of the dual goals of higher yields with fewer negative consequences for the environment." And this one element of the report's recommendations has received such intense focus that the other parts of the integrated and holistic approach for which the report urgently calls, seem to have been largely ignored.

What does the term sustainable intensification mean?

Unlike many definitions that I've heard, the UN Food and Agriculture Organisation's take on sustainable intensification is a pretty good start: "productive agriculture that conserves and enhances natural resources. It uses an ecosystem approach that draws on nature's contribution to crop growth ... and applies appropriate external inputs at the right time and in the right amount to improved crop varieties."⁶ The journey towards this endpoint will be very different for an intensive cereal farmer

in East Anglia compared to a subsistence farmer in Cameroon. Indeed it will depend very much on the scale and importance of existing tensions between the environment and production at the local and regional scales. There is clearly not a 'one size fits all' answer for UK farming, let alone for farming across the globe.

One thing is clear: producing more food in the UK will, on its own, do little to 'feed the world'. The UK holds only 0.34% of the world's agricultural land. Our average wheat yields are already around 8 tonnes per hectare,⁷ compared to the average of 3.5 tonnes that it's estimated the world will need to meet demand over the next 25 years.⁸ And the fact is that the world already produces more than enough to feed everyone – the problem is of poverty, access and distribution.⁹

As for me, tucking into a slice of toast on a sunny morning in Bedfordshire, I'm lucky enough to enjoy a high degree of food security. I live in a country with a diverse food supply base, high domestic production capability, a well-developed food supply chain infrastructure and high standards of food safety.¹⁰ However, we in the UK urgently need to look to the environmental sustainability of our food system if we want to keep it that way, and to have a thriving countryside, environmentally and socially.

The key question is whether reducing the negative impacts of food production on the environment is enough to address the pressing environmental challenges we face in the countryside around us? The evidence suggests not. Reducing natural resource use, diffuse pollution and greenhouse gas emissions of every tonne of wheat or litre of milk produced is clearly a desirable thing. But does this approach embrace the fundamental concepts of sustainable development? That there are environmental limits within which farming – like every other sector – operates and that, despite our achievements in developing and applying amazing technological innovations, there will be levels of production beyond which we cannot go without compromising both our present and our future.

Agricultural changes

The UK countryside has undergone major changes since the Second World War as farms have become more intensive and specialised. This shift was driven by the Common Agricultural

Policy (CAP) during its drive to increase food production. While the CAP was highly successful in this aim, an unwanted side-effect was a deterioration in farmland habitats, leading to precipitous declines in the populations of many species. Across Europe, farmland bird numbers have dropped by 50% since 1980: a loss of around 297 million birds from the European countryside.¹² Grassland butterflies across Europe declined by almost 70% between 1990 and 2009, driven largely by agricultural intensification and abandonment.¹³ The National Ecosystem Assessment¹⁴ showed that increases in UK agricultural production to date have been associated with increased external environmental costs and have been at the expense of other ecosystem services.

That slice of toast I'm eating is made from wheat produced on an intensive arable farm. The environmental challenges posed by conventional arable farming are well-documented. These include biodiversity declines (arable plants, for example, are the UK's most threatened group of flora)¹⁵ and pressure on soils: erosion moves 2.2 million tonnes of arable topsoil annually.¹⁶ Intensive arable farming depends on chemicals derived from non-renewable sources, and in some areas is contributing to increased demand for water.¹⁷ However, science and policy have moved on since the early days of the CAP and there are some grounds for optimism. Pollution from farming is decreasing, albeit much too slowly,¹⁸ and we now have a good understanding of what farmland biodiversity needs to thrive within an intensively farmed landscape and agri-environment schemes which hold the potential to turn things around. Indeed the many farmers with whom the RSPB works across the UK fill me with enormous hope and inspiration and the increasing number of farmers championing the cause of wildlife-friendly farming deserve a greater platform.²⁰

As I head into the kitchen to make a cup of tea, I can hear a skylark singing through the open window from the fields behind my house. Skylark numbers have declined significantly,²¹

but they're hanging on, helped by those farmers taking actions like leaving bare 'skylark plots'²² in arable crops in return for agri-environment payments. Indeed agri-environment is the main source of funding for environmental land management. England's Entry Level Scheme is certainly not perfect, with still too many agreements delivering very little on the ground. But it has enormous potential to really make a difference for farmland wildlife if agreements were required to have the right mix of measures.

The evidence for the effectiveness of the more demanding and targeted agri-environment schemes (like the Higher Level Stewardship scheme in England) is even more impressive and these approaches are critical for protecting and enhancing rare species, areas that are 'biodiversity hotspots' and for sensitive management of special sites including protected areas.²³

As part of the CAP, agri-environment schemes are one of the few parts of this controversial policy that represent a genuinely effective and appropriate use of public money. Research has shown that a lot more money needs to be spent on the environment if the EU is going to meet its targets²⁴ but agri-environment only receive a very small proportion of the CAP budget, and even this meagre allowance seems to be under constant threat. Moves during the current round of reforms to 'green' the CAP are important, but whatever the eventual details, such measures cannot substitute for well-funded, well-designed and targeted agri-environment schemes.

The skylark is still singing as I add milk (organic on this occasion) to my tea. The UK dairy industry is facing its own challenges – some would say a crisis – with fluctuating milk prices and an ongoing decline in the number of dairy farms.²⁵ The environmental picture is not too rosy either, with intensive dairy farming associated with biodiversity losses, water pollution and unsustainable use of feedstuffs imported from the tropics.²⁶ Intensification of livestock farming since the



Photo: Pascal Thauvin

war is considered a major cause of farmland bird declines in the lowlands, with local extinctions more common in grass-dominated areas compared to arable areas.²⁷

Attempts to address these challenges have so far tended toward increasingly large, intensive dairy farms, but this trajectory may not be economically, environmentally or socially sustainable for the long-term (and remember this is the key challenge set by Foresight). There is no relationship between herd size and profit²⁸ – pretty much any size of farm can be profitable. The key factor is minimising the costs of production, which in a world of increasing and volatile commodity prices may make high input systems less viable and low input systems more attractive. And public opinion can't be ignored, after all quite a lot of taxpayers money goes into farming every year! Recent proposals to build a 'super dairy' met with strong opposition on the grounds of animal welfare and environmental hazard, and ultimately had to be scrapped.²⁹ A move towards less intensive, pasture-based dairy farming, making good use of high quality agri-environment schemes, and much better integrated with sustainable beef production, might bring multiple benefits for farmers, the environment, the landscape and animal welfare.

The challenge of consumption

So far my tea and toast have highlighted a range of challenges for farming and the environment. The cottage pie I'm planning to have for dinner will involve me in further sustainability dilemmas! Globally, the livestock sector (including dairy) is responsible for an estimated 18% of anthropogenic Greenhouse Gas Emissions, has led to the extinction of numerous species, and is probably the largest sectoral source of water pollution.³⁰ To achieve a sustainable and equitable global food system, and to improve our own health, there is no getting away from the need for us to curb our consumption of animal products.³¹

It's not just about eating less meat and dairy, however. It's also about making pro-conservation choices. Intensive livestock farming based on high inputs brings a range of environmental problems from ammonia pollution to habitat destruction in the tropics (to produce soy for animal feed). On the other hand, extensive livestock farming can have multiple environmental benefits. The recently launched RSPB report telling the story of Tarnhouse Farm, on Geltsdale reserve in the North Pennines, gives a clear picture of how this organic beef and sheep farm and its sensitive management are vital for important species and habitats, as well as for protecting water quality and carbon storage.³² And there are similar stories across the UK's more 'marginal' farmland. Whereas feed for intensive livestock tends to be grown on land that could otherwise grow food for people, extensive grazing often takes place on land that is unsuitable to grow anything else.

And what of the vegetables (seasonal and local of course) that will accompany the cottage pie I eat this evening? We are told we need to eat more fruit and vegetables,³³ but horticulture is frequently ignored in discussions about food security (as is fish, from both the marine and freshwater environments). This is also a good moment to mention the huge issue of food waste.

It is likely that over two million tonnes of fruit and vegetables are either ploughed back into the field or do not make their intended grade, suffer loss in storage or are disposed of to anaerobic digestion in the UK per year.³⁴ On top of this, UK households throw away 7.2 million tonnes of food annually.³⁵

The need for changes in consumer behaviour is widely recognised but government intervention or leadership is insufficient. The most recent research has made clear that over-consumption and 'fatness' is not only shortening people's lives but also driving climate change and the destruction of the environment.³⁶ Yet there is growing evidence that people want to do their bit to consume more sustainably, but this is dependent upon the cooperation of others.³⁷ The public may not like the idea of having to make lifestyle changes, but are prepared to do so once they understand the broader social issues at stake. Herein lies the vital role of Government – to provide leadership in setting a credible and independent policy framework, one that informs the public and helps provide them with meaningful steps that they can take, whilst being assured that others are doing the same. Things certainly can't go on as they are, with most of us overweight or obese³⁸ and spending an average £20 a month per household on wasted food.³⁹

Policies in Europe are still failing to fix current environmental problems, the unintended consequences of the last round of post-war intensification and current levels of production,⁴⁰ even where we know the reasons and have cost-effective solutions.⁴¹ Policy makers are ignoring the vital role of good regulation, well implemented and enforced, and the need for all of our taxpayer money to be made to deliver the vital goods and services that the market fails to pay for.

The international dimension

At an international level action is equally vital. Food and farming is a big part of the discussion at the Rio +20 Conference in Brazil – the recognition of the vital importance of achieving more sustainable crop and livestock production is there in the words, but as I write we can only hope that we get some commitments to action.

In the world of policy, you quickly get used to using jargon – terms (like sustainable intensification) which might allow agreement to be reached by a wide range of stakeholders but which hide all manner of different interpretations. I think everyone engaged in these discussions agrees that farming and the food system in the UK needs to become more sustainable than it is now. But the differences arise in terms of how much improvement (in both production and sustainability) is 'enough' and how we can best achieve this. There will be tough choices and trade offs in fixing things but those choices should not and need not be between saving our skylarks here in the UK and saving the tigers in the forests of Sumatra, or between getting back our clean and thriving rivers and achieving real food security for everyone across the globe. We need to, and can, achieve all of these. ■

Abi Bunker heads up the Agriculture Policy team at the RSPB, where she applies her training and experience as a behavioural ecologist and chartered accountant to help secure a more sustainable future for farming and the countryside.

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Sustainable intensification

Defining terms

Tara Garnett of the Food Climate Research Network and the Charles Godfray of the Oxford Martin Programme on the Future of Food have been working with a community of key thinkers on the meanings, issues and challenges around sustainable intensification.

