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The Food Revolution

**Appetite for innovation.
Hunger for change.**



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Ayming Institute (AI) aims to help leaders in the private and public sectors gain a deeper understanding of the evolving global economy by focusing on three areas:

The first area is sustainability. We believe that the environment and social responsibility are critical issues for businesses today. For this reason, our content aims to help companies integrate these issues into the way they make decisions.

The second area is business development. Through our content, we wish to help companies to develop a stronger business culture and a sustainable approach to growth.

The third area is the people side of the business. With our content, we want to support individuals as they navigate their careers, learn new skills, and find ways to contribute in a world that is constantly changing.

Our strongest commitment is to help organizations better understand how markets are changing, and how they can build better businesses as a result. We aim to do this by providing analysis of the global economy's transformation, sharing our insights through thought-provoking publications, and engaging business leaders in conversations about the economic changes that are affecting all of us.



A food revolution is under way.

And it goes beyond the rise of e-commerce, home delivery, meal kits, and the rollout of new flavors, formats, and fads in the fast-moving world of packaged foods.

Disruptive though these trends may be, the revolution is more fundamental and far-reaching. And it is being propelled by profound changes in technology, the natural world, and people's needs and numbers.

In developed countries and among the growing middle classes of the developing world, consumer power is driving demand for healthier diets, including alternatives to meat and dairy. A flowering of innovation in foodtech and agritech is both enabling and responding to this shift, growing the market for plant-based alternatives, spawning a new category of lab-grown proteins, and cultivating more sustainable means of food production.

Two other powerful and inter-linked forces are at work. Together, the climate emergency and population growth are already testing the global food system to breaking point. Modern agriculture and food chains are intensifying global heating and exhausting natural capital. Increasing current production methods to feed a global population of nearly 10 billion people by 2050 would require the resources of three planet earths.

A one-planet solution hinges on this food revolution.

Table of contents

Conscientious consumerism p.05 ✦

A broken system p.06 ✦

Climate accelerator p.07 ✦

Searching for solutions p.08 ✦

Organic growth p.09 ✦

A heavy hoofprint p.10 ✦

Leaner and lighter p.11 ✦

Methane menace p.12 ✦

Big Food, big ask p.13 ✦

Plant-based growth p.15 ✦

Milking the market p.17 ✦

Cell by date for meat? p.18 ✦

Sea change p.20 ✦

Blue economy p.21 ✦

Insect bites p.22 ✦

Rise of vertical farms p.23 ✦

Tackling food waste p.24 ✦

Regenerating agriculture p.25 ✦

Carrots, not sticks p.27 ✦

Cultivating innovation p.28 ✦

Conscientious Consumerism

Concern for health of the individual, as well as the planet, is changing food and drink consumption.

In a backlash to the obesity and diabetes epidemics, more consumers are buying into healthier lifestyle choices. Shoppers are better informed and searching for products free of additives and allergens, lower in sugar, salt, and trans-fats. Consumers are also more suspicious of 'Big Food' brands and receptive to newcomers that espouse a healthier or higher purpose.

Research linking diets heavy in red meat and highly processed foods and pesticides with cancers and other health risks gives people further reason to change old habits. 'Flexitarianism', vegetarianism, and veganism are on the rise, especially among millennials.

The trend is reinforced by concerns about animal welfare and the climate emergency.

Study after study confirms that to continue feeding the world, consumers must eat less meat to shrink livestock farming's massive carbon footprint.

The coronavirus pandemic too has focused more attention on healthy eating and immune systems, while also exposing vulnerabilities in our food supply chains.



A broken system

Our global food system is broken. In 2020, the World Food Program estimated that 690 million people – 8.9% of the global population – did not have access to enough food to be healthy.¹ Their ranks increased by nearly 60 million over five years.

The pandemic only added to food insecurity and hunger. Some 957 million people across 93 countries do not have enough to eat in 2021.²

Zero hunger was the UN sustainable development goal for 2030. Nor is the world on track to reduce the number of children affected by low birth weight, stunting, and wasting. Most regions are failing to meet targets for reducing the number of overweight children, and adult obesity is rising worldwide.

So are food prices and populations in African and Asia. Our food supply must meet a 70% increase in demand by 2050.³



¹ <https://docs.wfp.org/api/documents/WFP-0000117812/>

² <https://un-food-systems.medium.com/2021-is-going-to-be-a-bad-year-for-world-hunger-6a7c43a294cf>

³ Inside Climate News

Climate Accelerator

Climate change can only exacerbate the planet's food system failures.

Agriculture is extremely vulnerable and already suffering the effects of increasing temperatures, weather variability, shifting agroecosystem boundaries, invasive crops and pests, more extreme weather events, and soil loss and degradation. This is reducing crop yields, the nutritional quality of major cereals, and lowering livestock productivity.

As much as 50% of food production is at risk due to climate change.⁴ Only recently has it become apparent how global warming has been hampering food production for decades. About 21% of growth in agricultural output was lost since the 1960s – the equivalent of losing the last seven years of productivity growth.⁵

Agriculture is both victim and villain. Producing more food with our current systems will itself accelerate the climate crisis. Not only are livestock production and agriculture the main drivers of deforestation, together they are responsible for one quarter of the world's global greenhouse gas emissions. This vicious cycle also drives biodiversity loss and the rise of zoonotic diseases (like Covid-19).



Searching for Solutions

As with the climate crisis, no one all-important solution can fix the world's broken food system. There will have to be many solutions, all of them important collectively. And their mix and magnitude will vary between continents and countries – with the terrain and political and economic models.

Consumer behaviour, agri-foodtech and innovation, system-level changes, government policies and support for research and development and for producers must all contribute. Some of the more significant trends and opportunities are covered here.



Organic growth

Thirty years ago in the US, and other industrialized economies, organic produce was a niche taste, and vegetarian prepared meals cooked with fresh, organic ingredients an innovation. Since then, a growing movement of farmers, campaigners and manufacturers have sold the health benefits to more and more consumers – if not the message that organic farming free of pesticides is also essential for healthy soils and regenerative agriculture (see below).

Organics are now mainstream in the aisles of mega-retailers and volumes are growing, as consumers vote with their wallets. US sales of natural, organic, and 'functional' foods and beverages grew more than twice as fast as conventional products in 2019, and quadrupled since 2005.⁶ Europe is on a similar trajectory. The organic market grew by 8% in 2019 to reach €45 billion, second to the US, with some segments enjoying double-digit growth.⁷

In both regions, affordability is another limiting factor. Organic growers' yields are lower, ingredients more expensive, and economies of scale smaller, compared with conventional food processing. While prices may represent good value, they are still out of reach of large sections of society.

Across the undeveloped world, people cannot afford healthy food, but it's a first-world problem too. An estimated 42 million Americans, including 13 million children, are at risk of food insecurity, even as the US faces rising obesity rates and healthcare costs – prompting the launch of a task-force aiming to improve access to healthy foods.⁸

A sustainable food chain not only needs agriculture that does not rely on harmful chemicals, its healthy produce must also be affordable for the average family. That will require systemic change – from agricultural practices and land use to innovation by Big Food and new entrants, not to mention a cultural shift for consumers.

While this revolution takes root, existing food systems must be improved.



