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ONLINE NOW

Growth (ltd.)

So, the UK is officially out of recession. Judging by the ambivalence of the headlines writers ('UK crawls out of recession', admitted the FT at the end of January), no-one is quite sure what to make of it.

On the one hand there is clearly a reason to be cheerful – no-one wants recessions. Even those most committed to steady-state, ecological economics realise that a recession is not a sustainable way in which to reduce an economy to its ecologically appropriate size – it is messy, causes great amounts of non-economic suffering, reduces investment in environmental projects and encourages politicians to reach for the nearest quick-fix solution. If that means shovelling in the coal, oil or gas even faster then so be it, most politicians would reason.

But at the same time there is a pervasive feeling that the recession woke the West up from its collective dream, and, like most dreams, certain parts of it don't make a right lot of sense.

Mervyn King, the Governor of the Bank of England, told MPs in late January that, in light of the fact that the UK banking sector was five times the size of the nation's GDP, 'one way or another it doesn't make sense to pretend... that this is a system we can credibly, easily support'.

It's true that in the last couple of years King has enjoyed rocking the boat, but the significance of these words from the man whose institution is busy pumping money into propping up the banking sector should not be underestimated.

And his words are important on a broader scale: they remind us that, sooner or later, no matter how well a system seems to be functioning it will have to acknowledge natural limits.

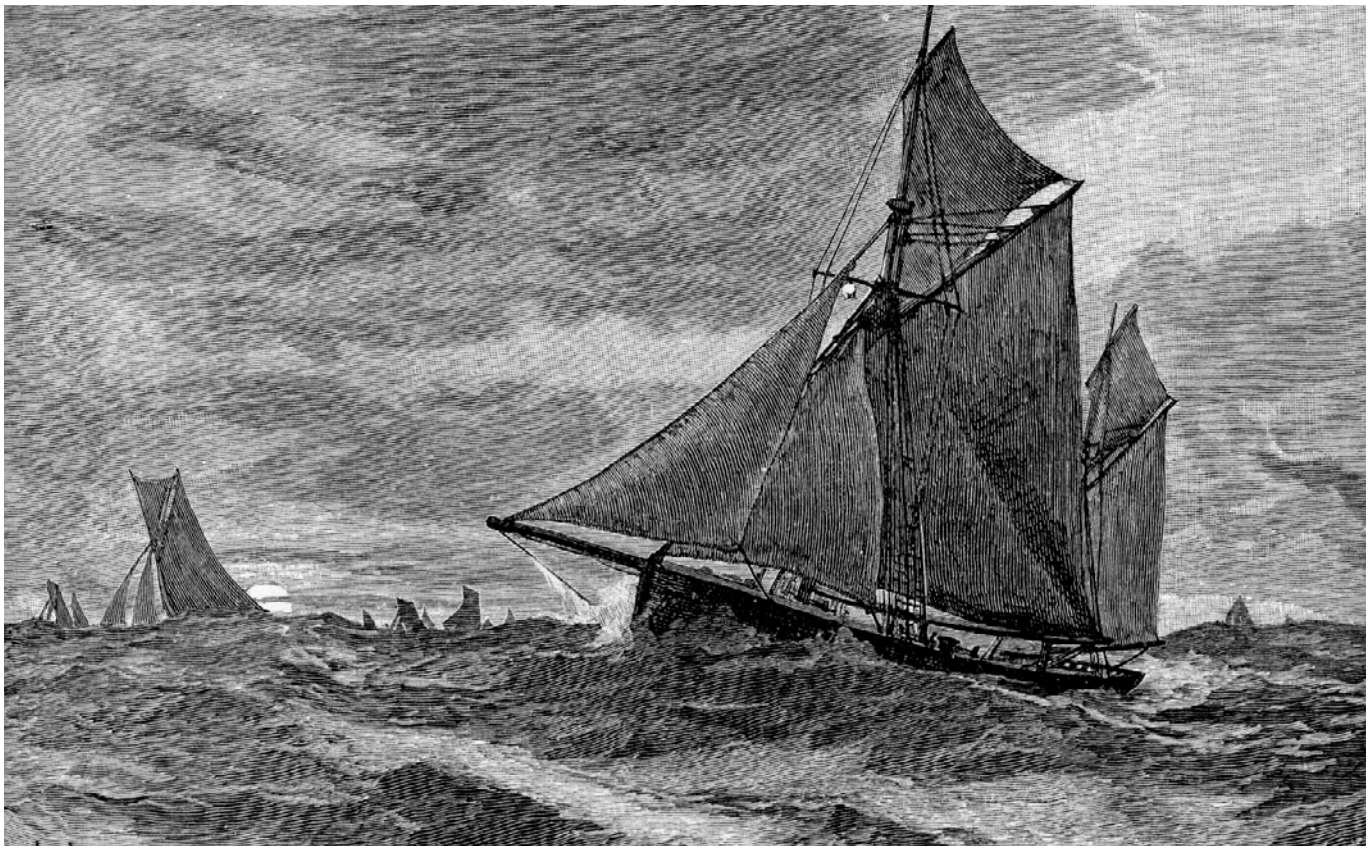
Several of our writers have addressed the very same issue this month. Professor Tim Jackson, author of the highly influential Sustainable Development Commission report 'Prosperity Without Growth', argues (page 4) that 'to resist growth is to risk economic and social collapse; to pursue it relentlessly is to endanger the ecosystems on which we depend for long-term survival'. He suggests that the existing 'Cinderella economy' of sustainable businesses might form part of a new economic blueprint.

Like him, Ewan Kingston (page 6) blows the whistle on the extraordinary failings of governments worldwide to face up the possibility of 'peak phosphorus' – the point beyond which supplies of that element, indispensable in all types of agriculture, will go into a terminal decline.

And last but not least, environmental researcher Paul Mobbs (page 10) argues in his comment article that, despite the popularity of 'efficiency' projects, there are simple physical limits to have far we can decarbonise our economy using existing approaches. We will, he argues, simply have to make do with less.