The Food Ethics Council has had a preview of the draft report, and here we look at the implications it has for the future direction of food policy. We assess the insights it can bring to bear on initiatives such as the UK Government's Green Food Project which aims to consider how we can increase food production and enhance the environment.

Garnett and Godfray intend that their report will help policy makers around the world work out what the definition of sustainable intensification might most usefully be, and help them understand the trade offs, differences and commonalities, rather than perpetuating entrenched positions around terminology. They conclude that while sustainable intensification is a useful concept for thinking about food system issues, it is not the golden key to unlock global food security – actions on other fronts are also necessary, including approaches that modify demand for resource intensive food, to reduce food losses and waste, and to improve governance of the food system. They also assert that the alternatives to sustainable intensification – non-sustainable intensification, or increasing the amount of land used for agriculture – are not environmentally viable options.

Drawing together experts with diverse views on what sustainable intensification means, the authors led discussions on issues ranging from land sparing/land sharing, animal welfare and the impact of other problems such as distribution, waste and governance on providing adequate food supplies across the world. The authors discovered that while policy makers all agree that the food system has got to change to face the challenges ahead, there is a wide disparity of opinion about how. They note that those opinions are often informed by values which define how they think about the economy, the environment, development priorities, or even how they would describe 'a good life'.

Different definitions of Sustainable intensification are also driven by individual values, and herein lies the problem. Many argue that the emphasis in Sustainable intensification should be on increasing the amount of externalities and technologies (in other words the intensification side of the coin). They believe that increasing food supplies will 'solve' global hunger. Others believe that you can't solve the problem of global food supplies without addressing demand, and put the emphasis on the sustainable side of the coin. Others who emphasise sustainable advocate an 'agro-ecological' approach to farming.

Garnett and Godfray argue instead that sustainable intensification should be about an equitable balance between "sustainable" and "intensification", and as such it will be a radically different food system than we have today. Tracking the history of the term, the authors explain that it first emerged in the 1990s, in the context of African agriculture, where yields are very low and environmental degradation a real cause for concern. So sustainable intensification began life as a pro-poor, smallholder orientated definition of farming.

They point out that the original smallholder orientated approach to Sustainable intensification was about what mix of interventions worked best in individual situations. Yet it seems that what was originally a flexible 'blank canvas' approach to farming has become a canvas so crowded with opposed views on what Sustainable intensification should mean that there is now very little consensus on any of the principles behind it.

Speaking in December last year to the Environmental Audit Committee on sustainable food, Caroline Lucas Green MP for Brighton Pavilion said "Sustainable intensification to me sounds weird ... is there not a danger that it will be used as a Trojan horse for those who want us to have lots more biotech and GM and so forth? ... is there a potential conflict between how this idea might be used and the future of small-scale farming?" And as if confirming Ms Lucas's prediction, writing in the Times Peter Kendall, Chair of the NFU said: "...sustainable intensification ... will take many forms. Biotechnology ... will undoubtedly be part of the picture ... housed livestock will also be part of the picture".

So how can we find commonalities in definitions of sustainable intensification; what will help us achieve those agreements; and what kind of support in terms of research, metrics and governance do we need to make Sustainable intensification a workable part of the solution to sustainable food supplies?

Firstly, the report suggests that we need to ditch our current assumptions about sustainable intensification. Those assumptions are defined as: 1) it's either a description of how the current farming system can adapt to meet the challenges it faces; or it's an aspiration of how the farming system should change to meet them. 2) It's about production, driven by the current 'fact' that we need to increase food production by 70% by 2050 or it's about demand – more food doesn't necessarily mean less hunger unless the distribution of food is equitable. There's a third assumption, which the authors consider more helpful. That is to tackle hunger you need to get to grips with supply, demand, waste, efficiency and population. This "third way" is vital to the Sustainable intensification debate, suggest the authors, because the more successfully you tackle demand, waste, efficiency and population, the less you will need to increase yields.

Garnett explains: “Our argument here is that the ‘need’ for sustainable intensification is independent of the ‘need’ to produce more food. The goal of sustainable intensification is to raise productivity (as distinct from increasing volume of production) while reducing environmental impacts.” She goes on: “Sustainable intensification is a really useful concept to help us think about the issues facing our food system, and helps us see that alternatives, such as turning more land over to agriculture or merely intensifying production without even trying to do it sustainably, are just not credible options for the environment.”

The authors argue that if we lived in a world where excessive consumption, unequal distribution of food, waste and social injustice were things of the past, we wouldn’t need to increase our food production. Sustainable intensification could instead focus on how to allow our current levels of food to be produced on less land, allowing more to be set aside for other ecosystem services, like afforestation. However, this scenario is unlikely, so – particularly in regions such as sub Saharan Africa – we will need to increase food production. But the report argues that rather than setting an arbitrary worldwide target for how ‘much’ intensification is required, levels should be set locally, taking into account how much extra food needs to be produced sustainably.

Garnett and Godfray’s report identifies three key issues of concern about food production and consumption. They acknowledge that while there are many more, these three come up repeatedly in discussions about Sustainable intensification. They are issues that relate to the environment, animal welfare, and what the ‘outputs’ from the system should be.

Environmental sustainability

When we talk about sustainable food production, we often mean a form of farming that is fit for the future. But it’s unclear what we mean by ‘fit for the future’, particularly in environmental terms. Do we mean a general aspiration to do less environmental damage? Or does more specific ideas like only using organic techniques? It all goes back to those ‘values’ that make Sustainable intensification such an emotive topic. The authors argue that policy makers need to set pragmatic environmental goals and targets that satisfy private sector investment aims, and reflect the best available environmental science. These might involve water quality, GHG emissions or biodiversity targets, for instance. In practice this may be difficult to achieve within domestic and regional political frameworks. Different interest groups will lobby for their own ‘value’ sets; some policies might negate others, and there may be unintended consequences.

Animal welfare

Another key example of how elements of Sustainable intensification are viewed through a subjective, ‘values’ driven lens, is animal welfare. Different actors place different weight on the importance or otherwise of physical, emotional and behavioural criteria in animal husbandry. Intensive livestock farming excites much debate. On the one hand many people believe that an emphasis on Sustainable intensification may

deliver environmental benefits (such as fewer GHG emissions), but do nothing to promote – and may even be detrimental to – animal welfare. And yet others believe that considerations of food security, economics or even just food preferences are more important. So can we manage these conflicting issues by ensuring that any definition of Sustainable intensification explicitly includes the need to achieve animal welfare? And how would that be achieved? This, argue the authors, is a debate that needs to be held.

Food system outputs

What, asks the report, do we want to intensify productivity of? Food, of course, is a given. But what types of food, and what are the non-food outputs that have a beneficial effect on society? Some of those other outputs or outcomes would be health, livelihoods, soil fertilisation, economic security, or cultural status. The report suggests that we need to ask ourselves what outputs we value most in order to guide policy in the ‘right’ direction.

Environmental sustainability; animal welfare and other outputs: all different issues but all come up time and again when trying to get to the bottom of what Sustainable intensification means. And, the report suggests, two key questions are linked to these three issues. Firstly we still don’t understand enough about them; and secondly even if we think we understand the ‘facts’, people assign different values and meanings to them. It’s clear, the authors agree, that whilst they don’t have all the answers to those questions, there is a job to do in defining the issues that need to be considered when making decision, or investing in research to strengthen the evidence base. And that’s where the concept of Sustainable intensification comes in: to provide a framework for thinking about the issues.

The report concludes that Sustainable intensification is a new and evolving concept that should be seen as providing a process of enquiry and analysis for navigating the issues and concerns, and as part of a wider ‘systems based’ approach to achieving sustainability in the food system. The other elements to this approach are governance of the food system to improve equity and distribution; measures to moderate demand for resource intensive foods, actions to reduce food losses and waste throughout the supply chain; a renewed focus on modifying the rate of population growth – and sustainable intensification.

The report’s final message is that not one of these measures on its own is a silver bullet that will achieve a sustainable food system. Each has to work in tandem with the rest. Policy makers and key actors in championing their own ‘versions’ of Sustainable intensification should do well to remember that Sustainable intensification is not a substitute for any or all of those other measures, but one piece of a jigsaw that only when complete will deliver a food system that is fair for people, animals and the planet. ■

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Supply and demand

Increasing production and efficiency sustainably



UK Champion for Global Food Security, **Professor Tim Benton**, explains how a growing world population and an expanding global middle class are putting increasing pressures on our food system, leading to new challenges for feeding the world sustainably.

As the world's population grows, global demand for food is increasing.^{1,2,3} By 2050 the global population is predicted to grow to around 9 billion people. As countries develop, people get richer, with the growth of the global middle class predicted to rise to about 5bn in the next 20 years. Many of these people will want to eat more meat and dairy in their diets. The growth of both the numbers of mouths and their increased average demand for food will put considerable strain on food production.

In meeting this growing demand, we have to contend with competition for land and climate change. There is globally limited scope for expansion of agricultural land. The majority of recent expansion has come at the expense of tropical forest⁴ – with the ensuing societal costs of loss of natural capital and emission of greenhouse gases with the resulting considerable mitigation costs levied.⁵ In addition, increasing urbanisation of the world population is changing the relationship between society and the land, not least as decreasing rural populations provide less available labour for agriculture. Land is also increasingly used for non-food crops such as oil palm and environmental degradation has also led to abandonment of former agricultural land.^{6,7} Climate change is also likely to have major impacts on agricultural productivity and practices^{8,9} with a recent study suggesting that by 2050 average yields in sub-Saharan African agriculture will decrease between seven and 27%, with higher productivity areas being more directly affected.¹⁰

There are therefore strong drivers underpinning the productionist agenda: increasing demand against the constraints of no more (perhaps less) land and climate change. However, there is also increasing recognition that the environment provides an important range of services, often termed “ecosystem services”, that need protecting.^{11,12} These include those that may aid food production (such as soil fertility, pollination, natural pest control, water) or may have monetary or non-monetary value for society as a whole (for example contributing to climate control by storing carbon, flood control), or cultural value such as the look of the landscape and the existence of iconic biodiversity. The history of recent decades suggests that despite the immediate gains, the green revolution has often come with unsustainable environmental impacts and resource use in terms of inorganic nitrogen, phosphate fertiliser, fuel use, soil degradation and biodiversity loss. This has resulted in the degradation of the

ecosystem services upon which both agricultural productivity (in the long term) and society relies.^{13,14,15} Thus, there is a third constraint acting against the productionist agenda: the need to reduce the environmental impact of agricultural practices, and increase their sustainability. This “sustainability challenge” is a very real one, because in the long run, sustaining production requires it and, as with climate change, the longer agriculture fails to embrace the agenda, and develop the business opportunities it brings, the more it is likely to cost to get back on track (in monetary values, ecosystem losses and human costs).