A Heavy Hoofprint

Notwithstanding the trends in favour of alternatives, meat and dairy will remain part of the diet for humans worldwide for decades, if not forever.

There are parallels with the climate change debate. Since the Industrial Revolution, developed countries have generated most of the carbon that is overheating our atmosphere. Poorer countries are now industrializing and raising their people's living standards. That means higher consumption of meat and dairy produce, and an increasing carbon footprint. Yet they and their food systems are most vulnerable in a volatile climate.

Consumption has increased as the world gets richer. Production of meat more than tripled in 50 years (to 340t million in 2018), and milk more than doubled (to 800t million).⁹ While in Europe and North America meat output doubled, it tripled in other regions, and rose 15-fold in Asia.

Poultry has expanded to rival pork's 35-40% share, but livestock is the most carbon-intensive and least efficient protein source in terms of feed conversion, energy, land, and water use. By 2030, it alone could consume nearly half the world's carbon budget, the amount of greenhouse gas the world can emit without trampling global climate targets.

As the world expands its capacity to produce plant proteins, the efficiency of meat and dairy production – which varies widely across the world – could be improved. One way would be to share advanced countries' scientific knowledge and best practice – often developed with research incentives from governments – with other regions.



Leaner and Lighter

Over decades, farmers in North America and Europe have made huge strides in efficiency, increasing yields while reducing overall inputs. This 'total factor productivity' (TFP) is achieved through precision mechanization, improving animal genetics and care practice, and advanced transgenic and hybrid seed varieties, according to Virginia Tech university's annual GAP report for 2020.¹⁰ Compiled on behalf of agri-giants Monsanto, John Deere and others, it argues that a growing TFP gap between high/middle-income countries and the rest of the world needs to be bridged to double global food production sustainably by 2050.

From 2008 to 2017, global TFP grew by an annual average of 1.63%, but the rate of growth has been declining in low-income countries. An overall rate of 1.73% is needed over the next 30 years. GAP also attributes a slowdown in North America's TFP to 1-2% since the turn of the century to reductions in public sector agricultural R&D investment – "The cornerstone of TFP growth". It foresees technologies such as CRISPR-Cas and artificial intelligence boosting TFP in coming years if they can gain US consumers' acceptance. By contrast, GAP notes, in Europe, conservation – with less land and inputs – is the priority rather than output growth.

The OECD and FAO agree that productivity improvements will be crucial to feed a growing global population sustainably. For crop production, it expects 87% to come from yield growth alone, with 6% from expanded land use and 7% from cropping intensity. Productivity gains may be high for livestock and fish production too, but herd enlargement will be significant in low-income and emerging economies.¹¹

Agri-tech R&D must serve a twin purpose – productivity and sustainability – so that farms produce more with less. As well as other natural and man-made resources, that includes land use, and not invading forests and other ecosystems, or land suitable for tillage. The environmental impacts also need to be curbed, not least methane from livestock.



Methane Menace

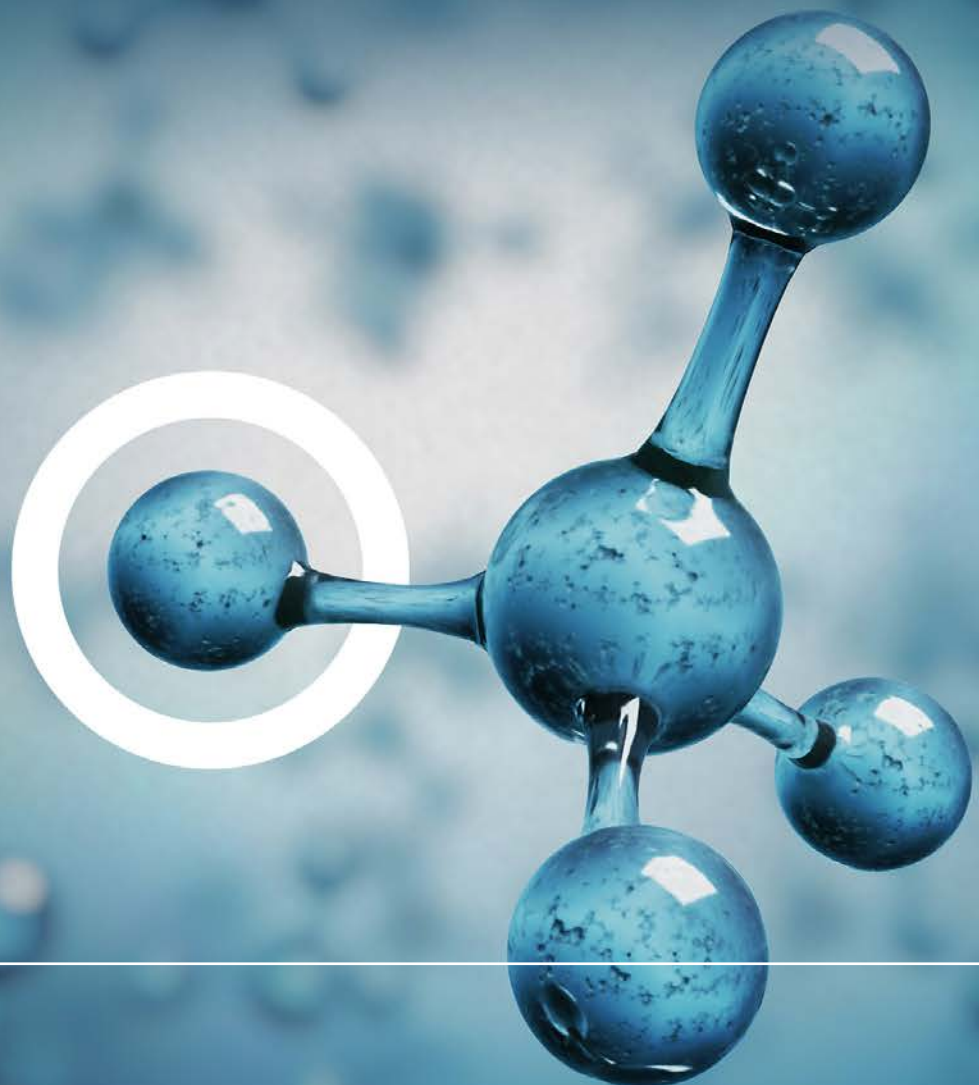
Methane is a far more potent greenhouse gas than CO₂. Curbing its emissions from cattle is an urgent priority.

Genetic variation accounts for a 25% variation in methane output. Selective breeding could replace the most polluting animals, though each generation takes 5-8 years.

Feed supplements offer a faster and potentially significant solution. Mootral, an Anglo-Swiss agritech start-up, claims its supplement makes cows burp 38% less methane in real farm conditions. It uses compounds from garlic and flavonoids derived from citrus.¹²

An incredible 99% reduction for beef and dairy cattle and sheep was achieved in trials of another supplement.¹³ It uses asparagopsis, a red seaweed abundant around coastal Australia and New Zealand, to neutralize the volatile fatty acids in the gut. This inexpensive marine bio-product is also said to improve protein conversion and cut costs. Initial commercial production will target these local markets and the US.

Other proposals include systems in cow sheds to capture methane emissions and mini anaerobic digesters that use manure and urine to create clean energy.