If 2010 is to be the year of recognising financial limits, let's hope we might start to recognise some natural ones too.

Mark Anslow, Editor



How can we have fish tomorrow? Ask the past

Dismissed initially as a good storyteller but nothing more, environmental historian Poul Holm has mapped the history of marine animals in such detail that it is having profound impacts on our current understanding of the oceans. By **Anthony King**

When Danish historian Professor Poul Holm began attending fishery conferences his message attracted interest, but also a large slice of scepticism. The fishery scientists thought his ideas made for a good yarn, nice for an after dinner talk, but they cut no ice in the serious business of fishery management.

Holm wanted to talk about historical catch data, and what it implied about the condition of today's fish stocks. But, whilst his ideas won the misty-eyed attention of older marine biologists, keen reminisce about times past, Holm was told that his data were simply too anecdotal to be considered proper science.

'You will never be able to do this in a consistent way that will convince anyone that it is anything but loose ideas,' he was warned.

But Holm proved his critics wrong. In just the last two or three years fishery science heavyweights have begun standing up at conferences and praising his data. Holm's HMAP (History of Marine Animal Populations) project was seen to have 'shifted the baselines', repositioned scientists' ideas of what an un-fished marine ecosystem might look like.

A decade of history

The HMAP project, a ten year global initiative under the Census of Marine Life, has dug up enough historical evidence to shake our ideas about man and the marine environment.

'The problem with ecosystem theory is that it is established on the basis of ten, fifteen or twenty years of data,' explains Holm, which he says is just not long enough and includes data collected during the boom of industrial fishing. The HMAP researchers aimed to peer much further back into history: 100, 200, or 300 years, to reveal a true picture of the impact of fishing. They collected historical documents such as old ship logbooks, customs books, literary texts, legal documents, tax accounts, ties accounts from the church, private records and even trophy fish photographs.

What they discovered is helping to rewrite the marine biology textbooks. Logs from 17th and 18th century voyages of discovery, for example, are stacked with evidence of strange encounters with marine species Europeans had never seen before. They tell of abundances of whales in places where there is no evidence of them in living memory, says Holm. Before whales were harpooned in their millions, it appears that large pods of blue whales and killer whales, blue sharks and thresher sharks patrolled the waters off Cornwall and herds of harbour porpoise were then well named for pursuing fish into harbours and up rivers.

Secrets of the deep

A key find for the HMAP team came early on in the project, when a US historian told Holm about a treasure trove of fishery logbooks dating from the 1850s from the Gulf of Maine.

'We found 3,000 logbooks,' says Holm, 'and no historian had ever touched them before.' The logbooks were kept by skippers encouraged by special regulations to document fisheries and so collect bounties.

'We were able to establish that the biomass of cod in the 1850s would have been at least 10 times larger than the current recommended conservation level for the entire Scotian Shelf,' Holm explains excitedly. The upshot was that the present conservation goals for this shelf were shown to be far below what these seas once sustained.

Part of the HMAP project has involved training a new breed of researcher with the talents of a historian crossed with those of a marine biologist. Historians might read logbooks but be oblivious to the biological significance of a sighting of a gray whale in a particular bay; biologists would not know whether the report could be depended upon or was just another tall tale.

Holm had just this kind of experience while studying haddock in the North Sea. It's just a common species, typical fare for the fish and chips business, says Holm, 'so I was not surprised when, looking through data from German and Danish fishermen in the 18th and 19th century, [that] I was seeing lots of haddock caught off the island of Helgoland in the southern North Sea'.

He recorded the details, but thought little about it until he spoke to Brian MacKenzie, a Canadian fishery scientist at the Technical University of Denmark. 'What?' MacKenzie cried, 'But haddock are never caught in the southern North Sea. They are not endemic there, it's impossible!' Eventually the pair realised that once abundant cod populations had simply been fished out. Gone, only to be discovered centuries later in dusty logbooks.

Tuna warning

MacKenzie had a similar experience when looking at bluefin tuna populations. Scientists had previously thought that the species had existed in northern European waters, but he discovered records of sports fishermen catching huge tuna year after year in the straits between Denmark and Sweden. 'We were astonished,' says Holm. 'At first we thought it was a freak event, but it wasn't. They were all over the place 50 or 60 years ago, but they were fished out and have sort of gone not only from the public imagination but also from the radar of fisheries conservation.'

The pair took the data to the Atlantic tuna commission and argued that the crisis for tuna was much, much worse than thought.

A long time coming

But one of the most consistent, and revealing, findings from the HMAP project has been the revelation that our seas and islands were depleted much earlier than we might imagine.

When Charles Darwin stepped on to Chatham Island in the Galapagos in September 1835, we all imagine he found pristine seas and an island wilderness. But whalers had hunted there for decades, pursuing quarry that had already been fished out of North American waters, and it took two days hiking for Darwin to find a Galapagos tortoise, a favourite food of seamen. The Beagle, too, carried some off.

Even simple technology can have a huge impact, says Holm, who notes that moving from a single hook to several per line in 1850s sent Maine cod populations tumbling.

He also points to Jeremy Jackson's study of the Caribbean turtle populations. Jackson, the son of a historian and himself a biologist, had been struck by the use of turtle shell in the cupboards, cabinets and inlays in 18th century noble homes and in European museums. Turning to the Blue Books of British Empire, which give trade statistics, he realised that hundreds of thousands of turtles had been caught each year, and that the Caribbean ecosystem had once sustained a population of perhaps 40 million green turtles. 'They were able to wipe out the green turtle population well before industrial fishing technology was introduced,' says Holm, who stresses that there are lots of cases where subsistence fisheries have had a devastating impact.

Consumer choice

'We need to tell the story about fisheries and make people aware and at least give you the choice as a consumer,' Holm argues. The Common Fisheries Policy of the European Union is still driven by economic and social interests, he believes, and has proved disastrous. Holm blames the fact that it is too politicised, a result of compromises that have nothing to do with ecosystems. 'You almost despair when you hear politicians say there is good news: the haddock is gaining some strength or we can increase cod fisheries quota in this area because it has recovered over the last two years. It is such a narrow timeframe and they have no idea how plentiful the oceans use to be.'