The context outlined is summed up in the notion of ‘sustainable intensification’: the need to produce more food per unit area, with fewer inputs, whilst minimising or mitigating environmental costs.^{17,18}

As discussed above, the main drivers for increasing global demand for food are population and income growth, particularly in developing nations. So does this mean we need not worry about increasing UK production? The answer is “no” and for a host of reasons. Firstly, our population is growing. The population of the UK is expected to grow from around 62 million now to 69 million by 2050 – an 11% increase over 40 years and more mouths will require more food. Secondly, we are far from self-sufficient in food production. Given the global market for food, our production systems have specialised to a range of products to which UK agriculture is best suited. Our diverse demands (such as for year round fresh fruit) mean that we have to import much of what we eat and in economic terms we import more food than we export. Self-sufficiency in food (and drink) would require radical changes in diet and land use and it is difficult to see the drivers that might lead to increases in production for local consumption. Recent research indicates that diverse farming systems produce a lower mean economic yield (though one which fluctuates less from year to year),¹⁹ and so moving towards self-sufficiency would lead to lower overall yields, more diversity of products and an overall requirement for more land at a time when it is already under considerable pressure. Furthermore, consumer choice would be restricted as many everyday ingredients like fruit are not well suited to UK production systems. Thus, we will rely on the global market unless something happens to restrict it. Self-sufficiency did increase during the Second World War but this came at a considerable cost in terms of land, labour and food availability.

The UK is part of a global food system. This means that our needs are inter-connected with those of the rest of the world. If we produce more food than we use, others will want to buy it, leading to UK economic returns. The UK produces about seven percent of the global production of wheat, as we have very good conditions for its production. As climate change impinges on global production, we are going to be less affected than other areas, and others' demand for our production will grow. Our society's choices also impact on land management across the world. Demand for food for livestock is driving deforestation in the tropics; therefore our local demand for livestock has environmental consequences levied "offshore". At the moment, the EU uses a land area about the size of Germany outside its borders to supply our food, a "virtual land grab" which has grown by the size of Portugal in the last decade.²⁰ Given that the producing countries have, themselves, a growing demand for food, there is no certainty that they will continue to allow us access to these resources, especially as competition increases from elsewhere. Contributing food onto the global market gives us economic leverage to purchase food from it.

My view is that as global demand grows, and as we compete ever more for access to the global market, we need to play our part and increase production. If we don't, we are placed in an ethically complex position: "we'll not intensify our agriculture to save our environment, but if you do, we'll buy your food". The "you" here will almost certainly be somewhere in the tropics where the environmental cost of intensification may be considerably greater than ours, both due to more biodiverse and fragile ecosystems, but also to lower levels of environmental regulation. The caveat is always that intensification needs to be done sustainably.

The question is: how? There are two broad approaches leading to sustainable intensification: promoting greater resource use efficiency, and management of non-production areas within the farmed landscape to support ecosystem services. The former is akin to producing more food with fewer inputs. The routes to this are through innovative use of technology: applying the right amount of chemicals (like nitrogen fertiliser or pesticides) at the right place and at the right time. This is "precision farming". Investing carbon in the soils can increase fertility, aid water retention and mitigate climate change. The second route is through management of non-cropped land for ecosystem services. For example, field margins can be managed to support pollinators or small wasps that kill crop pests. Other areas of land can be managed to produce other ecosystem services (from buffer strips to protect water courses, to coppices for domestic fuel, to areas managed specifically for biodiversity). This managed non-cropped land can contribute to a landscape-wide network of habitat to support biodiversity in general.

Land throughout the world is under growing competition (for agriculture, roads, housing, recreation, conservation) and therefore the land that is devoted to a purpose needs to work harder. Some areas can naturally produce food more easily than others, and conversely, some areas are better at providing other ecosystem services (such as biodiversity, the cultural value of the landscape, providing flood defences or clean

water). Different areas may need to become more specialised to maximise the total needs. This is the "Henry Ford" solution – by specialising the overall efficiency increases.

The 'sustainable' in sustainable intensification is not optional. Increasing resource use efficiency is a 'no brainer'. As resources become ever more expensive, trying to find ways to reduce their wasteful use makes sense. In times of drought, farmers who are more water efficient are in a better position than those who have not previously invested in water management. Increasing the resilience of agriculture will require that production systems recognise that resources will become rarer, and perhaps access will be more volatile, and adapt to that eventuality. Finding ways to grow production (such as through developing new varieties underpinned by genetic research), whilst innovatively becoming more efficient, is what sustainable intensification is all about. ■

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Sustainable food systems

Meeting the challenge of the sustainable intensification of agriculture



Merely increasing food production or crop productivity is unlikely to resolve the issue of global food insecurity, writes **Professor William Davies**. But stagnation of productivity with continued resource input at current levels will certainly exacerbate the emerging tensions between actors in the food system.

In a 2009 policy report, the Royal Society¹ focussed on opportunities for the sustainable intensification of agriculture. The success of China in dramatically increasing the availability of food for its population over the last fifty years² is due in large part to intensification of crop production. This arises from the introduction of a range of innovations and the exploitation of novel crop science through crop improvement and modified crop management.

Although highly successful in purely production terms, China's 'green revolution' has been accompanied by significant increases in use of water, fertilisers, agrochemicals and energy. Limited availabilities of water, land and energy (for fertiliser manufacture *etcetera*) are likely to become a massive limitation to crop productivity in many parts of the world.

If year on year gains in productivity are to be sustained or increased to address the challenge of feeding an increasing world population, attention must be given to the variety of innovations that might deliver more sustainable changes in farming practice. We focus here on the delivery of 'more crop per drop' of resource input into food production.

Environmental services

One driver for the reduction of water and nutrient use in agriculture and for giving increased attention to sustaining or increasing soil quality is the urgent need to restrict environmental degradation that can be caused by inappropriate agricultural practices.

When intense agricultural activity is combined with the effects of a changing climate, the negative impact on environmental services can be dramatic. For example, on the Indo-Gangetic plain, a major wheat production region for India, excessive groundwater usage for irrigation has resulted in declining water tables at rates between one and three metres per year. This reduction in availability of water to farmers can lead to highly unproductive agriculture.

Equally seriously, native vegetation will be unable to flourish and desertification may result. In the Shiyang river basin in NW China, reduced water flow in inland river systems, due to reduced snow melt and overuse of water by farmers

in the upper reaches, is resulting in ecological catastrophe, a decline of previously productive agricultural areas along with a deterioration in the livelihoods and quality of life of a substantial local population.³ The key issue is how water use in agriculture can be controlled while food production is sustained or even increased.

Crop management

Crop production requires substantial quantities of water. It requires around 1m³ of water to produce 1 kg of wheat, and 1kg of rice requires at least 1.2m³ of water. In hot, dry regions, 1kg of grain yield may require as much as 3–5 m³, which must be provided from precipitation or irrigation. Although irrigated agriculture occupies less than 20% of the land area devoted to food production, this produces more than 40% of the world's food. Due to changing rainfall patterns under climate change there is increasing demand for irrigation. However, competition for water with industrial and domestic users means that irrigated agriculture will increasingly take place under water scarcity.⁴ So irrigation management that previously focused on maximizing production per unit area must now focus on maximizing crop production (yield) per unit of water applied. This quantity is the 'water productivity' of a cropping system and can be enhanced by deficit irrigation (DI), defined as the application of water below full crop-water requirement.

Soil drying resulting from deficit irrigation will almost inevitably reduce crop production and we now have a good understanding of the basis of this limitation.⁵ Recent work has shown how simple, low cost DI techniques can be designed to minimize this yield penalty. But some problems are not easy to avoid. Because evaporation from crop canopies is tightly linked with carbon uptake for photosynthesis, reducing crop water loss is very difficult to achieve without decreasing crop production.

Nevertheless, painstaking trials in many parts of the world with many different crops have identified periods during crop development when water can be saved without yield penalty. Our increasing knowledge of crop physiology also allows us to ensure that water is available for crop development at times when yields are critically sensitive to soil drying (or even allow us to use less water to increase yield).



Novel understanding of plant drought stress biology has led to the use of DI as an inexpensive, low-technology means of manipulating plant growth, water use efficiency (WUE) and crop quality. Another easily-applied technique devised to save irrigation water and exploit the biology described above is alternate wetting and drying (AWD) of soil in rice production. Paddy rice production in Asia is demanding on water use. Increased grain yield and water use efficiency (WUE) under AWD might be attributed to improved canopy structure and reduction of excessive vegetative growth.^{6,7} One further benefit from AWD can be the reduced uptake of arsenic and cadmium into rice grains, compared with grains from plants grown in flooded fields. Such changes in ion accumulation can deliver safer food and substantial health benefits without the need for potentially expensive genetic manipulations.

In the Shiyang river valley, local water managers and researchers from China Agricultural University have recommended shutting wells, returning farmlands to forests and grasses and adopting water-saving irrigation techniques. As a result of these changes, the irrigated area and water consumption in irrigation are reduced in the upper and middle reaches of the river valley and the surface water flow into the reservoir in the lower reaches is increasing significantly. It seems likely that these changes and associated changes in ground water levels can have substantial positive impacts on the local population, environment and food production. Agronomic techniques such as soil mulching, protected cropping, the use of skip rows, crop rotations, alteration of planting or sowing dates and intercropping can result in greatly increased efficiency of water use in agriculture. These are all relatively low cost, low-technology interventions which can be applied immediately to enhance the sustainability of agriculture. In contrast, the development and introduction of a new plant variety can take between ten and twelve years.

Crop Improvement

To date, we have had some success using conventional plant breeding and selecting genetic material for superior yielding under conditions where water is often in short supply.

However, there is reason to believe that modern biology can speed up the crop improvement process and increase its effectiveness. This may be through the introduction of drought resistance genes via modern genetics; but on its own this approach will likely be only a partial contribution. It seems more likely that an approach to crop improvement associating genomics, physiology, genetics, high-throughput phenotyping and some crop modelling (see www.drops-project.eu) is more likely to make a bigger contribution to extra food production when water is scarce.

Searching for 'drought resistance genes' to address the problem of yielding under drought has to date delivered only limited success. In contrast to this approach, Richards has pointed out that action of constitutive genes apparently unrelated to plant water relations can have a big effect on drought tolerance. Thinking of this kind has had a significant impact on plant improvement programmes around the world. For example, Edmeades and co-workers have shown how shortening the anthesis-silking interval in maize (a period when yield development is highly sensitive to drought) can reduce seed abortion and reduce the incidence of complete crop failure. Recently, physiological trait-based breeding has shown promising results when, for example, plants with deeper roots incorporated in a wheat breeding programme delivered superior performance under drought.⁹

Conclusions

In parts of the world where landscape is valued for particular services in addition to food production, it may be that to safeguard the delivery of these services, agriculture must be less intensive. In other traditionally productive regions, if we are not to risk extra greenhouse gas emissions by extensification, then we must intensify.