Big Food, Big Ask

Big Food has begun to change, but it remains to be seen if this will be fast and profound enough to help stabilize the climate.

Business models that minimize costs and maximize shareholder returns may put a brake on transformation. Bosses at several food giants, including Campbell Soup Co¹⁴ and Danone¹⁵, for example, have paid the price for diversification that diluted earnings. Proponents of organic food, challenger brands, and foodtech disruptors believe that big-volume producers that can't adapt to a more sustainable approach could wither and die within 10 or 20 years.

There are real business risks to major meat producers associated with the climate, consumer behavior and regulation that will drive change. Ethical investor network FAIRR reports that two out of five global food manufacturers have dedicated teams to developing and selling plant-based alternatives to meat.¹⁶ FAIRR graded 44 of the world's 60 largest meat, fish, and dairy companies as "high-risk" in a pandemic ranking.

They include JBS, one of the world's giant meat producers. It has committed \$1 billion to cut its emissions by 30% by 2030. It is also investing \$100 million to research regenerative farming practices, and has pledged to eliminate Amazon forestation from its Brazil supply chain.¹⁷

In dairy, Arla Foods back in 2019 announced its net-zero goal, underpinned by a science-based target to reduce emissions per kilogram of milk by 30%.¹⁸ Globally, the average dairy farm produces 2.5kg of CO₂e for every kilo. That falls to 0.9kg on the most efficient farms.

Horizon Organic aims to become the first US national brand to be carbon-positive across its full supply chain. Part of Danone, two thirds of its emissions come from on-farm activities including soil management, fermentation, manure management, and milking.¹⁹



¹⁴ <https://www.wsj.com/articles/campbell-soup-ceo-exits-as-company-plans-strategic-review-of-portfolio-152643602>
¹⁵ <https://www.reuters.com/article/us-danone-management-idUSKBN2B60PN>
¹⁶ <https://www.edie.net/news/7/2020-will-be-watershed-year-for-plant-based-foods-vegan-vegetarian-investor-coalition-predicts>
¹⁷ <https://www.edie.net/news/6/Meat-giant-JBS-commits-to-net-zero-emissions-and-zero-deforestation>
¹⁸ <https://www.arla.com/company/news-and-press/2019/pressrelease/arla-foods-aims-for-carbon-net-zero-dairy-2845602>
¹⁹ <https://horizon.com/carbon-positive>

Fast food empires are also coming under pressure. FAIRR has been engaging with the global big six since 2019 on their meat sourcing. Five have now publicly committed to emission reductions approved by the Science-Based Targets initiative. So far, only one is conducting the 2°C scenario analysis recommended by the Task Force on Climate-Related Financial Disclosures. Progress on mitigating water and pollution risks is also slow.²⁰

Multinational food manufacturers too are trumpeting commitments to carbon emission reductions and innovation. They are also nurturing foodtech start-ups that can inject new thinking on health and sustainability that mega-corporations find hard to replicate.

In 2020 Nestlé launched an incubator program targeting plant-based dairy products. This follows collaboration with universities in sub-Saharan Africa on sustainable cocoa, eco-friendly packaging and 'affordable nutrition'. The group aims to halve its emissions by 2030, en route to net zero by 2050.

PepsiCo has committed to reducing emissions across its value chain by 40% by 2030. Its Nutrition Greenhouse accelerator program began in 2017. North American and European winners have included fledgling plant-based food and seafood businesses.²¹ It has also teamed up with alternative-protein pioneer Beyond Meat to form the PLANeT Partnership, producing new plant-based protein snacks and beverages.²²

In 2020 Danone joined forces with Microsoft to launch the AI Factory for Agrifood, an accelerator for start-ups harnessing big data in the cause of regenerative agriculture, sustainable food, and waste minimisation.²³

These programs are also a defense against the cannibalization of Big Food's mature markets. Challenger brands may end up on the menu. Coca-Cola has swallowed several ethical brands, including the UK's Innocent Drinks, a certified B-Corporation committed to balancing purpose and profit, and the highest standards of social and environmental responsibility. More recently, Mars Inc took a final bite of healthy snacking Kind North America,²⁴ while Danone captured Follow Your Heart.²⁵ It was by acquiring such plant-based pioneers (including WhiteWave Foods and Alpro, Europe's leading dairy alternative) that the French group became a leader in this market. The feeding frenzy is expected to continue.²⁶

But the real test of Big Food's commitment to change will be its investment in decarbonizing supply chains and in-house R&D focused on making core product lines sustainable.

²⁰ https://www.just-food.com/analysis/hatching-new-ideas-big-foods-incubator-and-accelerator-programmes_id139272.aspx

²¹ <https://www.thegrocer.co.uk/mergers-and-acquisitions/pepsico-and-beyond-meat-launch-win-win-planet-partnership-joint-venture/652671.article>

²² <https://www.foodnavigator.com/Article/2020/02/18/Danone-Microsoft-join-forces-for-AI-accelerator-The-success-of-the-food-revolution-will-depend-on-data>

²³ <https://www.nytimes.com/2020/11/17/business/dealbook/kind-bars-acquired-mars-snickers.html>

²⁴ <https://www.fooddive.com/news/danone-acquires-plant-based-pioneer-follow-your-heart/595346>

²⁵ <https://www.fooddive.com/news/food-business-after-covid-19/598957>

Plant-based Growth

Two thirds of the world's agricultural land is given over to pasture or growing feed for livestock. The climate emergency, urbanization and farming practices are reducing the productive land available, even as animal production accelerates global heating.

The logic of feeding plant protein to people rather than animals is compelling. Ten kilos of feed go into 1kg of steak; that inefficiency of conversion is double that for pork, and halves again for chicken. The food grown exclusively for US livestock could feed 800 million people, about two-and-a-half times its population.²⁷

Given embedded consumer tastes, alternative proteins that mimic meat must be part of the answer, and they're growing. Estimates vary, but America's Good Food Institute values global plant-based meat retail sales at \$4.2 billion in 2020, up by almost a quarter on 2019. The US market grew by 45% to \$1.4 billion.

Another forecaster predicts the meat substitute market will be worth \$8.1 billion by 2026.²⁸ This covers products prepared from tofu, tempeh, textured vegetable protein (usually soy, seitan (wheat gluten, mycoprotein (Quorn, and other plant-based sources. Growth will be driven by diet shift – up to 30% of Americans are already eliminating meat and moving to plant-based substitutes – and rising incomes in Asia-Pacific.