Whenever there are traces of a recovery, politicians are jubilant and take measures to drive the population back to the abyss. The solution is to close areas for at least five year periods, says Holm, who points to the Second World War as a good example of conservation working – fish stocks recovered in the North Sea, for instance.

Certain industries, such as the tuna industry, need to be tackled and regulated, Holm believes. He looks to the climate change negotiations as offering a possible beacon of hope, believing they could open up a dialogue which will allow us manage resources that nobody owns and imbue politicians with an interest in issues that may take 50 years to play out, he says.

Drastic measures

But real action to preserve fish stocks requires something even more dramatic. Holm argues that we should set aside 50 per cent of the oceans as no-take zones, as marine protected areas (MPAs), with industrial fishing in the other half. His views on marine protected areas are echoed by Callum Roberts, author of The Unnatural History of the Sea. He notes that in its closing days, the Bush administration created a number of large marine protected areas in the Pacific and collectively increased the size of such areas by 31 per cent globally: 'That said two things. Number one, the size of the areas wasn't very significant. But two that the global network of MPAs is still very small: it went up from 0.6 per cent to 0.8 per cent of the seas worldwide'.

Roberts' group at the University of York studied coastal reserves and advised that they need to be 10 to 20 km in diameter and 40 to 80 km apart (though smaller reserves are still valuable). He says fishermen would benefit enormously; in the US, he notes, three-quarters of the haddock caught by the U.S. fishing fleet is captured within 5 km of the boundary of a closed area. Unfortunately, the Common Fisheries Policy has not embraced marine protected areas as a tool to deliver sustainability. Holm says the European Union does not have a proper ocean policy and is too fixated on the industrial use of the oceans.

When it finishes next year, the History of Marine Animal Populations study might not make for feel-good reading. What it will do, however, is provide an invaluable record of what has been lost, and what we stand to lose if fishing continues along its current course. The option for sustainable ocean management is there; whether politicians are brave enough to take it is another question.

Anthony King is a freelance journalist

It's called the 'Cinderella economy'. You know it as the local, sustainable businesses that don't make the GDP figures soar, but do provide jobs and glue communities together... By **Tim Jackson**

Farmers' markets, coops and repair shops: the new economy

Society is faced with a profound dilemma. To resist growth is to risk economic and social collapse. To pursue it relentlessly is to endanger the ecosystems on which we depend for long-term survival.

For the most part, this dilemma goes unrecognised in mainstream policy. It's only marginally more visible as a public debate. When reality begins to impinge on the collective consciousness, the best suggestion to hand is that we can somehow 'decouple' growth from its material impacts. And continue to do so while the economy expands exponentially.

The sheer scale of action implied by this is daunting. In a world of nine billion people all aspiring to western lifestyles, the carbon intensity of every dollar of output must be at least 130 times lower in 2050 than it is today. By the end of the century, economic activity will need to be taking carbon out of the atmosphere not adding to it.

Never mind that no-one knows what such an economy looks like. Never mind that decoupling isn't happening at anything like that scale. Never mind that all our institutions and incentive structures continually point in the wrong direction. The dilemma, once recognised, looms so dangerously over our future that we are desperate to believe in miracles. Technology will save us. Capitalism is good at technology. So let's just keep the show on the road and hope for the best.

Eco-fundamentalists

No surprise then, that the response to the recession was a ubiquitous call to re-invigorate consumer spending and kick start growth. Those inclined to question the consensus were swiftly denounced as cynical revolutionaries or modern day luddites. 'We do not agree with the anti-capitalists who see the economic crisis as a chance to impose their utopia, whether of a socialist or eco-fundamentalist kind,' roared the Independent on Sunday late in 2008. 'Most of us in this country enjoy long and fulfilling lives thanks to liberal capitalism: we have no desire to live in a yurt under a workers' soviet.'

With that confusingly-attired bogey-man looming over us, kick-starting growth looked like a no-brainer. And the closest we got to doing anything other than business as usual was the possibility that somehow out of the crisis we might create a 'different engine of growth' as Achim Steiner from the UN Environment Programme called it. 'Green growth' became the holy grail of economic recovery.

Similar proposals had been voiced for some years by ecological economists. Pointing out that 'ever greater consumption of resources is [in itself] a driver of growth' in the current paradigm, Robert Ayres argues that 'in effect, a new growth engine is needed, based on non-polluting energy sources and selling non-material services, not polluting products'.

Business as usual?

This idea is still essentially an appeal to decoupling. Growth continues, while resource intensity (and hopefully throughput) declines. But here at least is something in the way of a blueprint for what such an economy might look like. It gives us more of a sense of what people are buying and what businesses are selling in this new economy. Its founding concept is the production and sale of de-materialised 'services', rather than material 'products'.

Clearly this can't just be the 'service-based economies' that have characterised certain Western development over the last few

decades. For the most part those have been achieved by reducing heavy manufacturing, continuing to import consumption goods from abroad and expanding financial services to pay for them.

So what exactly constitutes productive economic activity in this new economy? Selling 'energy services', certainly, rather than energy supplies. Selling mobility rather than cars. Recycling, re-using, leasing, maybe. Yoga lessons, perhaps, hairdressing, gardening: so long as these aren't carried out using buildings, don't involve the latest fashion and you don't need a car to get to them. The humble broom would need to be preferred to the diabolical 'leaf-blower', for instance.

The fundamental question is this: can you really make enough money from these activities to keep an economy growing? And the truth is we just don't know. We have never at any point in history lived in such an economy. It sounds at the moment suspiciously like something the Independent on Sunday would instantly dismiss as a yurt-based economy – with increasingly expensive yurts.

A new economy

But this doesn't mean we should throw away the underlying vision completely. Whatever the new economy looks like, low-carbon economic activities that employ people in ways that contribute meaningfully to human flourishing have to be the basis for it. That much is clear.