We argue here that many novel cropping practices are compatible with this course of action and can also deliver a range of environmental services in addition to yield. The Royal Society's 2009 report on science for sustainable intensification of agriculture has stressed that no options should be ruled out

at this stage. This statement applies to agro-ecology just as much as it applies to GM technology.

Rather than a single 'magic bullet' to limit resource use, an enhanced production of food, delivery of enhanced soil quality and other services, it seems likely that each manipulation may contribute an incremental change in yield if we are to deliver an increase in food availability through increased production. A 'productionist' approach to making food more available need not be technologically intensive and is not necessarily at odds with an ethical, sustainable food system. ■

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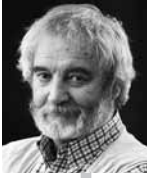
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Photo: Michael Law



Enlightened agriculture

A people's takeover of the food supply



Colin Tudge discusses the role of agro-ecology in feeding the world sustainably.

The term 'agro-ecology' certainly means something – or it ought to. It ought to mean farming in ways that are roughly in line with how wild nature works; and in ways that do no more harm than is necessary to wild nature – and might even in some ways be helpful. The expression 'sustainable intensification', recently coined by government, has not to my knowledge been properly defined and could mean more or less anything. It could mean something perfectly compatible with the aims and ideals of agro-ecology or the precise opposite: the creation, or rather the continuation, of a system of agriculture that is designed primarily to be 'efficient' – where 'efficiency' is defined purely in financial terms: the most money in the shortest time.

When cash efficiency is the *sine qua non* all other considerations, including the quality of the food, the quality of human life, animal welfare, the wellbeing of wild creatures, and the integrity of the Earth itself become secondary. Then, measures intended to improve human wellbeing, or raise standards of welfare, or reduce damage to what is now called 'the environment', at best become exercises in cosmetics and fire-fighting. There is no reason to suppose that 'sustainable intensification' will be any different; and every reason to suppose that in reality, it will mean business as usual – with even more high tech and a very great deal of propaganda.

To begin at the beginning: I take it to be obvious that the purpose of agriculture is to provide people with enough good food to ensure sound nutrition and preferably (indeed vitally) to support fine gastronomy. The imperative is to do this without wrecking the rest of world – without driving our fellow creatures to extinction, or polluting or otherwise squandering the waterways and the soil. This is a moral, aesthetic, and, many would say, spiritual imperative: we are only one species among many and we just don't have the right to screw things up for everyone else. It is also a matter of self-preservation. If we wreck our world as we seem well on the way to doing, there will be no second chance. I call farming that is expressly intended to provide good food without wrecking the rest, 'Enlightened Agriculture'.

It is also obvious when you look at the facts, as opposed to the particular statistics that governments, corporates, and

their expert and intellectual advisers choose to work from, that Enlightened Agriculture – good food for everyone and a synergistic relationship with the rest of nature – ought to be relatively straightforward.

First, according to Hans Herren of the Millenium Institute, Washington DC, the world already produces enough food to feed everybody well – in fact it already produces enough to support the predicated 9.5 billion population in 2050 (which the UN tells us is the most there will ever be, since numbers are levelling out). In fact, says Professor Herren, the world currently produces enough to supply the present population with 4800 kcals per day per head – twice our average requirement (given that a high proportion of the present population are small children, who eat less). If those food kcals are produced as standard staple crops – cereals, pulses, the major tubers – then protein more or less takes care of itself. So the macro-nutrients should pose no problem. Then the primary role of horticulture and to a large extent livestock is to provide micronutrients: vitamins, minerals, and the no-doubt extensive list of unknowns which the pharmaceutical industry now likes to call "nutraceuticals" (such as plant sterols which apparently reduce blood cholesterol).

The main reasons why we apparently produce too little (and a billion people are chronically hungry) is that we waste so much of what is grown (in the field, in store, and – in the western world – after it reaches the kitchen) and because we produce so much in the wrong places. In short: the idea that we need 'intensification' – implying that we need to grow significantly more than we do now on the land available – is far from obvious. Yet official reports and corporate brochures continue to insist that we need 50% more food by 2050 or even 70% more by the end of the century. I have never heard anyone in high places convincingly spell out why they think this is necessary.

Demonstrably, the best way to produce the amount we need is on mixed farms, with tightly integrated interaction of different crops and animals outdoors. Under normal farming conditions, a well-run mixed holding can produce far more good food per unit area than any other kind of system, and certainly when

averaged over a few years. Highly-intensive monocultural horticulture can and does produce very high yields, but only in highly protected conditions. 'Sustainable' takes us towards organic farming, in which inputs of non-renewables such as oil are kept to a minimum; with no collateral damage from agricultural chemicals. Mixed, tightly integrated farms that veer towards the organic are inevitably complex, and so need to be labour-intensive – meaning skills-intensive: good farmers rather than slave labourers. In farms that are complex, organic or quasi-organic, and skills-intensive there is no advantage in scaling-up. So in general the kind of farms we need – productive yet non-damaging – will be small to medium sized. Mixed, integrated farming systems imitate nature and are in this sense 'agro-ecological'. They minimise collateral damage (and make good use of local predators for pest control), so they are 'agro-ecological' in this sense too.

Small mixed farms geared to what local landscapes can support almost invariably produce a lot of plants (both arable and horticulture); some meat, but not much – because animals are confined to grazing (cattle and sheep) and leftovers (pigs and poultry); and provide enormous variety. These nine words – “plenty of plants, not much meat, and maximum variety” – summarise the nutritional theory of the past 40 years, and encapsulate the basic structure of all the world's great cuisines (Turkish, Indian, Chinese, Provencal, south Italian). So farming that can really feed us well and sustainably goes hand in hand with the best nutrition and the best cooking. So what is supposed to be the problem? Perhaps all we really need to do to feed ourselves and the world – or more precisely re-learn how to cook. It's clear (my own favourite slogan) that the future belongs to the gourmet.

The kind of farms we need ... will be small to medium sized

Can small-to-medium sized quasi-organic farms really feed the world? According to the industrial farm lobby that is now called 'conventional', overseen by the government and their corporate partners, the answer is “No”. Apparently we need oil-based agrochemicals and GM as a matter of urgency. In reality half the world's food already comes from small to medium sized, mixed farms. Another 20% comes from hunting, fishing, and people's back gardens – so the much-hyped industrial farming that is supposed to be vital provides only 30% of our needs. But small mixed farms are sidelined by modern governments and swept aside while vast tranches of cash (including taxpayers' money) is poured into industrial farming in the form of grants for farming and research.

Yet if Britain practiced Enlightened Agriculture based on small, mixed, quasi-organic farms we could easily be self-reliant in food. We could also employ all of the three million who are now unemployed, including or perhaps especially the one million unemployed under-25s, in jobs far better than the

shelf-stacking and mail-order cold-calling that are now on offer. Instead we produce only about half our food while politicians wring their hands over what Ebenezer Scrooge in a remarkably similar economy called “the surplus population” who alas are left on the sidelines.

However, if the aim of farming is to do as the present economy and the last five British governments (Thatcher, Major, Blair, Brown, and now the 'Coalition') have demanded (maximize cash efficiency), then we must go down the opposite route. We cannot be content simply to produce enough – we have to maximize output, by whatever means; which in general means more and more oil-based agrochemistry. We are easily capable of producing far too much, as demonstrated by the European cereal and butter mountains of earlier decades. But if we do, we simply have to waste the surplus, which can be very rewarding financially. The easy way to waste cereal and soya is to feed them to livestock (who should be eating grass and leftovers) – and hence the vast modern factory farms. Even easier, though – the latest scam! – is to call the surpluses 'biofuel', and burn them. Correspondingly, costs are reduced by getting rid of labour – so in Britain and America only about one per cent of people are full-time farmers.

So what in practice will 'sustainable intensification' mean? It certainly could mean agro-ecology. If the aim was truly to produce more food (intensification) without wrecking the rest (sustainability) then it could mean encouraging small, mixed, quasi-organic, labour-intensive farms in line with the principles of Enlightened Agriculture. But we can be pretty sure that it won't. The ultra-competitive, neoliberal, global market, geared entirely to the maximization of wealth, is now granted the status of a law of nature. Any system that does not maximize short-term profit is deemed 'unrealistic', even though the systems that do maximize profit are threatening to kill us all.

'Sustainable intensification' in practice is likely to mean even more of the same. We can expect cattle factories with 30,000 animals (with filters to remove carbon monoxide); GM crops grown in ever larger monocultures with less pesticide (until the pests learn to overcome the in-built resistance); and crops for 'biofuel' in every square inch (for the lazy generalisation has it that biofuels are 'carbon neutral').

Above all we can expect yet another elaborate scam at our expense overseen by people with no direct knowledge of agriculture but an absolute belief in high technology and their own right to be in charge.

What is really needed in Britain and across the globe is for people at large to take control of our own affairs; nothing less than 'a people's takeover of the world's food supply'. To this end my wife (Ruth) and I began the Campaign for Real Farming (www.campaignforrealfarming.org). For a general outline of what is needed and why and how please see *Good Food for Everyone Forever* (Pari Publishing, 2011).

Colin Tudge is a biologist and writer, and co-founder of the Campaign for Real Farming.

The big question

What does sustainable intensification mean for food and farming?



Professor Sir John Beddington is the Government Chief Scientific Adviser

The challenges of sustainably feeding the world's population are profound, and with a food supply chain more globalised and interconnected than ever, it will be critical for the UK to work with organisations and governments around the world to help farmers everywhere adopt sustainable methods of agriculture.

In 2008, I commissioned 'The Future of Food and Farming: Challenges and Choices for Global Sustainability' report to explore how the global food system can balance these competing pressures. It concluded that achieving sustainable intensification of agriculture – the raising of yields whilst reducing negative environmental effects – must be a priority both domestically and abroad. This will require knowledge, technologies and expertise to encourage the adoption of more efficient farming practices, which reduce emissions, enable cost savings, enhance landscapes and protect biodiversity. Tackling this will need a global strategic approach but with actions appropriate to local contexts. It will also necessitate cross-disciplinary scientific research; technological innovation, and new business models. Improvements to governance and infrastructure will also be needed, as will, ultimately, behaviour change by producers and consumers alike.

The UK farming system also faces the global challenges brought about by a growing and more affluent world population, human-induced soil degradation and climate change. However, action is now being taken. Initiatives such as the Department for Environmental Food and Rural Affairs' 'Green Food Project', are looking at how to reconcile the need to increase food production with the Government commitment to also improve the environment, and the Future of Food and Farming report's messages on sustainable intensification have had an impact throughout the UK food system.

