Science AMA Series: Hi, I am Professor Tim Benton. I work with governments, universities and the World Economic Forum on how to feed the growing human population without ruining our planet. Ask me anything!

universityofleeds [1] and r/Science AMAs[1]

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Abstract

I'm Professor Tim Benton, Professor for Population Ecology at the University of Leeds and former UK Champion for Global Food Security. At the moment, on a global basis, our food systems are not working well. Half the world's population is of an unhealthy weight (too light, too heavy), the cost of malnutrition in all its forms is growing rapidly and food-related ill-health is now the major global mortality factor. The world's food systems drive climate change (accounting for about a third of all greenhouse gases), are the major cause of global biodiversity loss, use 70% of the world's extracted fresh water and impact heavily on water and air quality. In some cities, agricultural emissions drifting over the urban areas have similar levels of impacts as diesel emissions. As the world's population grows, dietary transformations are necessary for people's health. We need to eat more fruit and vegetables and less (processed) carbs, sugar, fat; tackling climate change is likely to require eating less meat too. How can such a change be brought about? What difference would people eating a healthy diet have on farming and its environmental impact? Can we actually live sustainably on the planet or is the rising demand to eat (and waste) ever cheaper food likely to continue, along with its consequences for people and the planet? I'll be here from 3PM BST/10AM EST to answer your questions on these global challenges! I have to switch off now (its 1700 in the UK, Tues)....Please continue to post questions and I'll check tomorrow (Weds) and see if I can add some new responses. More about my work can be found here

the WINNOWER

REDDIT

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UNIVERSITYOFLEEDS R/SCIENCE

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Will lab-grown meat economically and environmentaly be sustainable to completely remplace conventional meat ?

DaLuckyNoob

Hello everyone.

Certainly, there is scope for lab grown meat (or other types of "fake meat") to have a lower environmental footprint. So, if people adopt it in preference to real meat, some environmental impacts will be reduced (e.g. greenhouse gas emissions, the need to grow feed and their impacts) - but if everyone eats MORE meat as a consequence, it may not reduce overall impacts as much as it could do. In other words, for many countries we eat too much (hence our growing overweight) and eating less is also an option

What are the least destructive crops that produce the most food?

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Mac642

Hmmmm...difficult one. Different crops clearly have different footprints through the area gown and how they are grown...but the difficult question is "what is meant by food" - volume of food, nutrients, calories? My gut feeling (to answer your question) would be a big, mature, fruit tree might be lowest impact (as well as storing carbon, requiring little soil distrurbance, home to biodiversity etc)

Given their relative ease of management, low water costs and volume of food produced, what role do you think aquaponics will play? Any tips on convincing councils that these are viable agricultural options and not weird hippy shit?

theprintmaker

Yep, I think there is a good role in future (especially in glasshouse/enclosed/urban/vertical farming) - but most people don't eat of lot of food that is grown in these circumstances (aquaponic wheat is not likely to be a winner). Also, such systems can be quite capital intensive. So a role, for sure, but not a silver bullet. However, I like the concept of urban farming - as people can see food growing and value it more (so waste less), so perhaps most mportant through this route, rather than the total volumes?

Is this going to mean a heavier reliance on GMO foods? With population increasing, space is harder to come by so farming will not necessarily be easier either. With all the hate towards GMO (im pro GMO) how do we tackle the challenge of producing more sustaining (or nutritional) food without the negativity that surrounds it?

Pia-the-Pangolin

This is a good question. If you look at the whole food system, it is horribly inefficient - with the amount of food wasted, and the inherent waste of over-consumption of calories (and under-consumption of nutrients on a global scale). If we re-designed the food system to deliver healthy diets, sustainably produced, and waste less food in an efficient system - it could be that we don't need a huge increase in production. The need of and role of technology to deliver more food therefore depends on the assumptions one makes. I can see advanced biotech potentially playing an important role in climate resilience and perhaps pest resistance as well - but again the extent to which this is needed (as opposed to being useful) depends on how much food we want to grow, and how wasteful we want our system to be.

Can apartment dwellers realistically grow edible food other than a few herbs? How much space/cost to just grow romaine lettuce indoors, for example? (You can exclude legal costs, even though the DEA previously said they pretty much raid anyone buying hydroponic stuff, assuming they're growing something illegal).

Teddnnite

Good question. On average, for each person in the world, it takes about 0.7 ha of land to grow the food we eat. Clearly, that cannot translate into an urban environment other than at the margins. However, I do think growing food is a good idea in general because it takes food away from the concept of it being plastic wrapped commodities to be something to be valued and respected a bit more. Those people who do grow their own food, are often less willing to waste other food they buy because they recognise what goes into producing it. You'd be surprised but many kids these days don't know where food comes from (e.g. milk comes from cows, sausages from pigs etc) and when consumers do not recognise the "real costs" of producing food, they value it less in general. So grow

your own is often an education in values.