So rather than starting from the assumption of growth, perhaps we should start by identifying what we want a sustainable economy to look and behave like. Clearly, some form of stability – or resilience – matters. Economies which collapse threaten human flourishing immediately. We know that equality matters. Unequal societies drive unproductive status competition and undermine wellbeing not only directly but also by eroding our sense of shared citizenship.

Work – and not just paid employment – still matters in this new economy. It's vital for all sorts of reasons. Apart from the obvious contribution of paid employment to people's livelihoods, work is a part of our participation in the life of society. Through work we create and recreate the social world and find a credible place in it.

An ecologically-bounded economy

Perhaps most vital of all, economic activity must remain ecologically-bounded. The limits of a finite planet need to be coded directly into its working principles. The valuation of ecosystem services, the greening of the national accounts, the identification of an ecologically-bounded production function: all of these are likely to be essential to the development of a sustainable economic framework.

And at the local level, it's possible to identify some simple operational principles that these new economic activities need to fulfil. Let's call these activities 'ecological enterprises' if they satisfy three simple criteria:

- they contribute positively to human flourishing;
- they support community and provide decent livelihoods;
- they use as little as possible in the way of materials and energy.

Notice that it isn't just the outputs from economic activity that must make a positive contribution to flourishing. It's the form and organisation of our systems of provision as well. Ecological enterprise needs to work with the grain of community and the long-term social good, rather than against it.

'The Cinderella economy really does offer a kind of blueprint for a different kind of society'

Enter the Cinderella economy

Interestingly, ecological enterprise has a kind of forerunner. The seeds for the new economy already exist in local, community-based social enterprise: community energy projects, local farmers' markets, slow food cooperatives, sports clubs, libraries, community health and fitness centres, local repair and maintenance services, craft workshops, writing centres, watersports, community music and drama, local training and skills. And yes, maybe even yoga (or martial arts or meditation), hairdressing, and gardening.

People often achieve a greater sense of wellbeing and fulfillment, both as producers and as consumers of these activities, than they ever do from the time-poor, materialistic, supermarket economy in which most of our lives are spent. So it's ironic that these community-based social enterprises barely count in today's economy. They represent a kind of Cinderella economy that sits neglected at the margins of consumer society.

Some of them scarcely even register as economic activities in a formal sense at all. They sometimes employ people on a part-time or even voluntary basis. Their activities are often labour intensive. So if they contribute anything at all to GDP, their labour productivity growth is of course 'dismal' – in the language of the dismal science. If we start shifting wholesale to patterns of de-materialised services, we wouldn't immediately bring the economy to a standstill, but we'd certainly slow down growth considerably.

People matter

We're getting perilously close here to the lunacy at the heart of the growth-obsessed, resource-intensive, consumer economy. Here is a sector that could provide meaningful work, offer people capabilities for flourishing, contribute positively to community and have a decent chance of being materially light. And yet it's denigrated as worthless because it's actually employing people.

This response shows up the fetish with labour productivity for what it is: a recipe for undermining work, community and environment. Of course, labour productivity improvements aren't always bad. There are clearly places where it makes sense to substitute away from human labour, especially where the working experience itself is poor. But the idea that labour input is always something to be minimised goes against common sense.

In fact, there's a very good reason why de-materialised services don't lead to productivity growth. It's because for many of them it's the human input to them that constitutes the value in them. The pursuit of labour productivity in activities whose integrity depends on human interaction systematically undermines the quality of the output.

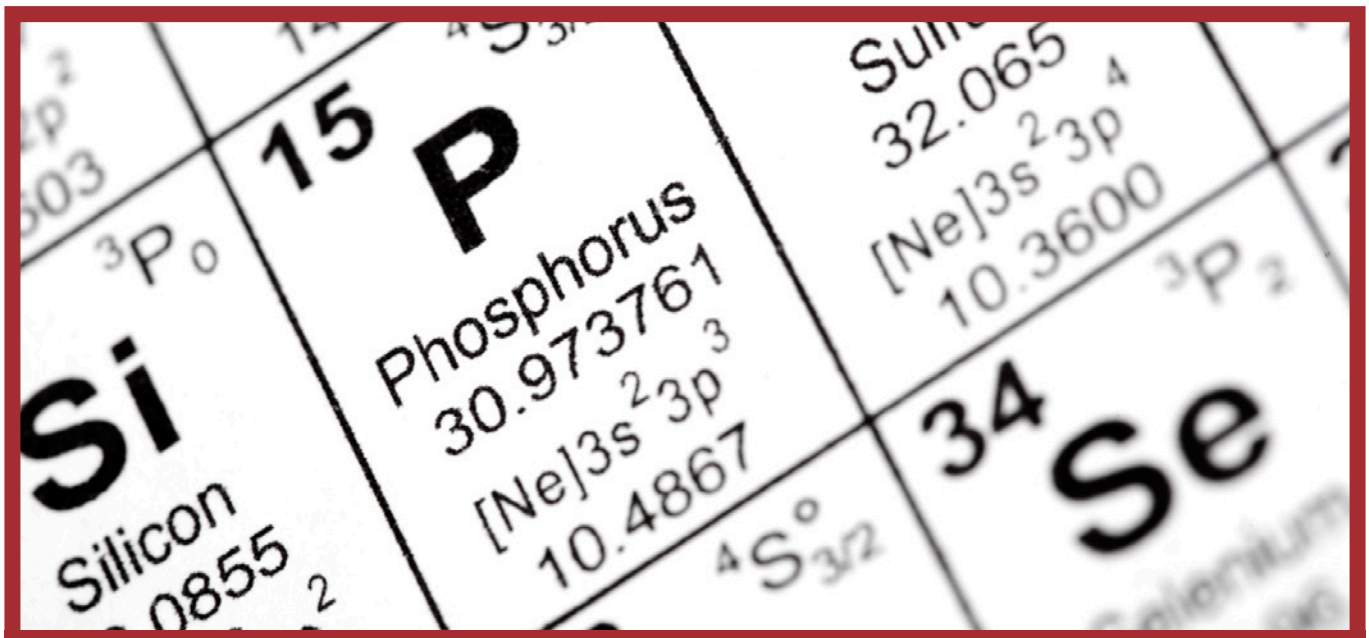
The value of work

Besides all that, work itself is one of the ways in which humans participate meaningfully in society. Reducing our ability to do that – or reducing the quality of our experience in doing so – is a direct hit on flourishing. Relentless pursuit of labour productivity in these circumstances makes no sense.