Sustainable intensification gives the UK an opportunity to address these pressures, and be a world leader in sustainable food production, helping to supply the rest of the planet with the practical solutions that are urgently needed.



Jonathon Porritt is Founder Director of Forum for the Future

Language matters. It matters a lot in the field of sustainability, where the concept of sustainable development has been systematically abused pretty much from the moment it first entered the mainstream in the pages of the Brundtland Report (Our Common Future) back in 1987.

Given its provenance (in a Foresight Report on the future of food and farming), I was at first inclined to give the 'sustainable intensification' terminology the benefit of the doubt. That was naïve. It's quite clear, two years on, that the idea of sustainable intensification is being used by big farming interests and agrochemical companies to describe exactly the same old model of intensive farming, linguistically (and dishonestly) embellished with the 's' word.

So full marks to Peter Kendall, long-serving NFU supremo, whose recent call for mega-farming (for both livestock and arable enterprises) avoided any sustainability tokenism: his farming vision is all about fewer farmers making bigger profits by more efficiently / ruthlessly mining the soil, exploiting animals, whilst not worrying too much about water, biodiversity and greenhouse gases.

So should we try and salvage the concept of sustainable intensification? Not on those terms. Let's just stick with 'sustainable farming' – pure and simple. That still means putting a lot of importance on increased yields in many parts of the world, but achieved differently – through improved agronomy, building up farmers' skills and securing livelihoods, reducing inputs, developing agro-forestry and mixed cropping, and putting a priority on building up soil carbon and dramatically reducing our near total dependence on fossil fuels.

All of which is eloquently and authoritatively elaborated in the IAASTD (International Assessment of Agricultural Science and Technology for Development) – a source of insight and wisdom cordially despised by those who now enthuse about the deceit that is sustainable intensification.



Gethin Owen farms beef & sheep along with some cereals, potatoes and pigs on a 190 acre organic farm near Abergele, North Wales.

As a ruminant farmer, I'm guilty of being part of the biggest contributor of GHG's within the food chain. To mitigate our GHG emissions, the Foresight report advises us that we need to 'sustainably intensify' and implement high production, grain-based feeding systems. Compared to extensive, forage based systems, the animal trumps and burps less for every kilo of milk or meat produced.

As we're using field mapping technology to efficiently apply fertiliser on the grain crops which are grown to feed them and scientists will probably find a way to perennialise them, everybody's happy.

Is it me, or is this bonkers? Ruminants were domesticated because of their evolutionary ability to produce food on land unsuitable for cultivation and be an integral part of the fertility-building phase within crop rotations – not to eat what we could digest ourselves.

It appears that the green light is being given to accelerate the increase in scale, intensity and associated pollution issues of ruminant production in western areas, while the soils of the south and east will continue to be drained of their inherent fertility in order to sustain them.

The increase in intensity and specialisation of agriculture could be another nail in the coffin for the biodiversity we have left within the 75% of the UK which is farmed, that evolved to depend on the varied habitats traditional mixed farming provides. Maybe we need to look back in history and remind ourselves of the effect official doom-mongering and the policies created in response to those fears have had on our rural landscapes, biodiversity and the quality of our food.



Jeanette Longfield is Co-ordinator of Sustain: The alliance for better food and farming, and Food Ethics Council member.

In my view, the definition of sustainable development by Gro Harlem Brundtland has not been bettered since she coined it 25 years ago: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” ‘Sustainable intensification’ cynically strips the philosophy of its meaning.

In a way you have to admire the sheerchutzpah of some of those behind this neologism. As a cover for ‘business as usual’ (which the same folks say they agree is “no longer an option”) it is rather clever. Under this shiny, but paper-thin veneer agri-business worldwide, including in the UK, can continue with energy intensive monocropping, using up finite supplies of fossil fuels, artificial fertilizers and water, stripping our land of both biodiversity and skilled labour. To call it ‘sustainable’, you have to use ever more expensive technology so that you use just a little bit less of everything else and produce just a little bit more food. And then, with a breathtaking rhetorical flourish, you claim that this has to be done so that “we can feed the world”.

Readers of this magazine know that the world is not short of food. What the world’s hungry are short of is money and power. To paraphrase Amartya Sen, rich people don’t starve. ‘Sustainable intensification’ does nothing to put money into the pockets of the world’s poor and, arguably, concentrates power into fewer and fewer multinational hands.

Instead what we need is ‘intensive sustainability’ (with acknowledgements to Charlie Clutterbuck); taking Brundtland’s definition and implementing it with speed, vigour and imagination.



Andrew Opie is Director of food and sustainability at the British Retail Consortium.

In some ways I don’t understand why everyone is suddenly talking about sustainable intensification; it has been at the heart of our businesses for decades. Nor do I understand why it is sometimes portrayed negatively. Surely this is good for consumers, farmers and the planet.

Successful retailers have built their businesses on the basis of resource efficiency, getting the maximum value from the supply chain. This is for long term commercial reasons. In the paper we released last month ‘Retailers and Farming – Investing in our Future’ we documented the research we are sponsoring to help farmers increase production whilst reducing carbon emissions and water use and maintaining biodiversity. We are doing that to remove risk from our supply chain. We know the cost of carbon and water will increase over time, and that we need a secure supply chain based on UK farming, so the best way to do that is to sponsor practical research on how farmers can produce more but reduce their impact on the environment, and ultimately the cost.

The two things that puzzle me about the debate are firstly that initial thoughts tend to be about new technology. It may have a part to play, depending on consumer acceptance, but as our own paper shows there is so much more that can already be achieved in conventional farming. Secondly, why is the UK not pushing for more debate on this in Europe?

We have great expertise on food policy in the UK but frankly unless we get a constructive debate in Europe discussions here are merely a talking shop when you consider Europe has all the levers in terms of trade, food safety, labelling and approval of new technology. To really advance we need co-ordination and prioritisation of European food policy that involves relevant stakeholders and spans across all the various departments of the Commission.



Mike Bushell is the principal scientific officer at Syngenta.

Sustainable Intensification in arable crops must achieve three things; increasing productivity, better environmental protection and increasing the efficiency of use for all inputs. This concept should be applied to all farms. No-one should be under the illusion that feeding 10 billion people this century will be easy. There will be trade-offs; sustainable systems must balance economic, social and environmental benefits.

Sustainable systems integrate farmers’ agronomic knowledge and best management practices with four technologies – mechanisation; fertilisers for crop and soil nutrition; better seed varieties; and crop protection to combat weeds, pests and disease losses. By growing crops like wheat productively ourselves, we avoid increasing the demand for land use changes elsewhere. Tropical deforestation is particularly bad for biodiversity loss and greenhouse gas emissions.

By planning how we use land at a field and farm level we can limit negative consequences such as diffuse water pollution. Field margins are multi-functional landscape elements that can protect water courses from run-off and provide high value habitat to promote biodiversity on farm. Thinking at a catchment and landscape scale can deliver the biggest benefits to water quality and biodiversity.

A systems approach to “Resource use efficiency” will use metrics to make the most of all inputs – (land, labour, energy, water and nutrients), and will seek to reduce waste throughout the entire supply chain.

Syngenta will be at the forefront of developing practical, integrated systems working with farmers, partners and stakeholders to meet the challenge of feeding 10 billion people sustainably in the future. Ethically, collectively, we must not fail.

The politics of plenty

Business as usual or radical reform?



Vicki Hird of Friends of the Earth describes how, as a concept, sustainable intensification has become very influential very quickly but may merely endorse existing policies. She warns that by excluding nothing, the concept has become a meaningless catch-all.

It may be tempting to suggest that sustainable intensification¹ is purely a matter of production – ensuring optimal productivity within environmental (and social) limits. But definitions of sustainable intensification and assumptions about what it is and what it can deliver are now myriad and confusing. In some cases these assumptions are politically, financially or socially motivated, and it is not always clear what ‘problem’ sustainable intensification is actually solving.

Most crucially these definitions may distract from the more important issues and workable solutions which need to be explored. New research from Friends of the Earth International – to be launched in the summer – addresses these concerns.

Is it just business as usual?

Will sustainable intensification merely represent more business as usual (BAU), or can it really help to deliver the radical changes needed to tackle food insecurity, environmental damage and justice? In a world that produces more than enough food for everyone, it is a tragedy that nearly a billion people go hungry.

In order to deliver more diverse and nutritious food where it is needed, and reduce the expansion of agriculture into biodiverse rich areas increasing productivity (but not necessarily intensity) per hectare will certainly need to be part of the mix in some areas.

But we also need to de-intensify production in other places where intensification has caused major problems of nutrient or pesticide pollution and depletion of soils and water. Other impacts of intensification include reduced resilience to climate, food prices and other shocks through, for instance, an emphasis on monocultures for export. And we’ll see future threats to food production of soil degradation and water shortages as a result of intensive farming practices exacerbated by climate change in many parts of the world.²

So do we need a different term to describe the way we need to change the food system to make it more sustainable? One that avoids the connotations of business as usual associated with

sustainable intensification. Some suggest ‘eco-intensification’³ which sounds similar to the approach recommended by the EC Standing Committee on Agriculture Research, which suggests solutions – “that promise building blocks towards low-input high output systems, integrate historical knowledge and agro-ecology principles that use nature’s capacity” should receive the highest priority for funding.⁴

Does a drive for sustainable intensification push other solutions off the agenda?

Common amongst the many reports on the future of food is the necessity for a suite of actions to transform the food system into one that delivers what’s needed equitably and sustainably.⁵ Tackling unsustainable levels of demand for food by wealthier communities and regions⁶ is consistently high on the agenda. This invariably means reducing meat and dairy production and consumption which uses up a disproportionately large quantity of land, water and energy per kilo of food produced compared to other foods. The UN’s High Level Panel of Experts on Food Security and Nutrition notes “the unlimited demand of rich consumers for food products generates negative pecuniary externalities for the poorest ... Demand is significantly affected by public policy choices and can be reduced”.⁷

Whilst demand can be reduced, it’s easier for governments to avoid this political hot potato. Instead they can claim that SI offers a win-win scenario, allowing higher levels of production, on less land or in sheds, with less environmental damage. And in doing so, they avoid the politician’s worse nightmare: telling people what to eat.

There is a very real concern that sustainable intensification is being used – particularly by politicians but also by some in the industry – as a means to avoid tackling consumption. DEFRA’s Green Food project (GFP) aims to *improve growth & competitiveness in the farming and food industry; increase food production in the UK, and consider our role in global food security; protect and enhance our natural environment*.⁸ DEFRA are looking at these goals through the lens of specific products like wheat, bread and curry. Given the nature of the GFP stakeholder discussions so far, it’s hard not to conclude that the goal of



increasing production and yields is primary. In other words, we can keep eating the same amount as long as we do it in a 'greener' way.