Barclays Investment Bank is even more bullish. By 2030, new and incumbent players in this “under-developed category” (including cultured meat – see below could corral around 10% of the \$1.4 trillion global meat market.²⁹

Alt-protein options are moving mainstream, from grocery stores into fast food. US retail giant Target launched its own-brand range meat and dairy alternatives in spring 2021 as market analyst Nielsen reported 28% growth across all-plant based categories in 2020.³⁰

Unilever reports a shift in diets in every country, including emerging markets. Since acquiring The Vegan Butcher in 2018, it has expanded into 45 countries including Burger King's own-brand burgers and chicken nuggets.³¹



²⁷ <https://news.cornell.edu/stories/1997/08/us-could-feed-800-million-people-grain-livestock-eat>
²⁸ <https://www.alliedmarketresearch.com/press-release/global-meat-substitute-market.html>
²⁹ https://www.investmentbank.barclays.com/content/dam/barclaysmicrosites/ibpublic/documents/our-insights/InsectProtein/Leaflet%20Alt%20Meat_WEB.pdf
³⁰ <https://edition.cnn.com/2021/05/11/business/target-plant-based-food/index.html>
³¹ <https://www.unilever.com/planet-and-society/positive-nutrition/plant-based-foods>

Beyond Meat – a leader of the meatless herd in the US with Impossible Foods and Just Foods – is now preferred supplier of the McDonalds McPlant burger, which was market-tested at the end of 2020 in Denmark and Sweden. Beyond Meat has also signed multi-year deals with Yum! Brands, the company behind Taco Bell, Pizza Hut and KFC.³²

America's big hot-dog brand, Nathan's Famous, launched a plant-based product made by UK-based Meatless Farm.³³

Meat substitute sceptics should also look to beef-loving Brazil, where The New uses GMO-free peas to produce beef, salmon, cod, and chicken products. One national retailer reported that 30% of hamburger sales were plant-based.³⁴

Plant-based markets are growing in Korea and across Asia too. Karana, said to be Asia's first whole-plant meat brand, launched its pork made from jackfruit in Hong Kong restaurants.³⁵

Innovation is continuing in this space as start-ups vie to create 'whole cut' products for meat lovers. Slovenian start-up Juicy Marbles claims to have perfected a steak with the marbled look and taste of filet mignon.³⁶ Its machine (the Meat-o-Matic Reverse Grinder 9000) uses sunflower seed oil to make the fat structure in a base of soy and wheat protein.

Mycelium, the root structure for mushrooms, is used by bacon maker Atlast. It has raised \$100 million so far and is building a mycelium farm to ramp up production.³⁷ It claims MyBacon is a profitable product that competes with real bacon on price and sizzle. Others have already diversified into pork and chicken (US examples include Rebellious Foods, Simulate, OminPork and Beyond Meat).

Affordability will be key to the next phase of growth. Both Beyond Meat and Impossible Foods slashed prices in 2021, moving the alt-protein sector closer to price parity with animal meats. In the UK, the Co-op retail chain committed to price-matching its range to real meat and dairy products,³⁸ while rival Tesco announced a plant-based range to be produced with Beyond Meat.³⁹

Investors are also backing the industry. It attracted a healthy \$2.2 billion in 2020, making up almost half of all capital invested in the sector since 1980.⁴⁰ New unique investors in the plant-based space increased by 44% on the year before to 196.



³² <https://www.forbes.com/sites/rachelsandler/2021/02/25/beyond-meat-signs-deals-with-mcdonalds-yum-brands-for-plant-based-menu-items/>

³³ <https://www.businessgreen.com/news/4030588/american-classic-meatless-farm-nathan-famous-team-debut-plant-hot-dogs>

³⁴ <https://www.proteinreport.org/newswire/pioneering-brazilian-plant-based-meat-brand-newtm-announces-fresh-backing-lever-vc-and>

³⁵ <https://hk.asiatriller.com/dining/karana-hong-kong-launch>

³⁶ <https://www.foodnavigator.com/Article/2021/03/15/World-s-first-plant-based-steak-marbled-with-sunflower-oil-It-s-not-just-for-aesthetics-It-behaves-as-marbling-does-in-animal-meat>

³⁷ <https://www.forbes.com/sites/chloesorvino/2021/04/15/maker-of-mushroom-sourced-bacon-raises-40-million-to-reach-grocers-at-scale/?sh=6c4b046a72d1>

³⁸ <https://www.thelondoneconomic.com/news/co-op-pledge-to-make-plant-based-food-range-cost-the-same-as-meat-equivalents-267834/>

³⁹ <https://www.zombobase.com/cours/action/TESCO-PLC-4000540/actualite/Tesco-nbsp-s-associe-a-Beyond-Meat-pour-des-plats-sans-viande-33337754/>

⁴⁰ <https://gfi.org/wp-content/uploads/2021/05/COR-SOTIR-Plant-based-meat-eggs-and-dairy-2021-0504-1.pdf>

Milking the Market

Many investors as well as bosses of established food giants believe 2021 could be a watershed for plant-based foods in dairy as well, as milk leads the way for meat.

Alt-milk sales are worth an estimated \$17 billion a year, and growing, though still only a drop in the \$650 billion dairy bucket.

US sales were up 25% on 2019. In British supermarkets, the increase was 16%. Leaders like Oatly, which has floated on the US stock market with a \$10 billion valuation, insist that plant-based milk is no fad. Over the next 10 years, as the spending power of today's millennials and Generation Z grows globally, they are not likely to go back to eating animal-based products.⁴¹

The range of vegan milks is also expanding from oats to nuts and now peas, along with the line-up of producers.

Ripple Foods in the US, which has raised almost \$100 million from investors, has a pea-based range. Berlin start-up Vly, which uses yellow split peas, launched its brand in Germany, Austria and Switzerland.⁴²

Nestlé unveiled its Wunda brand to market a milk made from yellow peas.⁴³ It was created in just six months, reflecting Nestlé's desire to speed up innovation to keep pace with new consumer trends.

Other technologies are emerging. Israeli start-up Remilk uses microbial fermentation to reproduce milk proteins as a powder base for a variety of dairy products.⁴⁴ A German dairy company was among investors who provided \$21 million for expanding production.⁴⁵ In the US, Perfect Day also uses precision fermentation, while Nature's Fynd (backed by Danone) makes cream cheese (and a meatless burger) from fermented fungi.⁴⁶

In the Netherlands, The Protein Brewery has raised \$22 million. Across the border in Belgium, start-up Those Vegan Cowboys, which creates casein proteins through fermentation, has partnered with Dutch cheese maker Westland Cheese.⁴⁷

Yoghurt and milk alternatives led the plant-based revolution in developed markets over the last decade. They are now penetrating the more recent adopters (France and Italy twice as fast as more mature markets (like the US and Germany).⁴⁸

As input costs can be lower and vegan milks command a price premium, producers can cream off profits for reinvestment. It also helps that the EU dropped proposals for a marketing ban on dairy terms or environmental and health comparisons.⁴⁹ Several US states have also rejected court actions that would have hamstrung producers of meat alternatives.

Barclays forecasts that this segment will grow by 250% over the next 10 years.



⁴¹ <https://gfi.org/wp-content/uploads/2021/05/COR-SOTIR-Plant-based-meat-eggs-and-dairy-2021-0504-1.pdf>
⁴² <https://www.theguardian.com/business/2020/jul/19/oatly-gets-a-sprinkling-of-stardust-as-it-rides-the-wave-of-alt-milk>
⁴³ <https://sifted.eu/articles/vly-pea-milk/>
⁴⁴ <https://www.reuters.com/article/us-nestle-plantbased-idUSKBN2CL2AW>
⁴⁵ <https://www.remilk.com/>
⁴⁶ <https://www.thecorner.com/en/aw-dairy-startup-remilk-nabs-11-3-million-from-investors>

⁴⁷ <https://www.digitalfoodlab.com/natures-fynd-launch-products-made-next-generation-protein>
⁴⁸ https://thosevegancowboys.com/wp-content/uploads/2020/12/PartnershipWV_LVC_ENG-1.pdf
⁴⁹ https://www.investmentbank.barclays.com/content/dam/barclaysmicrosites/ibpublic/documents/our-insights/InsectProtein/Leaflet%20Alt%20Meat_WEB.pdf
⁵⁰ <https://vegconomist.com/policies/breaking-dairy-lobbies-amendment-171-is-rejected-by-the-eu-parliament>

Cell by Date for Meat?