So in summary, it seems that those calling for a new engine of growth based around dematerialised services are really onto something. But they may perhaps have missed a vital point. The idea that an increasingly serviced-based economy can (or should) provide for ever-increasing economic output doesn't quite stack up.

On the other hand, we've made some clear progress here. The Cinderella economy really does offer a kind of blueprint for a different kind of society. New, ecological enterprises provide capabilities for flourishing. They offer the means to a livelihood and to participation in the life of society. They provide security, a sense of belonging, the ability to share in a common endeavour and yet to pursue our potential as individual human beings. And at the same time they offer a decent chance of remaining within ecological scale. The next economy really does mean inviting Cinderella to the ball.

Professor Tim Jackson is economics commissioner at the Sustainable Development Commission



Peak phosphorus:
our most important nutrient running out

It has no synthetic alternative and some scientists believe supplies may already be in a terminal decline. But there is still no international effort to tackle the massive agricultural problems that will arise when the phosphorus runs out, says Ewan Kingston

There are no substitutes for phosphorus in agriculture.

That's the hard truth that appears in the 2009 issue of the United States Geological Service annual commodity survey for phosphorus.

It has been printed in every issue in the same place in that dry official document, but recently it seems to have taken on a special significance . In the last few years some analysts have claimed production of phosphorus has already peaked, and demand is rising continuously. It is becoming painfully clear that we need to start looking seriously at how we manage this vital nutrient.

Life-giver

Obtaining sufficient phosphorus is crucial for the survival of all forms of life – it forms an irreplaceable part of cell membranes, energy transfer molecules and DNA – it is truly part of every living thing.

Compared to how important phosphorus is to life's flourishing, it is often the hardest nutrient for organisms to obtain in the natural world, making it a 'limiting factor' of many ecosystems, or as science-fiction writer Isaac Asimov wrote in *On Chemistry*, 'life's bottleneck'.

As in the wild, so on our fields – phosphorus, alongside nitrogen and potassium, is one of the three major nutrients needed for plant growth. Increasing the availability of phosphorus is a key technique used by farmers of all persuasions in order to improve their yields.

In the last 100 years, world agriculture has developed an increasing dependence on mineral phosphate fertilisers – a suite of compounds produced exclusively from phosphate rock. Extracted from phosphate rock mined from Morocco to Florida, phosphorus has been spread on farmers' fields to the tune of 1 billion tonnes of pure phosphorus since 1950.

Until now, the main concerns about phosphorus production were how to manage the toxic and radioactive byproducts of phosphate mining and reducing what ecologists call eutrophication – the toxic growth of algae when excess phosphorus spreads from the land into watercourses. The non-renewable stocks of phosphate rock were treated as if they were limitless.

Suddenly however, it seems the limits are almost upon us. In 2007, physicist Patrick Déry applied to phosphate rock the same statistical method that has been used consistently to predict when oilfields will peak. His results suggest that phosphate production has already peaked. If true, that would be catastrophic news, especially for the less-industrialised world, where demand is growing for phosphorus fertiliser at several percent a year, soils are generally much more deficient in phosphorus and higher fertiliser prices will be much harder to absorb.

Will it, won't it?

While Déry's analysis has its detractors, there is a growing consensus that peak phosphorus is a real threat. Just last year, the esteemed scientific journal *Nature* published an article entitled 'Phosphorus – the Disappearing Nutrient'. One conclusion of the article was that the lack of urgency in implementing solutions to phosphorus depletion could lead to catastrophe.

So how long have we got? Governments, mining companies and fertiliser companies all have incentives to guard the information they do have, meaning it is difficult to form a definitive answer. Eric Kueneman, deputy director of the Food and Agriculture Organisation's Plant Production and Protection Division admitted to Nature that the body has no real idea about the future of phosphate reserves. 'To give a reliable answer to the question, "will phosphates run out?" we need a crystal ball,' he said.

Some groups, made up of scientists rather than clairvoyants, are placing the date of peak phosphorus in the near future. The Global Phosphate Research Initiative, a growing group of academics concerned about phosphorus scarcity, says in its Declaration on Global Phosphorus Security: 'we are likely to see a peak in global phosphate rock production within the next few decades after which demand will exceed supply.'

The world had a preview of such a situation in 2008, when the mismatch between demand and supply caused a 700 percent increase in the price of phosphate over just a year. This triggered an international panic – China placed a 100 per cent tariff on its phosphorus exports, and rocketing fertiliser prices triggered demonstrations and a fatal stampede in India. The price of phosphate has returned to 'only' around 3 times the 2005 level, but the spike signals how unpredictable the price of phosphorus inputs will be.

Organics to save the day?

It's clear that phosphate rock is politically sensitive, overused and, most worryingly, becoming scarce. Dependence on mined phosphorus is one of the major flaws of conventional agriculture. So can organic agriculture save the day?

Jack Hunter of the Soil Association thinks so: 'organic farming in many ways represents mainstream farming-in-waiting. Because organic farming uses much less phosphate rock, much more effectively, it represents the best use of this depleting material'.

But it's not quite so simple. Studies in North America and England found phosphorus levels were typically low in organic farms, with the lowest levels often in the fields that had been farmed organically the longest. Nathan Nelson, an authority on nutrients in organic systems at Kansas State University, is familiar with the problem. Most organic farms, he says, are on land that once received chemical phosphorus fertilisers, and some are living off this legacy, gradually depleting the soil of phosphorus.