Modern aquaponic systems can be amazingly productive, so even a small flat can produce something. But even a windowsill can be used to grow tomatoes...

Tim

Urban farming initiatives seem to be becoming more popular. It seems I'm coming across more mention of projects like inner-city community gardens, urban foraging and rooftop beekeeping in recent years. Are these having any effect on food diversity and reducing pollution? Do you feel these local projects can be a major part of the solution to protecting bees and other pollinators; or does change need to happen in the agriculture industry at large?

twinkyhouse

Thanks for the question. As I have said in other answers, urban (etc) farming has important roles in the future (particularly in changing consumers' perception of the value of food, but also in some places providing fresh fruit and veg - especially in some cities in the developing world, the infrastructure of providing fresh produce is mainly urban and nearby). However, the biggest foodprints on air, water, soil, biodiversity and climate come from large-scale, large-extent, intensive agriculture - and if we want to live within "planetary boundaries" we need to change this.

Tim

What are some developements you think that have the potential to have a good impact on this topic in the future? - other ways to grow/produce something (aquaponics, lab-meat) - trends in the population (veggie lifestyle) - "new" foods (algae, insects) - others

And another question as I mistrust the majority of the worldpopulation to change theyr eatinghabits in a significant time. How can we change the eatinghabits of the population without them changing themself intentionally? I think about prescribed gym (or similar), emission-restrictions for foodproducers or projects to get food to countrys with high malnutritionrates.

I hope you can at least partially answer my questions :)

Edit: Some words

trippyfroozer

Thanks for the Q - could write for hours! But briefly

The global healthcare crisis (with unhealthy weight being the norm) - aka "malnutrition in all its forms", I think, will drive changing diets over a decadal timescale. If we look back, diets HAVE changed a lot in recent decades, and are likely to do so again.

Diets can change through many routes, without it necessarily being deliberative driven by our wants. For example, changing the price of unhealthy food up, and the price of healthy food down, might create big changes; changing the availability of food likewise; changing healthcare incentives (e.g. health insurance reductions for healthier lifestyles etc etc) - so quite a lot of scope. Likewise, as climate change drives costs up, and as food contributes so much to driving climate change, governments and corporates may be driven to become better at delivering healthy and sustainable.

To address your first question: lots of scope for changing diets (as above), changing proteins (fake meat etc), reducing waste through many means, making the food system more transparent so

consumers can genuinely buy the food that they want (from a health or environmental perspective). Many routes, I think (outside simply thinking about driving agricultural productivity).

Tim

Hi Tim!

Do you lean more towards top-down regulation or bottom-up habitual change as being key to the (sustainable) transformation of the food system?

Or, perhaps, is this a false dichotomy?

TheMercian

Excellent question TheMercian!

Governments regulate when markets don't work - so they set the rules in which the market actors play. We "license" the system, and if we don't like things, we put pressure on governments and markets to change. Hence, I see a false dichotomy in your question. It is both top-down, and bottom-up, as well as middle-up and middle-down (the market interacting with govt, driving the economy, and with consumers providing what we like).

If you had to guess, what would you say that the maximum sustainable human population is, given present day food production technology?

cyclefreaksix

Interesting question (and one I think about a lot, being a population biologist by background). The answer, of course, depends on what we demand. We currently produce enough calories to feed about 11 billion people, but waste a lot of it - throwing it away, feeding it to livestock to grow meat (when we could eat more vegetable protein), over-consuming it. Our current food system is under 50% efficient at turning agricultural output into healthy diets. So one answer - based on our current production - would be about 10 billion. If we recognise production has a high impact and want to reduce that, probably a few less... But technology may have a role at making our system less impactful in future. So, as a guess 9-10bn.

Tim

How much washing-up do you think you could do without any washing-up liquid?

Alfiejay123

Hmmm...never thought about it - so here's some top-of-the-mind bull...

Washing up serves a range of purposes - making plates look clean and killing the bacteria left so we don't get ill. You can make plates look clean without washing up liquid, but often the antimicrobial benefits of washing up liquid are difficult to replicate without something (other perhaps than heating). So, sterilisation is possible, but would be expensive from an environmental footprint....

Basically, everything we do has consequences...can you think of a better way?