With global meat production projected to double by 2050,⁵⁰ the food revolution may need cultured meat (as well as plant-based alternatives to head off a climate-crushing stampede.

Cellular production in lab-factories could free up swathes of farming land for plant proteins for human consumption, while satisfying part of the demand for meat. However, this emerging technology would have to be cost-efficient, scalable, approved by regulators, and palatable to consumers.

That prospect may be still some way off, but the synthetic meat sector is getting closer to a breakthrough. The pioneers are now starting to manufacture cultivated meats at pilot scale. And the commercial landscape is widening – as of 2020 there were more than 70 start-ups with another 40 or so life science companies looking to supply inputs and services.⁵¹

Singapore also became the first country to approve the sale of cultured meat – Just Foods' Good chicken. The US or Israel may be next.⁵² It will probably be three to five years before the European Food Safety Authority follows suit, according to Belgium-based Peace of Meat, which uses stem cell technology to produce animal fats in industrial-scale bioreactors.⁵³

While questions remain about the feasibility, safety and even ethics (where bovine serum feeds cell growth, funds are flowing from both public and private sectors.

Investment topped \$350 million in 2020 – a breakout year with six times the 2019 total. As well as Eat Just, US companies such as Memphis Meats, BlueNalu and New Age Meats received multi-million-dollar injections. In Israel, Aleph Farms, Future Meat Technologies and MeaTech (which uses 3D printing, and acquired Peace of Meat) are also well backed.⁵⁴

⁵⁰ <https://gfi.org>

⁵¹ <https://gfi.org/cultivated>

⁵² <https://thespoon.tech/europe-the-u-s-israel-which-country-might-be-next-to-approve-cultured-meat>

⁵³ <https://www.foodnavigator.com/Article/2021/05/04/When-will-lab-grown-meat-reach-the-European-market>

⁵⁴ <https://www.timesofisrael.com/israel-carving-out-key-role-in-alternative-protein-market-report-says>

Multinationals are lending their weight. Mitsubishi of Japan and Brazil's BRF have partnered with Aleph Farms to commercialize cultured meat. Israel believes its expertise in agriculture, tissue engineering and stem cell research will make it a powerhouse in the sector. The Chinese government has also invested in Israeli companies.

Mosa Meat of the Netherlands served up the world's first cultivated meat burger in 2013.⁵⁵ Also Dutch, Meatable has raised \$60 million for its technology, which cultivates meat from a single animal cell using patented Opti-Ox cell technology at the Biotech Campus Delft.⁵⁶ Other European players include Blue Biosciences, Miraj and CellulaREvolution.

Cellular champions argue that, like semi-conductors and solar power, such early-stage high-risk R&D merits public funding to diversify our food supply. Governments are starting to bite, with a series of research grants each worth around \$3 million in 2020 to: researchers at University of California, Davis (from the National Science Foundation); Spain's BioTech Foods (EU Horizon program); Iceland's ORF Genetics (European Commission); and Integriculture (Japan's trade ministry).⁵⁷

UK-based Moolec is preparing to scale up molecular farming based on hybrid GMO plants containing animal cells. With bases in the US, South America and Europe, it also has regulatory approval and trademarked products.⁵⁸

Even as synthetic meat arrives on shelves and plates in a few years, the technical advances needed to undercut animal meats on price may take a further five to 10 years.

Consumers need time too. A 2020 European survey showed two out of three are willing to change their meat-eating habits, but little appetite yet for cultured meat or insects (see below). As might be expected, vegetarian and plant-based (if GMO-free) alternatives are much more palatable.⁵⁹



Sea Change

As on land, marine food systems are under grave threat from global heating and unsustainable harvesting. Nearly a third of all monitored global fish stocks are over-fished, and over 60% are at their sustainable limit. Illegal and unregulated fishing add further stress.⁶⁰

Meanwhile, seafood farms cause severe pollution due to their unsustainable management. Environmental impacts include pollution, habitat loss, disease outbreaks, over-use of antibiotics, and dependency on wild fisheries for feed. Aquaculture also drives mangrove deforestation, especially in South-East Asia.⁶¹

Since 2014, the sector has been providing more fish for human consumption than fisheries. By 2030, aquaculture is projected to provide 60% of global supply.

As with meat, there are a growing number of plant-based substitutes on the market, including tuna, salmon, caviar, scallops, squid, crab, and shrimp. The most common ingredients are soy, seaweed, yeast, legumes, and vegetable oils and starches.

Compared with meats, the variety of seafood is greater, the tastes and textures trickier to replicate, and the pace of innovation has been slower.⁶² Yet in 2020 both Forbes and the BBC labeled plant-based seafood as the 'big new trend' in the vegan market.⁶³

Gathered Foods' Good Catch brands (plant-based tuna, frozen fish burgers, fish cakes and crab cakes) are sold across North America and it has also raised funding in Europe.⁶⁴ New Wave Foods launched its shrimp – based on a seaweed extract and mung beans – in January 2021 with \$18 million in backing from investors, including food giant Tyson, which has a stake in the company.⁶⁵

Meanwhile, cellular versions are in development, and netting investors' cash.

Already mentioned, San Diego-based BlueNalu has raised funds to construct a pilot production unit as it navigates an initial FDA review.⁶⁶ It creates a variety of seafoods from fish and crustacean cells grown in large bioreactors.

Germany's Blue Biosciences (trout, salmon, carp) is the first European foodtech innovator backed by investors to catch this artificial wave of future-proof seafoods. It claims the ability to create an immortal line of self-reproducing fish cells.⁶⁷

Avant, the first cultivated fish company in Asia, (and China's cultured meat pioneer) plans an R&D center and pilot manufacturing plant supported by the Singapore Economic Development Board.⁶⁸ The island city-state is also home to ShioK Meats, a producer of cell-based lobster and shrimp, which are due to land on the market in 2022.⁶⁹

Given the buoyant demand for seafood worldwide and the unsustainable state of fishing and fish farming, the food revolution needs this sector to scale.

⁶⁰ <https://www.wwf.org.uk/what-we-do/addressing-unsustainable-fishing-and-seafood>

⁶¹ <https://oursharedseas.com/threats/threats-unsustainable-fishing-and-farming>

⁶² <https://veconomist.com/food-and-beverage/new-report-future-of-seafood-is-in-the-lab-and-your-garden-but-gap-in-market-is-closing>

⁶³ <https://veconomist.com/market-and-trends/launches-and-awards-in-vegan-fish-category-continue-as-forbes-and-bbc-suddenly-declare-plant-based-seafood-as-next-big-vegan-meat-trend>

⁶⁴ <https://hespoon.tech/gathered-foods-maker-of-good-catch-secures-26-35m-for-plant-based-seafood>

⁶⁵ <https://www.newwavefoods.com/press>

⁶⁶ <https://thespoon.tech/bluenalu-secures-60m-for-production-of-cell-based-seafood>

⁶⁷ <https://techcrunch.com/2021/03/25/bluu-biosciences-raises-cash-to-become-europes-first-purveyor-of-lab-grown-salmon-trout-and-carp>

⁶⁸ <https://www.proteinreport.org/newswire/leading-cultivated-fish-company-avant-announces-new-rd-and-pilot-manufacturing-facilities>

⁶⁹ <https://thespoon.tech/shioK-meats-unveils-prototype-for-cell-based-lobster>

Blue Economy

Despite these environmental pressures, the oceans could still provide a sustainable supply of alternative proteins, other than fish. Since 2012, the UN's Food and Agriculture Organization has championed the 'blue economy' as crucial to sustainable social and economic development – and conservation of marine bounty for future generations.