According to Nelson, the most problematic scenario is when farms are relying on ploughing in nitrogen-fixing cover crops to provide the main source of nutrients, as these crops reap nitrogen from the atmosphere but add no extra phosphorus. 'These [particular] organic farms are maintaining high production based on stored soil phosphorus,' he believes.

One of the products organic farmers are permitted to use to add phosphorus is far from green – crushed phosphate rock itself.

WORLD SOLUTONS TO PHOSPHOROUS SCARCITY

USE PEE POWER

There is great potential for recovering the phosphorus from human urine, especially through decentralised 'ecological sanitation' projects. Even the European Fertiliser Association has said that 'recycling by recovery from municipal and other waste products' is a 'major opportunity' for better use of of phosphate rock. Animal manure represents an even greater flow of phosphorus, and this study shows at least half of it is not being returned to fertilise our fields.

USE NATURAL SOIL PHOSPHORUS MORE EFFECTIVELY

According to Dana Cordell of the Institute for Sustainable Futures, agriculture that reduces soil erosion, promotes healthy root systems and encourages the right soil microorganisms allows plants to access more of the phosphorus locked away in the soil.

Apart from being of widely varying quality, a problem with adding this 'crude phosphate' to organic fields is the presence of heavy metals and radionuclides that remain in the unprocessed rock. The risks could be significant, but there is very little data or testing on the radioactivity or toxicity of crude phosphate. 'The risks are so clear cut and yet no one looks at it,' says researcher and organic fertiliser producer Dr Nikolas Stuttenhein.

Human waste

In contrast with crude phosphate, another, more sustainable source of phosphorus is highly regulated – human waste. One analysis shows about one sixth of the phosphorus that is mined each year ends up in our toilets, mainly as urine, and presently only 10 per cent of that is returned to our fields. Reusing such a concentrated source of phosphorus is essential, according to experts such as Carlo Leifert, who holds the Research Development Chair in Ecological Agriculture at Newcastle University. 'We need to redesign the whole waste system,' he says, 'and we have about 30 years to do it'.

As the *Ecologist* has pointed out, there are bureaucratic and systemic hurdles standing in the way of returning human waste to the land, even urine, which is relatively safe. While one might expect organic farmers to be leading the way, they are faced with a blanket ban on human excreta under EU organic regulations. Jack Hunter of the Soil Association says the Association follows the EU regulations, but is aware of the potential of human waste. 'We are bringing the issue up at the EU level, via IFOAM, the International Federation of Organic Agriculture Movements,' he says.

Demanding less

Broadly speaking, the challenge facing organic farmers is not so different then from the challenge the rest of the world faces – how to maintain or improve yields and soil fertility without relying on phosphate rock.

There's no silver bullet. According to Dana Cordell of the Institute for Sustainable Futures at the University of Technology, Sydney, and co-founder of the Global Phosphorus Research Initiative, the strategy should involve 'dramatically' reducing demand and recovering and reusing the phosphorus that currently is leaking from the system. The mix of ways to achieve this in naturally phosphorus-poor areas such as the tropics or Australia will look very different from that which is right for Europe, but the toolkit includes diet changes, wiser fertiliser use and reusing human waste (see box, left).

Problematically though, high quality information and co-ordinated policy responses to the challenge of peak phosphorus are almost non-existent. In contrast to other vital agricultural inputs, such as water or nitrogen, there is no international body responsible for phosphorus resources.

'Before we start talking about detailed policy measures, we need some kind of global co-ordination to oversee these kinds of tasks,' says Cordell. Not that she is suggesting a go-slow. 'Before 2007 there wasn't much discussion at all about this issue, which is alarming, considering what we know now... I don't think we have the luxury of a lot of time.'

It seems the world needs to rapidly start managing its phosphorus – it could be the most precious element of all.

Ewan Kingston is a freelance journalist

They're becoming more and more common, wrapped around everything from milk to chickpeas. But just how environmentally friendly are composite cartons compared to the good, old-fashioned tin or jar? By **Emilie Filou**

How green are tetrapak food cartons?

Over the last couple of years, customers buying chopped tomatoes at Sainsbury's supermarkets will have noticed a change: this staple of kitchen cupboards has swapped the good ol' tin can for cartons. Premium chopped tomatoes went first in November 2007, and the basic range followed last month. So why did Sainsbury's do it?

British consumers use about four billion cartons every year: they come in all shapes and sizes, can hold anything from fruit juice to beans, soups or milk and are as conspicuous as tin cans or glass jars. Many big brands use them (Innocent Drinks, Ribena, Tropicana, Covent Garden soups, etc); Tetra Pak, the leading carton manufacturer, is even a household name – although the same can't be said of its competitors, Norwegian company Elopak and Swiss outfit SIG Combibloc.

Many layers

Cartons are made mostly (about 75 per cent) from wood. Aseptic cartons (those that don't need refrigeration) then use a layer of aluminium to preserve the product and layers of plastic to seal the container. Non-aseptic cartons (for fresh products with shorter shelf lives) don't need aluminium.

Because of this multi-layer system, cartons have often been viewed as composite products difficult to recycle and not all that environmentally-friendly. Yet cartons are one of the greener forms of packaging available.

'Life Cycle Analyses (LCA) have demonstrated that cartons are a better solution, but we haven't communicated this to consumers very well to date,' says Michael Hecker, head of group environment, health and safety at SIG Combibloc.

Speaking in his capacity as a member of the Alliance for Beverage Cartons and the Environment UK (ACE UK), a trade organisation that comprises the three main carton manufacturers and the two main paper mills, Korsnäs and Stora Enso, Mark Eaves, Elopak's UK and Ireland general manager, says there was a certain level of complacency amongst carton manufacturers.

'We always knew we were green and we thought it'd be obvious to everyone else since cartons come from trees,' he says.

Scientific evidence

With consumers increasingly preferring scientific evidence to heart-felt assumptions, a number of Lifecycle Analyses (LCAs) have been produced over the last few years. A peer-reviewed study commissioned by Tetra Pak, which compared the Tetra Recart (the name of the tomato container) and steel cans, provided stark results: steel cans use twice as much energy during their life cycle as cartons, they produce 2.5 times more waste and more than three times the amount of CO2 emissions.