Environment and conservation groups closely involved with the GFP will find themselves facing a major dilemma if its final outcomes do not give sustainability considerations equal weight to production ones. But crucially, given the need to tackle consumption, demand side measures are largely neglected by the GFP as the project's parameters don't yet cover this issue. It's the same story elsewhere. The Rio+20 food security policy papers – including the draft outcome paper – place heavy emphasis on sustainable intensification but shy away from specific measures to tackle demand.

"No techniques or technologies should be left out"⁹

This phrase has become a key element of the SI debate. Why, when there are so many technologies and practices to choose from to increase yields sustainably, is the discussion usually about genetically modified (GM) crops?

There is no doubt that science has an important role to play in tackling the challenge of global food production, and Friends of the Earth is interested in the full range of systems and technologies which can help us provide safe and healthy food. These include integrated farming systems, mosaic farming, techniques for pest control such as 'push-pull' biological controls and traditional breeds and genotypes.

GM crops currently in use commercially, and those being developed for use in the near-term by the biotech industry, do nothing to solve the problems identified above nor increase yields. In fact they may exacerbate some of them (for example by encouraging more intensive monoculture practices and expansion of cheap feed crops).

The current political focus on GM crops, including research

funding, is a distraction from addressing the main solutions to the food crisis. There are also still many unresolved risks the introduction of GM crops would bring, including the interaction with – and impact on – the environment and soil, and liability for any damage to farmers' incomes or the environment.

In the US, GM herbicide-tolerant crops now dominate cropping systems because of favourable policies and because they held out promises of better weed control and cheaper crop management including no-till farming. But this has led to a crisis of 'superweeds' in farming – weeds resistant to glyphosate (Roundup: the herbicide used with Monsanto's Roundup-Ready crops) as a result of an over-reliance on this one herbicide. This is causing severe weed management problems. The response by the GM industry has been to develop crops resistant to more than one herbicide – such as 2 4-D – which is banned in Europe due to its toxicity.¹⁰

Crops engineered for drought and salt tolerance, nitrogen fixation and crops with altered photosynthesis are being developed. In theory these could help withstand climate stresses and may improve crop yields. But according to the Royal Society, these approaches are 'long term' and although there have been advances in research, this merely makes them 'less fanciful', rather than likely, with timescales of 20-40 years.¹¹

Another reason these new developments have failed to materialise commercially is the complexity and number of genes involved in mechanisms such as water use, and the complex interactions between genes and their environment.

Meanwhile, traditional crop breeding approaches – equally 'scientific' and sometimes enhanced and speeded-up through the use of genetic mapping – can work much faster. For example, drought tolerant maize varieties have already been

developed through conventional breeding.¹² Mixed populations of field grown crops have real potential to reduce disease and pest risks.

One could argue that funding and political attention is prioritised on GM, where major profits can be made, when cheaper and simpler alternatives are already delivering. As a society, we also need to be clear on how we 'proof' any proposed techniques or technologies against equity, efficacy and ecological criteria.

New governance needed

We urgently need fast, affordable and sustainable solutions to feeding people whilst protecting biodiversity, boosting rural livelihoods and reducing pollution. These include shifting to healthier diets with less meat and dairy, investing in agro-ecology or 'eco-intensification', ending biofuel mandates and tackling the huge waste of food along the whole chain. But it is clear we need major changes in the way the food system is governed too. We already have enough food to feed current and even future populations, but trading, inequality, poverty, waste, land grabs, food speculation, and over-consumption in high income countries prevents this from happening. We need to ensure the 350 million small farms – which account for 50% of the global agricultural output for domestic consumption¹³ – can flourish. That means improving livelihoods, access to land and resources for small-scale farmers since hunger is often the result of lack of 'entitlements' through land or income rather than lack of production.

Friends of the Earth has been working on food and farming issues for over 30 years. One major problem we identified for farmers was the huge buying power of the big retailers. We worked for eight years to get a stronger retailer Code of Practice and an ombudsman to oversee it. Not perfect, but a step in the right direction and showing why governance matters. This is relevant because sustainable intensification – if it is

to achieve the real gains proposed and not just BAU – will only happen if the rest of the food chain operates well under strong regulation, and the price of food reflects true costs of production.

Without adequate control of production, supply and distribution, pricing and use of food, we will see BAU, with or without more sustainable intensification, which tackles neither current problems nor the challenges that face us. ■

Vicki Hird is Senior Campaigner Land Use, Food and Water Security Programme at Friends of the Earth – www.foe.co.uk

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Photo: Goldlocki

Climate change mitigation

Planning for the future



Dr Isobel Tomlinson asks what the drive for sustainable intensification means for climate change mitigation by UK agriculture.

In the UK, sustainable intensification has emerged as the key policy solution to the perceived challenge of food security: feeding a growing population in the context of changing diets, the growing scarcity of resources such as energy, land and water, and facing the impacts of climate change. The apparent imperative to increase yields without adversely impacting the environment and without the cultivation of more land has put the concept at the rhetorical heart of UK agricultural policy, even though it is considered by some an 'oxymoron'. Despite its critics, the idea of 'sustainable intensification' is having an important impact on how the UK is responding to the need to cut greenhouse gas (GHG) emissions from agriculture.

As currently measured by the UK Inventory, agricultural emissions are around 48 Metric Tonne Carbon Dioxide Equivalent or 8% of total UK GHG emissions. They are made up of nitrous oxide from the use of fertiliser on soils (54%) and methane from enteric fermentation from the digestive systems of cattle and sheep (38%). However, in comparison with other economic sectors, the accurate measurement of GHG emissions from agriculture in the UK is difficult given that the major sources involve complex biological processes, occurring over a range of environmental conditions, and involving many varied farming practices. This complexity makes the identification and implementation of specific measures to reduce GHG emissions a difficult task. £12.6 million is now being spent by DEFRA and the devolved administrations on a new research programme to improve understanding.

Nevertheless, in their 2009 White Paper, 'The UK Low Carbon Transition Plan' (LCTP) the previous Labour Government set a target to reduce emissions from farming by 6% (three Metric Tonne Carbon Dioxide Equivalent) by 2020 through a focus on 'cost-effective action by farmers'. Here, opportunities to reduce emissions and save money were seen to lie in changing agricultural processes such as improving fertiliser efficiency, manure management, livestock feeding and breeding, and energy efficiency. Responding to the Government's calls for a proactive response, the agricultural industry's Climate Change Task Force, a partnership between the National Farmers' Union, Country Land and Business Association, and the Agriculture Industries Confederation, published in 2010 their GHG 'Action Plan' for meeting the three Metric Tonne Carbon Dioxide Equivalent reduction. This voluntary approach is currently the primary vehicle for delivering the LCTP target for

agriculture through manure management plans, the selection of crop varieties with traits which favour reduced nitrous oxide emissions, deployment of on-farm anaerobic digestion systems, manipulation of ruminant diets to reduce methane through dietary changes, and beneficial additives and increasing overall feed efficiencies.

The focus on these 'win-win' solutions for both the environment and farm finances is also reflected in the GHG reduction 'roadmaps' of the levy organisations of the English Agriculture and Horticulture Board. For EBLEX, the organisation that represents beef and lamb levy payers, 'the key to success is to maximize farm efficiency, whatever the enterprise type' whilst the Director of Dairy Co. states that 'dairy farmers have got the message on climate change – efficient production reduces carbon footprints and makes economic sense'. A similar direction is being followed by BPEX (representing pig levy payers) whose 'Two Tonne Sow Project' aims to help English producers achieve an industry average of 2000kg of pigmeat per sow per year by 2014.

It is clear to see that improving 'production efficiency' through changes in farming techniques and technology has become a panacea for reducing the climate change impact of the agriculture sector in the UK. Such an approach sits neatly within the wider context of UK agricultural policy agenda focussed on responding to the food security challenge through increasing yields with less environmental impact.

In their 'Carbon Plan', the Coalition Government state their commitment to ensuring the UK leads the way in sustainable intensification, that will also '...ensure that agriculture and the food sector can contribute fully to the low carbon economy by increasing productivity and competitiveness while reducing emissions.' Similarly, the agricultural industry's Action Plan engagement is on the basis that 'production efficiency gains should be the focus of activity, and that domestic production should not be compromised in the face of food security concerns.'

Estimates of the amount of GHG emissions reductions that can be obtained through production efficiencies are drawn from two reports commissioned by the Climate Change Committee (CCC). The reports show the relative cost of a number of technical changes or modifications to farming practice, focusing

on livestock and soils, that can be made to an essentially 'business-as-usual' farming sector under different 'feasibility' scenarios informed by non-adoption, policy and social constraints. The limitations and uncertainty surrounding this work have been acknowledged but they have been used by the CCC in setting carbon budgets and have informed Government and Industry policy. With terms of reference set by the CCC, one of the key limitations with this work is that it only measures the impact of mitigation methods on GHG emissions in isolation. The full life cycle impact of these measures has similarly not been calculated and the impacts of such measures on animal welfare, biodiversity and other public goods, such as landscape and water quality, are not quantified, although acknowledged. For example, reducing the use of nitrogen fertilisers may cut water pollution, whilst livestock measures such as 'improved genetic potential' may well have negative impacts on animal welfare. Even the Agricultural Industry's Climate Change Taskforce acknowledges that there 'are some difficult trade-offs to be considered between reducing GHG emissions and other environmental and animal welfare issues'.

The other key limitation of these studies is they use a static model that does not explore the potential for change in the quantity of production or a radical change in the farming systems that would change the nature of output. This limitation was set by the CCC, and it explicitly assumes no changes in output as this may lead to import substitution and thus does not allow for a change in demand due to dietary shifts. This becomes a particularly pertinent issue with the critical observation by the CCC that an approach based on the adoption of 'best' practices and technologies is unlikely to be enough for agriculture to contribute its share of cuts in GHG emissions by 2050 – and that other options, including 're-balancing' diets may well be needed.

Indeed, according to the CCC in its Fourth Carbon Budget, reducing agricultural emissions by three metric tonnes by 2050 would mean that agriculture would account for a large percentage (about 28%) of the total amount of emissions permitted by that date. The CCC calculates that an additional five Metric Tonne Carbon Dioxide Equivalent could be achieved through the uptake of best practices and technologies but this would still leave agriculture accounting for forty Metric Tonne Carbon Dioxide Equivalent out of the total 160 Metric Tonne Carbon Dioxide Equivalent target for 2050 (25%), and thus, 'Combined with emissions in other difficult to reduce sectors (industry direct emissions, aviation and shipping) this level of agricultural emissions would make the 2050 target extremely difficult and perhaps impossible to attain'. The CCC therefore says it is essential that work continues to identify further reduction opportunities.