Foodtech entrepreneurs share this vision of algae as a next-generation, sustainable superfood. Cultivation of seaweed and algae for food (and a variety of biotech applications) is expanding worldwide.

Marine microalgae provide a natural, abundant, and sustainable source of protein, Omega 3 and many other ingredients. South Africa's SuSeWi has a 30,000m² algae production facility in Morocco's coastal desert.⁷⁰ Using only sun, seawater, and wind, it stimulates algae to 'bloom' faster, and aims to become the world's largest algal producer.

Singapore-based Sophie's Bionutrients claims to have developed the world's first milk replacement from pure micro-algae. This is the basis of a flour that can be used in developing many foods from burgers to milk, safe for the lactose-intolerant. The micro-algae are self-sustaining, feed on food waste as part of the fermentation process, and can be harvested in just three days.⁷¹

Other companies – such as Triton⁷² and Algama⁷³ – are developing alternative food ingredients from algae.

GreenWave has demonstrated that a regenerative approach to farming is feasible offshore. It grows a mix of seaweeds and shellfish together off Newfoundland with zero inputs, while sequestering 'blue' carbon and rebuilding reef ecosystems. As well as food, the seaweed can be used for fertilizer, animal feed, bioplastics, and more.⁷⁴

Various marine research bodies from Australia to Scotland are working to scale up seaweed farming, by seeding rope-lines for vertical farms on this model.



⁷⁰ <https://www.susewi.life>
⁷¹ <https://www.pnewsire.com/news-releases/sophies-bionutrients-develops-worlds-first-dairy-free-micro-algae-based-milk-alternative-301282022.html>
⁷² <https://www.tritonai.com>
⁷³ <https://algamafoods.com/services>
⁷⁴ <https://www.greenwave.org/our-model>

Insect Bites

Given the impending gap between supply and demand, the world needs to make sustainable use of other natural protein sources. Insects are another underutilized resource championed by the FAO.

Some two billion people in 80% of the world's nations eat insects. About 2,000 species are edible. In parts of Africa and Asia they are a staple part of the diet. In developed countries, so far, they are a niche novelty or processed for animal feed or flour, but that may be about to change.

The European Food Safety Authority authorized mealworms for consumption in January 2021. This will "accelerate commercial traction," according to French insect farming start-up Ÿnsect, said to be the best-funded bug-based company.⁷⁵

In April 2021 Ÿnsect acquired Dutch manufacturer Protifarm, which grows mealworms in vertical farms.⁷⁶ It plans to raise production to 230,000 tonnes a year. Most of the protein is sold to pet food companies, but it has also secured a contract with a sports nutrition brand, and is targeting protein supplements for older people.

America's Aspire Food Group, which has an R&D center in Texas, is building the 'world's largest' automated cricket farm in Canada (backed by a \$10 million grant from Sustainable Development Technology Canada).⁷⁷ Aspire's main markets are pet foods and growers, who use frass – insects' waste, high in Chitin, a natural biopesticide and soil supplement. It also sells the Exo protein bar and develops robotics for smart farming of insects.

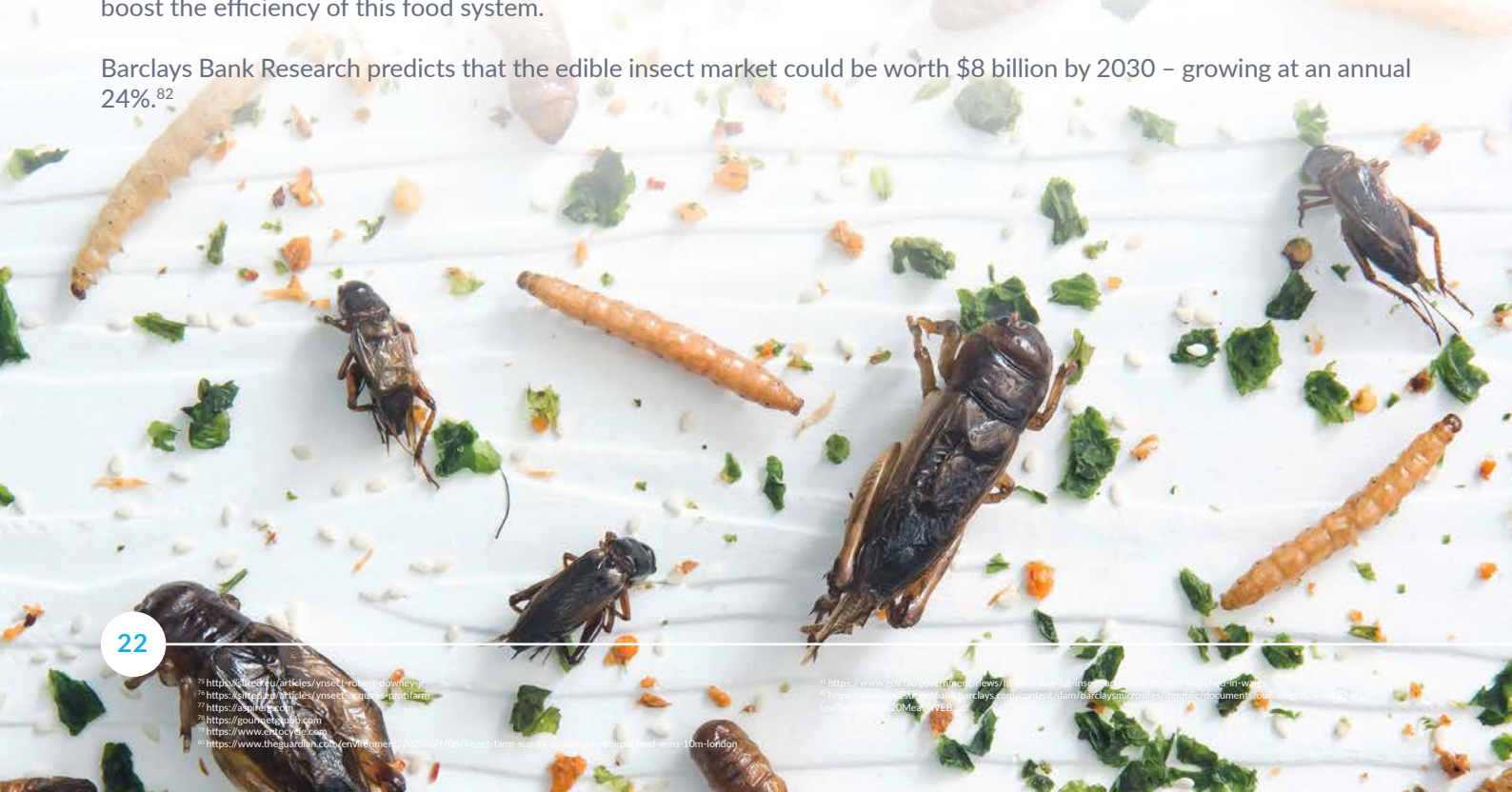
Gourmet Grubb in South Africa has alighted on the alt-dairy market.⁷⁸ Its Entomilk is made from black soldier fly larvae (BSFL, rich in fats and minerals, including calcium).