Another study comparing the environmental footprint of cartons (SIG's Combibloc in this case), glass jars, tin cans and retortable pouches came up with similar conclusions. The comparative LCA led by the German institute IFEU, measured performance in eight categories. Cartons came ahead in all but one category (use of nature, because of their use of trees). The study showed that cartons' total

primary energy consumption was the lowest of all four systems. The difference was even starker for CO_2 emissions, with pouches emitting 57 per cent more CO_2 over their lifecycle than cartons, tin cans 120 per cent more and glass jars 150 per cent more.

Both studies put the differences down to raw material, weight and shape. Cartons' main raw material is wood, a renewable source, and paper mills use wood dust and waste as their main source of energy to convert it to paperboard. Steel, glass or aluminium containers on the other hand need large amounts of fossil fuel to convert their respective raw materials. Then there's the light weight and the rectangular shape, two attributes that make cartons highly efficient to transport compared to round – and relatively heavy – cans and jars.

The problem of recycling

The cartons' Achilles heel remains recycling. Cartons are recyclable in theory, but the practice has somewhat lagged behind. The European average for carton recycling is 33 per cent, but it hides huge variations, from nearly 90 per cent in Belgium to around 15 per cent in the UK. The reason why it's so good in Belgium and so poor in Britain is down to politics. 'The insistence on UK recycling targets being weight-based has been terrible for cartons,' says Eaves. 'Cartons are a very lightweight packaging and shouldn't be treated the same way.'

They were, and the result is that until three years ago there was little carton collection or recycling to speak of. But in 2007, ACE UK started investing in bring banks to encourage collection and facilitate recycling. 'We have basically built a recycling infrastructure from scratch,' Eaves says. 'The onus is on local authorities to collect but since there are more than 400 of them, all with different methodologies, we saw the bring banks as the best short-term solution to kick-start the process.'

Almost 90 per cent of all local authorities are now equipped with bring banks. ACE UK won't say how much it has invested in this recycling effort, but the figure runs into millions. Contributions come from carton manufacturers and are based on market shares.

As well as the bring banks, the organisation has dedicated much of its time to working with local authorities to increase kerbside collection: 21 per cent now provide the service. Carton manufacturers have come under a lot of criticism for this poor performance, but Mario Abreu, director of forestry and recycling at Tetra Pak, stands his ground.

'We are not in the business of recycling,' he says. 'Cartons are recyclable but the rates are still not what we would like them to be because of a combination of inferior collection facilities, consumer habits and the economics of recycling.'

This last point is particularly relevant in the UK: the only mill capable of recycling cartons closed in 2006 due to economic difficulties, and there currently aren't enough cartons for another mill to invest in recycling facilities (the UK collects about 10,000 tonnes a year, while mills in Europe deal with more than 100,000).

So until the UK steps up its collection efforts, collected cartons will continue to be baled and shipped to a mill in Sweden on empty Ikea ships.

'Carton recycling is straightforward and generally sought-after because of the high quality of the wood fibres'

Greener, even in the bin

It's unfortunate, for carton recycling is straightforward and generally sought-after by recyclers because of the high quality of wood fibres. The paperboard, aluminium and polymer are easily separated. Fibres are turned into paper or cardboard; the fate of the aluminium and plastic depends on the mill. In Sweden, they are used for energy recovery. In other countries (Brazil, Italy, Poland), they can be used together as polyAl, a material used for injection moulding, or separated to be recycled individually.

Interestingly, the IFEU lifecycle assessment results mentioned above are based on average European recycling rates for all materials, cartons included. But sensitivity analyses reveal that even with zero per cent carton recycling and 66 per cent glass or steel can recycling, cartons would still outperform other types of containers because of their low energy requirements in the production process.

No wonder then that Tetra Pak et al are keen to highlight their product's renewability. The recent rush for Forest Stewardship Council (FSC) certification is a case in point. Tetra Pak announced that three-quarters of its cartons in the UK and Ireland would be FSC-certified by the end of 2010. That's a jump from 200 million to more than one billion cartons. All three companies have committed to sourcing 100 per cent of their wood fibres from legal and acceptable sources by 2015 and securing Chain of Custody Certification for their paperboard mills by 2015, and for their beverage carton manufacturing plants by 2018. This means cartons will have to be traceable all the way back from their shelf to the forest they came from.

FSC certification and the likes may not be perfect but it commands attention in the world of sustainable business. Stuart Lendrum, printing and packaging manager at Sainsbury's, oversaw the chopped tomato switch and says that the FSC certification definitely worked in favour of cartons.

'We make changes in our packaging to make things better – for instance by using less packaging or more recycled content – so if we're going to use virgin material, we want to ensure it comes from a sustainable source and FSC gave us that confidence.'

Winning hearts and minds?

Lendrum says customer response has been good and comforted their decision to extend cartons to the basic chopped tomatoes range. Hecker says that German supermarket chain Lidl has been enthusiastically promoting its FSC-certified juice cartons. And Harvey Lees, buyer manager at Asda, reports similarly positive feedback on the recent switch in the packaging of their baked beans from cans to cartons.

Carton manufacturers know they have to keep on innovating, however. Tetra Pak and Elopak have signed up to the WWF Climate Savers programme and committed to reduce their CO_2 emissions to 10 per cent below 2005 levels by 2010 for Tetra Pak and by 15 per cent from 2008 levels by 2011 for Elopak. SIG for its part is aiming for a 40 per cent reduction between 2010 and 2015, and a 25 per cent reduction in waste.

Tetra Pak is also experimenting with bioplastic; SIG is trying to address aluminium traceability with its suppliers, and all are exploring ways of reducing the amount of aluminium and plastic used in cartons since these materials account for 80 per cent of cartons' CO_2 emissions.