Tim

Do you believe insect consumption can help?

kyluci

I don't believe in silver bullets (especially in transforming our complex food system from unsustainable and unhealthy to sustainable and healthy), but I do think many interventions can make a difference. In most areas of the world (including Africa) on average more protein is consumed than people need for basic health reasons (and in some developed countries, 3x more protein is eaten than we need). So reducing protein intake is perhaps the first step towards sustainabilty, with changing the type of protein being the second. Of this, we can switch from resource-intensive meats (e.g. red meat) to plant-based, lab meat, myco-protein, aquacultured protein or insects - all of which may play a role. Personally, I suspect insects may be useful as a form of livestock feed, and some people may like to eat it. I doubt everyone will relish switching from a steak to a locust as a matter of course...

Tim

Hi Tim - do industrial countries have any chance at all in long term food production when soil science and soil protection is so low down the agenda? Would it be better to give up trying to produce food in fields altogether (in developed countries)?

What do you make of the idea that there are only x harvests left in British soils - an idea that one prominent British soil scientist thinks is (I paraphrase) total hooey?

fedoracat

Hi Fedoracat

We are eroding soils at rates far faster than they are produced, so, it we continue, at some point they deplete to the point that we can't use them as we currently do. Now, in principle, there may be technological solutions to growing food without soil, but soil serves also important roles for carbon storage and building resilience - as well as home to biodiversity (of a range of critters, including microbes) that help plants function well in "dirty environments". The soil microbiome can be sidestepped in more sterile growing conditions in glasshouses, but an artificial medium outside may not be easy to replace.

So, in short. I think soils are one of the critical issues we need to spend more care on, to ensure we can manage our food system into the future. The mid-West dustbowl of the 1930s is still reflected by lower land prices where the soil was eroded, even nearly a century on. So not total hooey....but "65 harvest left" is probably hooey in terms of its uncertainty and precision (range 50-150!)

Tim

Do you think there will be chances of decentralizing food production by the use of vertical farming?

m2k1

I think there is a lot of scope (perhaps driven by long supply chains becoming less resilient to changing climate and geopolitical contexts; and driven by consumer demand for more local food, as it is perceived to be more trustworthy) for food systems to become more localised. Smaller scale farmers around and in a city, as well as vertical farming, can be an important route to fulfill local demand.

However, local food production often comes at a cost (because, perhaps, it is less efficient to grow crops near a city than in the place where they are normally grown - due to scale and local geographic

"comparative advantage") so local production implies perhaps more pricey food. That may not be an issue if people waste less, but it does raise an issue for equality of access...

Tim

Could we use vertical space for food crops? Sides of buildings etc. For example could we start growing small fruits or berries for foraging along buildings etc?

We are familiar with small plots in garden spaces from decades past, is there room for that micro level of food production or should it be ultra large scale food production so it is centralized?

On a slightly sillier note, could humans start eating a wider variety of plant/animal life such as your old pet or animals which fo not have the same rep as a juicy steak?

forusebyme

As I mentioned elsewhere, an average person requires about a football pitch area of land to grow our food - and people in the developed world more than this average as we waste and consume more. So, whilst vertical farming makes space use more efficient for some crops (leafy greens, some veg, some fruit) it is not going to be THE SOLUTION. But, for sure, there is lots of space in our bult environments that can be used better for this, and help people reconnect to where their food comes from (and, in some places, creates new communities cooperating to grow their food, with all the benefits this drives).

As to your other question, I'm not sure I could eat my dogs when they finally die of decrepitude - not because I couldn't, but because they are getting old, smelly and probably very tough. My aim is to dig a hole and plant a fruit tree over them, and do it indirectly!

Tim

With the possibility of lab-grown meat on the rise, how would you say this could be implemented as a solution/supplement to the supply of meat currently? It’s been known that animals like cows produce mad amounts of methane, so would you say it is possible for lab-grown meat to be done on a scale that would allow for mass consumption?

AlbinoNemo

I recently had Impossible Burgers - which are made from bioengineered cells, inserting animal's haem producing genes into yeast. I also eat Quorn quite a lot (which is grown from a soil microbe, a fungus, in a huge fermenter on Teeside). So, industrial biotechnology is able to produce "lab meat" or "fake meat" at scale already. The issue is not "could we" from a techie perspective, but "is the demand there to make it possible economically?" Yes, I think, increasingly. The Impossible Burger was a good imitation of a real burger, and for many people, it is perhaps good enough (given it is both healthier and more sustainable) if not to replace all the time, ut replace sometimes. Even that will make a difference.