In the UK, Entocycle also farms BSFL, feeding the larvae on local food waste, including fruit and vegetables rejected by supermarkets, brewers' grains, and coffee grounds.⁷⁹ It produces Entofresh protein and lipids (from the insects' Lauric acid) for animal and pet feed, and grass as a growth booster in horticulture. In 2020 the London company won a £10 million grant from the UK's Industrial Strategy Challenge Fund to build a new factory processing 33,000 tonnes of food waste a year.⁸⁰

Government agency Innovate UK and the Welsh government also funded Bug Farm Foods, the entomological entrepreneurs behind VEXo, an alternative minced meat based on plants and insects with 80% less saturated fat. The company also operates an edible insect restaurant and research center/visitor attraction.⁸¹

Bug production is well suited to factory settings, as insects produce and need heat at different stages of their development. It also offers a closed-loop model for the circular economy – using food waste as feedstock and the insects' waste to grow food. As with other forms of vertical farming, robotics, AI, IoT and other technologies can further boost the efficiency of this food system.

Barclays Bank Research predicts that the edible insect market could be worth \$8 billion by 2030 – growing at an annual 24%.⁸²



⁷⁵ <https://www.euronews.com/articles/insect-farming-boom>
⁷⁶ <https://www.ynet.com/Articles/insect-farming-platform>
⁷⁷ <https://aspirefood.com>
⁷⁸ <https://gourmetgrubb.com>
⁷⁹ <https://www.entocycle.com>
⁸⁰ <https://www.theguardian.com/environment/2020/oct/06/insect-farm-wins-10-million-grant-to-process-food-waste-london>

⁸¹ <https://www.gov.uk/government/news/insect-farm-opens>
⁸² <https://www.barclays.com/content/dam/barclayscomposites/ibpublic/documents/our-new-2020-2030-Lead-Industries-20Meat-Web.pdf>

Rise of Vertical Farms

Vertical farms have wider applications beyond the bug world, producing crops from less land – and closer to urban markets. Plants grown in these controlled indoor environments require no pesticides and a fraction of the soil and water of traditional horticulture. If powered by renewable energy, they offer another model of sustainability.

Valued at \$4.5 billion in 2020, the sector is projected to grow by 23% a year to reach \$19 billion by 2027.⁸³ Asia, North America and Europe are seen as the fastest-growing markets.

Asia-Pacific pioneered hydroponics and other vertical farming technologies. Spread Co, one of 190 vertical farming businesses in Japan, produces 20,000 lettuces a day at a 3,000m² facility outside Kyoto.⁸⁴

In the US, Aerofarms operates four vertical farms in New Jersey using a patented aeroponic AI-enabled system.⁸⁵ The B-Corp is developing an 8,200m² farm in Abu Dhabi, that will “turn the desert green” by growing lettuce, cabbages, and tomatoes. Cloth made from plastic bottles would replace soil.⁸⁶

In the UK, LettUsGrow designs and builds indoor and vertical farms using its aeroponic technology and farm management software.⁸⁷ It is now targeting the commercial greenhouse sector.

French vertical farming company Jungle claims it can produce 30 times more food than traditional greenhouses. It is completing a 5,500m² farm with stacked platforms 80km north of Paris, and already supplies major supermarkets Monoprix and Intermarche, mainly with herbs and greens.⁸⁸ It achieves 14 harvests compared with three or four outdoors in the south of France, and undercuts organic prices by 20%.

Germany's Infarm picked a different model, implanting micro-units in supermarkets and even schools. The Berlin-based start-up, which has raised \$300 million so far, harvests more than half a million plants and mushrooms a month. It already has deals with supermarkets in the UK, US, France, and Germany, including Amazon Fresh. Infarm aims to scale across North America, Europe, and Asia by 2025.⁸⁹

These seedling enterprises will have to reproduce the viability of Asia's pioneers. Widening the range of crops grown may be a greater challenge, requiring cross-fertilization from other tech innovators.



Tackling Food Waste

Another manifest failing of our food systems is waste. An estimated 1.3 billion tons are wasted each year – a third of all food produced, and a \$1 trillion loss to the world's economy.⁹⁰

Waste occurs at each stage of the food chain from farm to household kitchen. The proportion ranges from 20% for meat to 45% of fruit and vegetables.

The UN's Sustainable Development Goals and the EU's food strategy set targets for halving food waste by 2023. This would be legally binding for EU member states.

Such a massive problem is attracting innovators and investors.

Hundreds of retailers in France, are using Smartway's AI-powered solution, said to reduce waste by 80% and boost net profits. It identifies products approaching their expiry date, decides whether to discount or donate, and handles re-labeling and admin.⁹¹

Upstream, Canadian sustainability experts Provision Coalition worked with the Walmart Foundation and a B-Corp engineering company to identify preventable waste at 50 food processing sites.⁹² They showed that each could save an average \$228,000 a year, avoiding 9 million kilograms of waste in total.

Up-cycling of food otherwise wasted is already a \$46.7 billion market and expected to expand by 5% annually over the next 10 years.⁹³ Re-use doesn't have to be high-tech. A small UK company sources imperfect fresh fruit and veg from farms to make high-quality ketchups and relishes. Rubies in the Rubble also uses aquafaba, the viscous water from cooking legume seeds such as chickpeas, in its egg-free mayonnaise.⁹⁴ In the US, the Upcycled Food Association is seeking regulatory approval for a certification scheme.⁹⁵



⁹⁰ https://www.investmentbank.barclays.com/content/dam/barclaysmicrosites/ibpublic/documents/our-insights/InsectProtein/Leaflet%20AI%20Meat_WEB.pdf

⁹¹ <https://agfundernews.com/smartway-french-food-waste-startup-snags-11-8m-for-expansion.html>

⁹² <https://bthechange.com/changing-mindsets-and-reducing-food-waste-65f647b1e3>

⁹³ <https://www.forbes.com/sites/daphneewingchow/2021/05/31/upcycled-food-is-the-coolest-trend-you-probably-never-heard-of>

⁹⁴ <https://rubiesintherubble.com>

⁹⁵ <https://www.upcycledfood.org/certification>

Regenerating Agriculture

Such is the scale of the crisis facing the world's food systems that the revolution must be systemic and global. That means a massive shift to regenerative agriculture that conserves and rehabilitates soil and ecosystems. Sustainable practices can sequester carbon, increase resilience to climate change, improve the water cycle, and boost output from healthier soil and crops.