So what are the other options? The CCC lists the development of 'stronger policy levers', than the current voluntary agreement, to ensure the attainment of the measures already discussed. It also lists novel technologies, including potentially controversial ones such as the use of GM technology, which would involve overcoming regulatory barriers 'conditioned by public acceptance.' A common example is non-legume crops

that can 'fix' their own nitrogen, but this is very technically difficult and the Foresight report on the future of food and farming admits that the introduction of nitrogen fixation into non-legume crops is unlikely to contribute significantly to raising agricultural productivity until at least the latter end of the 40-year period considered by the report. It also lists changes in consumer behaviour such as reductions in food waste or a changed mix of diets with less consumption of carbon-intensive foods. The CCC commissioned work by Cranfield University, which found clear scope for emissions reduction through changed consumption. The CCC has gone as far as recommending that the Government should consider encouraging a 'less emissions intensive diet' alongside other motivators such as nutrition benefits.

However, CCC advice seems to be far ahead of Government and Industry policy. Whilst the Coalition Government in its Carbon Plan recognises that emissions from agriculture will account for an increasingly large share of overall GHG emissions as other sectors decarbonise, it still states that 'In order to meet our 2050 target, the agricultural sector will need to contribute to reducing emissions by adopting more efficient practices.' Likewise, GHG Action Plan states that 'the [agricultural] industry expects that the bulk of both the short term and longer term reductions in GHG emissions in agriculture will result, not from reductions in agricultural activity and output (indeed these will have to increase in coming decades as population continues to grow), but from further advances in resource use efficiency.' Of course, the key tension is that a response to GHG emissions from agriculture through a change in output, that may well lead to a reduction in meat production (and associated inputs) in the UK, does not sit at all easily with an agenda driven through the imperative for sustainable intensification.

It is clear that something other than production efficiency is needed, and there are various paths that could be taken. There are obvious synergies between a lower carbon diet and public health improvements, but there are also bigger questions to consider: What proportion of GHG emissions should agriculture account for in 2050 given its critical function of producing food? What negative impacts are we willing to accept? It is very unlikely that agriculture will be able to reduce its emissions to zero, so to what extent should GHG emissions be reduced in order to avoid the need for larger reductions in other 'hard to reach' sectors such as aviation or shipping? Should we be thinking in terms of food rather than farming, given that estimates of emissions are much greater once the whole life-cycle assessment and land-use change associated with imports is taken into account? What role can soil carbon sequestration in pasture systems play and how can we integrate this into our tools for decision-making? The terms of reference for the Agricultural Industry GHG Action Plan are up for review in 2012. There is plenty for all those involved to consider. ■

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A fully referenced version of this article is available at:
www.foodethicscouncil.org/magazine

Animal Welfare

Assessing the advantages and disadvantages of sustainable intensification



Becky Hothersall asks whether it is possible to produce more from less without undermining the basic needs of farmed animals.

DEFRA's expressions of support for sustainable intensification of agriculture suggest there is no trade off between animal welfare standards and intensification of meat production, but its own Farm Animal Welfare Committee (FAWC) recently noted the ambiguity of the phrase 'sustainable intensification'. Its chairman cautioned that production specifically should not compromise current (or future) welfare standards or good husbandry.

Physical health and productivity

Physical health and productivity are clearly important and have traditionally been the main measures of welfare used within the livestock industry. Productivity is considered an indicator of good welfare because disease processes or stressors often have negative impacts upon it. Productivity and intensification have indeed gone hand in hand with increases in meat and milk yields achieved through genetic selection, advances in animal nutrition and automation of management and husbandry tasks. Yet in some cases, production traits can 'push' animals to the extent of creating or exacerbating health problems. A recent review by the European Food Safety Authority (EFSA) described long term genetic selection for high milk yield as the most significant cause of poor welfare in dairy cattle, being correlated with incidence of lameness and mastitis as well as reproductive and metabolic disorders. In pigs, higher lean tissue growth has been linked with an increased risk of tail-biting behaviour and with persistent hunger in breeding sows.

Intensification's impacts on health are not straightforward either. It tends to result in a more controlled environment, often characterized by indoor housing, which protects animals from climatic extremes. It also facilitates closer monitoring and administration of routine or preventative veterinary care, enabling speedy diagnosis and treatment of routine problems. Nutrition can be individually tailored and controlled, which can play a significant part in ameliorating production-associated problems such as those mentioned above. Biosecurity can be more readily controlled to manage parasites and diseases transmitted through air, water or soil. On the other hand, risk

of disease transmission within a system is clearly increased by higher stocking densities. Many people also feel uncomfortable about the use of routine vaccination and other prophylactic care to avoid disease colonization or spread.

Naturalness

Naturalness can be thought of as how closely the production system reflects the environment in which the farmed animals' ancestors evolved. It encompasses notions of freedom, and ability to express behaviours that might be curtailed or subverted by restricted spaces or man-made housing. This intuitively feels like an important component of providing animals with a 'good life', and naturalness is consistently shown to be an important yardstick for welfare-conscious consumers navigating the bewildering choice of animal produce. There is a clear tension between intensification and naturalness, but there are also problems in using it to assess welfare. Firstly, not all aspects of natural life are desirable. The more extensive a system, the harder it can be to ensure animals do not suffer discomfort, distress or even harm from extremes of weather or attack from predators or scavengers. Parasite burdens and even serious, painful conditions like footrot in sheep can go unchecked. It is also important to acknowledge that all farming is to some extent unnatural, and farmed livestock are not wild animals. In some species, they are not anything like them. A 'wild' foraging lifestyle would be inadequate to provide the energetic needs of virtually any chicken breed kept in the UK today. It certainly would not permit us to turn a day-old chick into a Sunday roast in under 6 weeks, or collect 300 eggs from a hen in a year. At the peak of lactation, high-yielding breeds of dairy cows often cannot maintain their body condition on pasture alone and indoor housing may be needed to feed a richer ration.

Feelings and needs

There will always be constraints on the space, time or resources a farmer can provide, so how can humans determine whether they're providing what really matters to the animals? These arguments indicate the difficulty in finding a balance between



nature and nurture, between 'maintenance' and manipulation. Animal welfare scientists are able to add an extra dimension by 'asking' the animals themselves. Like industry, scientific research on welfare has traditionally monitored measures of physical health such as disease, injury and stress indicators, along with observations of behaviour. But in addition, scientists have developed techniques to explore animal feelings. Using methods developed from economics, researchers offer their subjects choices then impose trade-offs or increasing the costs to determine their priorities.

Such research is typically done under tightly controlled experimental conditions, but it can – literally – be done in the field. Researchers at Harper Adams and Reeseheath Colleges have recently run a series of experiments offering dairy cows the choice of spending time on pasture or indoors in cubicle housing. In fact, cows made use of both environments but the studies revealed various influences on choice including season and weather conditions. Interestingly, cows chose to spend the majority of their night-time hours outdoors. Such experiments often don't provide easy yes/no answers but they show we can find objective ways to assess animals' priorities and ensure our systems provide for the most vital ones. For example, experiments showed laying hens will work hard (squeezing through a narrow entrance) for access to a nest or to litter to peck and scratch in. The EU directive governing the replacement

of conventional battery cages stimulated that enriched cages must contain both these resources.

Where now for intensification?

It's clear that these definitions of welfare lead to different conclusions about what constitutes sustainable intensification. Undoubtedly the naturalness angle gives a clear steer; understanding that this is a major influence in consumer decision-making explains recent disquiet over the potential proliferation of intensive, large scale or 'mega' farms. But naturalness seems to be just one part of the debate, and none of the approaches above can tell us how to settle conflicts between very different aspects of welfare. For example, recent data suggest that restricting sows within farrowing crates around birth is likely to cause them great frustration, yet the practice developed to reduce mortality due to accidental crushing of piglets in loose farrowing systems.

Farm assurance schemes have to battle with these trade-offs, and they generally select elements of each approach. Currently they tend to focus on what is put into the system, prescribing minimum standards for resources like as housing, space, feed, and veterinary care. It can be very hard to compare welfare across different production systems because their stipulations for things like stocking densities and access to outdoor space vary. Recently a Europe-wide project called Welfare Quality

has made progress in identifying reliable, practical 'welfare outcomes' that measure how these inputs translate to the health and behaviour of the animals themselves. Under the banner of the £2.7million Assurewel project, the University of Bristol is working with the RSPCA, the Soil Association and the UK Red Tractor Assurance schemes to identify key welfare outcomes that can be incorporated into farm assurance assessments for each of the main livestock species.

Measuring welfare outcomes instead of resource inputs should allow fairer comparisons across different production systems and countries, where breeds of animal, housing, size of flocks or herds and typical health problems can all vary. Comparing systems on a more level playing field is important because the arguments above have not even begun to address complexity of weighing welfare against the environmental and economic dimensions of 'sustainable intensification'.

Retail data suggest that while shoppers may value naturalness, their choices are overwhelmingly dictated by price. If this remains true then demand looks likely to be met by systems that can further accelerate growth rates and yields. The UK dairy sector has undergone a rapid process of intensification and up-scaling in recent years and illustrates some of the challenges and potential benefits to welfare this process can present. Intensive farms aren't necessarily megafarms (or vice versa), but investments in technology and infrastructure create economies of scale; this means new intensive units are often large. Indeed, UK industry figures show that an 18.8% increase in milk yields between 1999 and 2009 was accompanied by a rise in the average dairy herd size, while the total number of farms and cows both dropped.

Investment then drives the precise management needed to maintain productivity in high-yielding breeds. So far big units have largely been the province of innovative producers whose purpose-built facilities and management focus often give them

the welfare 'edge' over smaller, less modern units. On the other hand, the risks are higher because if things do go wrong, they go wrong on a bigger scale. There are other unknowns that remain to be explored. For example, research is only beginning to examine how large group sizes might influence aggression and other aspects of social behaviour. Regardless of size, intensification often introduces automation of systems for feeding or monitoring fertility. While this can help to efficiently tailor provision to individual needs, there are legitimate concerns that staff-to-animal ratios or training may dwindle, making it difficult to recognize and manage individual animal problems.

In this case at least, it seems that the pursuit of cheap, efficient production draws us towards large-scale intensive farming. Returning to our three perspectives, this obviously compromises naturalness, has the potential (assuming good management) to maximize physical health, and has uncertain impacts on mental wellbeing.

Arguably the more we remove animals' control over their environment, the greater our obligation to make the right choices on their behalf – and to do so in an evidence-based way. It's not yet clear how big the gaps might be between the welfare 'potential' and the welfare 'risk' of different systems. EFSA and the European LayWel project have recently begun to address this by evaluating the likely risk factors, benefits and disadvantages of different housing systems for several species, including specifying which welfare measures are affected. Clearly many evidence gaps remain, and policy should support FAWC's call for more research "focused upon the behavioural, welfare and ethical implications of future agricultural systems and new ways of producing our food". ■

Dr. Becky Hothersall's research at Bristol University evaluates how pain is experienced in domestic fowl.