Lees at Asda says the retailer doesn't exclude rolling out cartons to other products if the switch, which took place in June 2009, works out well. Other retailers and food manufacturers will no doubt be watching too: WRAP, the UK Government's Waste and Recycling Action Programme, plans to publish a LCA on milk packaging in spring 2010, the results of which should make interesting reading. A 2007 study by environmental consultancy LEK showed that cartons produced 30 per cent to 40 per cent less CO_2 emissions than HDPE [plastic] milk bottles. But Eaves says that historical investments, such as plastic packaging in the dairy industry, are hard to overturn, as are consumers' perceptions of what is 'normal', although he hopes that with increasing awareness, packaging decisions will be reviewed in the medium-term.

In the mean time, carton manufacturers know they have an uphill struggle to improve carton recycling in the UK. As ACE UK puts it, 'our plan is to continue working at local level and keep on ringing a bell every time a local authority converts to kerbside recycling'.

Emilie Filou is a freelance journalist

Face up to natural limits, or face a 1970s-style energy crisis

The history of Britain is one shot through with the results of cheap, indigenous energy. It's a brave new world now, says environmental researcher **Paul Mobbs**

Britain has a serious problem with its energy supply. After examining this issue for a few years now I perceive that the greatest difficulty we face is not that we lack energy resources (arguably we do), or that we are becoming precariously dependent upon imported energy (which we are), or that our large demand for energy makes reforming our economy extremely difficult (as evidently it does); the most significant problem is that the political and business community cannot accept that natural systems impose physical limits upon human society.

We may be told that our present problems can be solved through measures such as 'green growth', 'low carbon energy' or 'carbon markets', but such a view ignores the growing body of evidence concerning the relationship between the way the economic system operates and the physical nature of energy and material resources that the economy relies upon.

Cheap energy = cheap growth

Throughout its history, up to the Second World War, Britain was largely self-sufficient in energy. Then from the 1950s, on the back of the post-war consumer boom, this historic trend ended as imported oil gained a wider role in the economy and indigenous coal production declined. By the 1970s, when we imported about 50 per cent of our energy needs, the imbalances in the national economy caused a whole range of economic problems, essentially because Britain was trying to spend more than it could create through its national income.

What resolved this crisis, from around 1979/1980, was increasing energy production from the North Sea. Once again Britain became a net energy exporter, and once again the strength of the national economy improved. With the peak of North Sea oil and gas production, and with our demand for coal now largely met by imports, energy demand is once again becoming a drag upon the national economy.

The operation of the modern economy is predicated upon cheap and plentiful energy supplies: recent research into the causes of the credit crunch argues that it was high energy prices that initiated the crash, not sub-prime mortgages. The Government's own forecasts predict that we could be importing up to 60 per cent of our energy needs by 2020. As a result our dependence upon imported energy is not just an issue of 'energy security': these trends are redefining the basis on which the economy operates, and unless we act to change it the economic difficulties of the 1970s are likely to return.

What can be done to avoid this outcome? This again raises questions about how mainstream economists value different strategies, and only attach positive values to those strategies that can produce economic growth. Research suggests that up to half the value of economic growth is the direct result of adding additional energy to the economy, and a further fifth is the result of improving energy efficiency. For this reason changing the dynamics of our energy supply, through falling production and/or higher prices, invalidates many of the economic norms of the past few decades.

The limits to efficiency

The option to manage resources more wisely, improving the efficiency of use, is limited by the fact that it is not an open ended process; each improvement represents a one-time saving, and improving efficiency levels further requires that we invest in new technologies once more. This is because thermodynamics of efficiency dictate that each new generation of technology must, on average, save less than the previous generation, and so ultimately efficiency measures represent a diminishing return – eventually you will have to put more into the system to reduce consumption than it will save overall.

If we look at the trends of the last century or so, the value of economic growth has in most years exceeded the value of improving efficiency. That's because efficiency improvements create a confounding economic feedback – cost reductions in one part of the economy will spur consumption elsewhere. As a result most efficiency measures will usually only dampen, rather than reduce, overall consumption.

If the emission of greenhouse gases were the only problem with our energy system today then we might be able to do something to address the problem. The unfortunate reality is that there are an interrelated group of difficulties (principally food production, water resources, energy/mineral depletion, population and climate change) that are systemically linked to the accelerating growth in human activity within a finite ecological system.

The past bites back

Whether it is the ability of the environment to mop up carbon, or of the Earth's crust to provide the energy and material resources required to continue the industrialisation of human society, human development over this coming century is going to be constrained by these ecological limitations. This is not a new concern; it was highlighted back in 1972 by the Club of Rome's Limits to Growth study, and by the *Ecologist* in its Blueprint for Survival. The difference today is that the limitations on our future development are even more stark, and thus the outcome of present patterns of economic activity are seemingly more intractable.

In Britain we will have to reduce our economic activity – or 'have less' – to solve our present economic difficulties; Britain is in ecological and economic 'overshoot', and we're going to have to take action to resolve the problem before we just run out of energy, money, or both. The realistic way to reduce our impact on the environment, and manage the decline in resources, is to reduce economic growth – also called 'de-growth'; perhaps not directly, but because those strategies which make a significant difference to the level of energy and resource use will often lead to a reduction in economic activity.

For example, the best way to reduce consumption is not to make things 'more efficient' in their operation, it is to make them last many times longer by manufacturing them to higher standard – consequently fewer are sold, and as a result the standard index of growth, GDP, will fall; likewise, as most of the energy and resources used by modern gadgets is expended in their production, the best way to cut energy and resource use is not to simply recycle the waste products but to adopt measures that mandate the repair and reuse of goods – the result over time being lower economic activity and negative growth.

Britain was one of the first nations to industrialise – we 'made' the Industrial Revolution. Now, if we can abandon the delusional notion that human society is not subject to ecological limits, we have the potential to resolve the crises that will arise over the next few years by spurring a new 'Ecological Revolution' – one that addresses these past excesses through redefining markets and economic theory within ecological and biophysical limits.

Paul Mobbs is an environmental researcher and author of Energy Beyond Oil. This article is an edited version of a fully-referenced report available on Paul's website - www.fraw.org.uk/mei/