Tim

What are the barriers to removing/switching subsidies, forcing farmers to use hoop houses and sow diverse open pollinated plots with organic mulch, drip irrigation, and Sea-90 minerals, and requiring food vendors to sell organic plant based foods/meals in every municipality (not that anyone would know the difference between a veggie patty and what is now a McD burger)? If our "freedom of choice" could come in the form of dollar menu vegan options, even if it's 'faux animal products,' I imagine heart

disease would fall.

Boleo

Good question. The barriers are often more about the way we are locked into doing things, and the problem of "incumbency" as much as real constraints. Historically (and for largely good reasons), we have built public support for production based on commodity crops (nearly 3/4 of the world's calories come from 8 crops) to provide calories. Very little support (subsidies or R&D) has gone into horticulture or less impactful farming systems like organic. Equally, the ideology is that cheap food is a public good, and the cheapest way of producing food is best. We are starting to recognise that this incentivises moving costs from production to the environment (so called externalising the cost), but whilst consumers largely expect food to be cheap, then any food that is comparatively more expensive (e.g. organic) faces an uphill struggle. Clearly, there is potential both for consumers to change attitudes (perhaps especially through wanting to eat more healthily) and for govts to do more to incentivise healthier and more sustainable eating. This may come in future (e.g. through changing prices on unhealthy and unsustainable food - such as sugar taxes, carbon taxes etc)

Tim

SalMar's new fish tanks raise 8000 tonnes of fish in 14 months. They feed the fish automatically and are designed for 35+ meter deep water. If they are successful, what will be the impact?

LearnedGuy

Deep-ocean aquaculture clearly -like every brick in the wall - has a part to play. However, the important thing is if demand for fish ever increases, even off-shore aquaculture will start to have an impact. In the old days, we thought we could pollute as the volume of the air or sea would wash it all away - and look at the state air or water quality has got to. So, a good innovation, but if too many cages occur in any one area, it will drive impact, like any other method of food production

Tim

Do we all need to go vegetarian, or vegan, to stop catastrophic climate change?

simoncmoore

I am currently writing some assessments on this topic (for the IPCC) and have been reviewing the literature - which is increasingly extensive. Livestock production is producing somewhere around 15% of all human greenhouse gases (more than transport) so is a very significant emitter; reducing meat consumption is therefore a big potential lever. Food-related ill health is also the number one global mortality factor, so eating more healthily may be a good thing - and that generally means eating more vegetables (which potential crowds out meat), eating less meat, and especially eating less processed meat.

Now, as an ecologist, I think livestock can play a key role in managing land in a sustainable way - so I don't think a "vegetarian world" is necessarily the most sustainable one. Personally, I am not vegetarian, and I see "meat as a treat" - eating it occasionally, and when I do, making a fuss of it. So, on a global basis (I'm pretty sure on-going work colleagues are doing will say) on average, eating meat once or twice a week is sustainable, eating it every day is not.

T

A major issue raised by non-vegetarians is the bioavailability of iron. Do you think this issue needs more attention by authorities? I am not sure about quantitative data on the prevalence of iron-deficiency among vegetarian-diet cultures but people e.g. in central Europe seem to be puzzled about prevention of iron-deficiency when trying to become vegetarian.

m2k1

The bioavailability of iron (and some other micronutrients) is a real issue. Whilst it is not insurmountable - it is possible to have a healthy vegetarian diet with care (and or supplements), meat is a pretty nutritional meal. In the UK, malnourishment comes in several forms (undernutrition, especially of the elderly, obesity and related non-communicable diseases, from eating too many calories, and, particularly in young women, anemia through lack of iron (sometimes compounded by eating too little and trying to be too thin). So as I said elsewhere there is an issue of perhaps (on average) eating less meat in general, as much as more people becoming vegetarian.

To address your question directly, it is perfectly possible for a healthy diet to be enabled in many ways. Ion supplementation could be available in school canteens if young women want to avoid eating meat, as an example.

Tim

Various ideas relating to permaculture seems to offer a good solution to pest management. But is permaculture a scalable solution to any of the impending food crises?

m00thing

Permaculture is (theoretically at least) based on agro-ecological principles. In "nature" ecosystems are often pretty resilient (i.e. staying their same over long periods) and fluctuations of any species -such as we'd consider a pest outbreak - are often notable by their rarity. So, ecology can clearly play a role in suppressing and managing pests. A PhD student of mine estimated that small wasps provide about £50 per ha of "free" pest management for UK cereal growers, many of which don't know that "natural enemies" do an important job for them. I think there is a real science question about the extent to which we can design real pest management (without the need for inputs of pesticides), but part of this is that, around the world, govts have not invested enough in agro-ecological principles as much as developing new pesticides. However, that is changing (as least to a degree).

Tim