Factory farming

The unacceptable face of sustainable intensification



The recent history of the intensification of farming has led us to the dreadful position that we currently find ourselves in, write **Vicky Bond** and **Emily Lewis-Brown** of Compassion in World Farming: factory farming that maximises production over everything else.

In a tragic indictment of factory farming animals are treated as commodities rather than as sentient beings; many of their basic needs are unmet; and they typically suffer throughout their lives. Nearly six billion animals in the EU are kept in factory farms every year, accounting for over 80% of all farmed animals in the Union, with ever increasing numbers around the world. The intensification of farming has produced systems that often require mutilations, confinement, high stocking densities and severe restriction of the animals' species specific behaviours, all of which are detrimental to animal welfare.

Society must take responsibility for the care of animals within our farming system and ensure that the mistakes of intensification in the past are not taken forward into the future. In the EU there is a gradual shift away from the most extreme systems for some species, such as the ban on the barren battery cage for laying hens. Paradoxically, farming systems of other species, such as dairy cattle, are heading towards factory farming, with the increase of permanent indoor housing and high numbers within a herd.

It is crucial that the definition of 'sustainable' includes the humane treatment of both people and animals. Current intensive farming is not only cruel to animals, but the planet and people are suffering too. The environment is collapsing under the pressures of pollution, soil erosion and habitat destruction. Factory farming is heavily dependent on limited resources such as water, fuel and grain, often imported. To be sustainable, farming in the EU needs to de-intensify, be less wasteful, less polluting and less damaging.

Sustainable intensification is therefore clearly an oxymoron, 'intensification' as we know it in the EU is socially and environmentally unsustainable and unacceptable. Rather than being intensified, farming needs to be revolutionised.

The intensive farming construct also perpetuates the stark contrasts of around one billion people over consuming food and the almost one billion undernourished and disadvantaged people. Intensifying farming to increase food production is no guarantee of food security and seems more likely to exacerbate food, water and fuel insecurity, especially for the world's most vulnerable people.

Factory farms are food factories in reverse, they use more food than they make. For every 100 food calories of edible crops fed to livestock, we get back only 30 calories in the form of meat and

milk. Additionally, one third of the world's cereal harvest, which could otherwise be fed directly to people, is being fed to farm animals. In the EU this figure goes up to about 60%.

Feeding beef cattle grain or dairy cattle soya squanders valuable crops and arable land. Instead, ruminants should be pasture reared; this allows animals to convert plant-life that humans cannot eat into edible food by rearing the animals on mixed, rotational farms, permanent pastures or marginal lands.

Reducing food waste and recycling unavoidable waste is also key to an effective food system. Globally, about a third of food produced for human consumption is lost or wasted. Pigs and poultry are foraging animals that would be the perfect recyclers of some waste. Most pigs and poultry are currently confined to factory farms and fed cereals and soya. Instead, the future of farming should be moving these animals to mixed farming of crops and animals.

Intensification in less industrialised countries is not the answer either. There, the reduction in losses of farm animals to disease, drought and predation through the provision of veterinary services and other interventions can improve both animal welfare and farm productivity levels without resorting to factory farms and the associated negative impacts. While some may call this intensification it bears little resemblance to the way factory farming has developed in places like the EU. In fact, moving towards higher welfare, more productive and fair food systems which work within local ecological landscape across the globe would be better termed 'agro-ecology'.

Factory farming is inherently unsustainable because of the negative impacts it has on animals, people and the planet and is a design of the past. If we aim to meet future food demands, the focus needs to move away from the thinking of the last century and towards a system that works holistically. Placing the word 'sustainable' in front of 'intensification' is not enough to stop us repeating the mistakes of past intensification. We must design humane sustainable food systems which deliver sufficient healthy food for every child, woman and man in ways which are socially acceptable, including respecting the needs of animals, as well as being ecologically achievable.

Compassion in World Farming is spearheading a food and farming revolution and we invite you to join in online: www.raw.info

Vicky Bond and Emily Lewis-Brown are members of the Research team at Compassion in World Farming.

Fair Food: Growing a Healthy, Sustainable Food System for All

Oran Hersterman | 2011 | Public Affairs | ISBN 978-1610390064

This is an inspiring, accessible book by US agronomist turned activist, Oran Hersterman, founder of the Fair Food Network. His premise is that the food system is broken, particularly for inner-city, low income communities. He cites Detroit, a city in decline where in 2007 no major supermarkets served its 900,000 residents who instead rely on petrol stations, liquor stores and convenience stores for their food. His book draws on his experience to foster the creation of a redesigned system, one that is healthy for people, communities and the environment. In its three sections, he discussed the ways in which the current food system is no longer serving us well; then explains his four key principles for a redesigned food should alongside examples of how individuals and organisations are starting to integrate these principles; before offering a practical guide to how readers can move from conscious consumer to engaged citizen to shift public policy. SD

Ecological Public Health: Reshaping the conditions for good health

Geoff Rayner and Tim Lang | 2012 | Earthscan from Routledge | ISBN 978-1844078325

At over 400 pages this is a weighty tome that argues public health thinking needs an overhaul around ecological principles to fit the twenty-first century's challenges. Rich in understanding the history of the public health movement, the authors argue that a new ecological sense of public health is emerging based on the recognition of the limits on nature, that nature no longer offers an endless cornucopia of its resources for human use or that the biological world can be ceaselessly altered to human advantage. Nutrition gets its own chapter: the world continues to get fat and the mismatch between bodies, food supply, culture and the environment remains a growing challenge. Can even a recast ecological public health movement take on the power and economic incentives that are driving this transition? SD

Eco Crime and Genetically Modified Food

Reece Walters | 2012 | Routledge | ISBN 978-0415521130

The global food crisis has invigorated the debate about genetically modified foods. Author Reece Walters argues that GM food has little to do with feeding people and much to do with corporate power and profit. As a Professor of Criminology the author takes the debates about GM beyond the scientific and technical into the criminological arena to include harms of ecological and global concern and to critique actions that adversely affect nature and humanity. Such 'eco crimes', he argues, include the criminal and harmful actions of corporations and state officials. The book examines the legal and ethical dilemmas that surround this new food source. It questions the existing legal regimes and proposes initiatives for regulation and environmental justice. SD

Regulating Next Generation Agri-Food Biotechnologies: Lessons from European, North American and Asian experiences

Michael Howlett and David Laycock Eds. | 2012 | Routledge ISBN 978-0415693615

This academic review draws on the experiences of past and current regulatory oversight of agricultural biotechnology, and asks: how should we address new regulatory challenges in the agri-food genetics sector? Its focus is global, with contributors drawing on European, North American and Asian experiences. It highlights the huge challenges faced by regulatory regimes through the introduction of genetically engineered crops, animal cloning and now the development of 'third' generation technologies. The authors address the question of how societies, government and evolving international regulatory regimes can deal with these new and near future technologies. The book concludes with an argument for a more 'ethical' GM policy and regulation involving stronger participation of farmers, consumers and environmentalists. SD

Regulating food law: Risk analysis and the precautionary principle as general principles of EU law

Anna Szajkowska | 2012 | Wageningen Academic Publishers | ISBN 978-9086861941

For the past decade, European food safety law has been underpinned by principles of risk analysis and precaution. This fascinating book shows how these potentially dry-sounding notions are actually fundamental to the place of food in society – showing, for example, how they are bound up with consumers' perception of risk, local traditions, and ethical considerations. Given the centrality of the precautionary principle to pressing contemporary issues such as 'food speculation', this analysis is both enlightening and timely. SR

Agricultural policies for poverty reduction

Jonathon Brooks (ed.) | 2012 | OECD Publishing | ISBN 978-9264168633

This timely analysis is the outcome of an OECD project on agricultural policy choices in developing countries. The authors set out a strategy for raising rural incomes which emphasises the creation of diversified rural economies with opportunities within and outside agriculture. This volume assesses the short-term value and long-term implications of market interventions - price stabilisations and input subsidies - and suggests that such instruments do not crowd out essential investments in support of long term agricultural development. HW

What to Eat? Ten Chewy Questions About Food

Hattie Ellis | 2012 | Portobello Books | ISBN 978-1846272158

Food writer Hattie Ellis, provides a practical guide through the complexities of what to eat to discover a way to feed ourselves that is good value, good for the planet and good to eat. If you want help in understanding what is 'kind' meat or sustainable fish, how to green your kitchen and whether to eat 'local', this book helps provide some answers. SD

Forthcoming events

23rd July - 26th July '12	Royal Welsh Show Royal Welsh Agricultural Society http://www.rwas.co.uk/society Builth Wells, Wales
7th Aug - 10th Aug '12	Biodiversity Asia 2012 Society for Conservation Biology http://www.conferencealerts.com/show-event?id=88415 Bangalore, India
27th Aug - 31st Aug '12	EAAP Annual Meeting European Federation of Animal Science http://www.eaap.org/Content/meetings.htm Bratislava, Slovak Republic
19th Sept - 20th Sept '12	Sustainability in the food supply chain Agra Events http://sustainability.agraevents.com/ London, UK
4th October 2012	Impact Investing 2012: Investing for profit, people and planet Environmental Finance http://www.environmental-finance.com/events/view/56 London, UK
16th Oct '12	World Food Day FAO http://www.fao.org/index_en.htm Worldwide
29th Oct - 1st Nov '12	Global Conference on Agricultural Research for Development 2012 GCARD http://www.egfar.org/gcard-2012 Punta del Este, Uruguay
7th Nov '12	Next steps for food labelling policy Westminster Forum Projects http://www.westminsterforumprojects.co.uk/forums/event.php?eid=456 London, UK
9th Nov - 10th Nov '12	Biodiversity in the balance: Causes and consequences EMBL http://www.embl.de/training/events/2012/SNS12-01/index.html Heidelberg, Germany
21st Nov '12	Children and young people's health Westminster Forum Projects http://www.westminsterforumprojects.co.uk/forums/event.php?eid=468 London, UK
27th Nov - 28th Nov '12	SusCon 2012: International conference on sustainable business and consumption IFOAM http://www.ifoam.org/events/ifoam_conferences/SusCon_2012.html Bonn, Germany
18th Dec - 20th Dec '12	Annual Meeting of the British Ecological Society BES http://www.britishecologicalsociety.org/meetings/current_future_meetings/2012_annual_meeting/index.php Birmingham, UK



The Food Ethics Council works towards a food system that is fair and healthy for people and the environment.

Our independent research, and advice to business, government and civil society helps find a way through controversial issues and supports better choices in food and farming.

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