Agroforestry, for example, combines growing trees or shrubs with crops and/or livestock. This is crucial for smallholder farmers, according to the FAO.⁹⁶ Trees help prevent soil erosion and shelter 'alley' crops, chosen and rotated to improve the soil. Planting fruit trees can also enrich an impoverished community's diet and give a new source of income, while supporting the UN Environment's Trillion Tree Campaign for the developing world.⁹⁷

Also called silvopasture, the practice improves animals' health and weight as well as sequestering carbon, reducing flooding, and increasing drought resistance. Planting trees in pastures and arable land is a reversal of modern farming methods, now being trialled to test soil health and productivity on seven farms in Devon in the UK.⁹⁸ One farmer envisages robots displacing tractors to sow, spray and harvest between the trees.

The World Bank coined the term Climate Smart Agriculture (CSA for "an integrated approach to managing landscapes – cropland, livestock, forests and fisheries – that addresses the interlinked challenges of food security and accelerating climate change".⁹⁹ CSA promises a triple win: increased productivity, enhanced resilience, and reduced emissions.

CSA plans for 10 countries identify \$2.5 billion of investments to benefit more than 80 million people in Bangladesh and Africa. The Bank also cites around 20 diverse projects funded around the world from South America to the Philippines, and Afghanistan to Kazakhstan.



⁹⁶ <https://www.fao.org/forestry/agroforestry/80338/en>

⁹⁷ <https://reenearthappeal.org/what-the-green-earth-appeal-does>

⁹⁸ <https://www.theguardian.com/environment/2021/may/16/im-seen-as-the-fool-the-farmers-putting-trees-back-into-the-uks-fields>

⁹⁹ <https://www.worldbank.org/en/topic/climate-smart-agriculture>

Another initiative, FoodSystems2030 is an umbrella trust fund expected to leverage \$4 billion a year in World Bank lending. Launched in November 2020, it aims “to help steer trillions of dollars in private sector activity in the agriculture and food sector”.¹⁰⁰

The European Union sees a healthier and more sustainable food system as central to its post-Covid Green Deal.¹⁰¹ Its food strategy, From Farm to Fork, also aims to tackle climate change, protect biodiversity, and increase organic farming – to cover 25% of all EU farmland by 2030. The use of pesticides and antimicrobials would be halved, and fertilizers reduced by 20%.

The bloc promises €10 billion from its Horizon Europe for research and innovation “related to food, bioeconomy, natural resources, agriculture, fisheries, aquaculture and the environment”.

National initiatives include France’s €100 million plant protein strategy to replace imports and “regain agri-food sovereignty”.¹⁰² This would double land devoted to crops by 2030, but Greenpeace sees any strategy ignoring meat and dairy overproduction as unsustainable.

In the US, the Biden administration has pledged to halve economy-wide carbon emissions by 2030,¹⁰³ without setting specific targets for agriculture, which produces 10% of the total. The bi-partisan political consensus favors increasing financial incentives for farmers to adopt ‘climate-smart agricultural practices’, which could include sequestering carbon in soil, feed additives, and technology that taps methane from manure pits.¹⁰⁴ Critics fear plans for a beefed-up carbon credits system may reward big producers without significantly boosting regenerative agriculture or supporting more sustainable smaller farms.¹⁰⁵



¹⁰⁰ <https://www.worldbank.org/en/news/press-release/2020/11/03/new-funding-to-improve-food-systems-will-help-prevent-zoonotic-diseases>

¹⁰¹ https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/farm-fork_en

¹⁰² <https://www.foodnavigator.com/Article/2020/12/02/France-launches-100m-plant-protein-strategy-We-must-regain-agri-food-sovereignty>

¹⁰³ <https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-us-leadership-on-clean-energy-technologies>

¹⁰⁴ <https://www.politico.com/news/2021/04/22/climate-change-biden-agriculture-494351>

¹⁰⁵ <https://www.theguardian.com/environment/2021/may/13/arc-bidens-carbon-markets-as-good-as-they-look-no-say-smaller-farms>

Carrots, Not Sticks

Such is the favored status of farmers on either side of the Atlantic, government food supply reforms will rely on the carrot rather than the stick.

EU consumers too expect governments to take a lead and use incentives (not taxes to encourage sustainable farming and foods.¹⁰⁶ But the EU's commitment to grow the organics market will need to be backed up financial support under its Common Agricultural Policy and concrete actions by national governments, according to the sector's trade body.¹⁰⁷

In the US, policymakers are also more supportive than ever of organic labeling and what's now a \$50 billion industry, but more will need to be done to help farmers transition to regenerative agriculture. The sector needs to drive significant efficiencies in supply chains, and scale alliances of farmers, producers, distributors, and retailers if the organic movement is to dominate the food market by 2050.

Faced with the world's ultimate existential problem, US business and political leaders look to the market to produce the agri-foodtech equivalents of a Henry Ford or Elon Musk. However, there is also a role for enlightened incentives to spur innovation. Federal tax deductions for designers and builders of energy-efficiency buildings indicate how well-targeted measures might transform the food chain.

Venture capitalists are pumping cash into the sector. In 2020 agri-foodtech start-ups are estimated to have raised more than \$30 billion – a third up on the previous year.¹⁰⁸ That confidence was underlined early in the year when, amid the uncertainty of the impending pandemic, Impossible Foods was still able to raise \$500 million.

Earlier funding rounds have been heavily biased towards the last mile of the food chain. Lockdowns and restaurant closures further boosted those disruptors of food delivery, retailing and service (from Deliveroo and eGrocery to the 'cloud' or 'dark' kitchens of Keatz, Karma or Getir. But they and their bloated war chests don't serve the sustainable food revolution.

Yet 2020 was significant. For the first time more investment went upstream towards the farm and food supply chain – \$15.8 billion; compared with \$14.3 billion downstream investment.

¹⁰⁶ https://www.beuc.eu/publications/beuc-x-2020-042_consumers_and_the_transition_to_sustainable_food.pdf
¹⁰⁷ <https://www.fibl.org/en/info-centre/news/european-organic-market-grew-to-euro-45-billion-in-2019.html>
¹⁰⁸ <https://research.agfunder.com/2021/2021-agfunder-global-report.pdf>

Cultivating Innovation

The revolutionary changes and trends outlined here are not a complete solution to the global sustainability/sustenance challenge. Other radical changes and technological breakthroughs will have to play their part.

Not only are a wide variety of solutions required, their value will also vary with geography, economic model, cultural norms, and even between producers. University of Oxford research, for instance – involving 38,000 farms worldwide producing 40 different agricultural goods – concluded that producers should be provided with multiple ways to reduce their environmental impacts.¹⁰⁹ This requires a step change in thinking: “practices such as conservation agriculture or organic farming are not environmental solutions in themselves but options that producers choose from to achieve environmental targets”. Different priorities and practices will be appropriate for different producers depending on the trade-offs between yield, efficiency, and sustainability outcomes.

Without major technological changes, the lowest-impact animal products will continue to cause greater environmental harm than substitute vegetable proteins across greenhouse gas emissions, run-off, acidification, and frequently, land use. However, alternative proteins and other innovations must prove their sustainability too. For example, while dairy milk produces three times the greenhouse gas emissions of plant-based substitutes, not all are created equal. Almond farming uses water, fertilizer, and pesticides intensively, and large-scale cultivation risks making unsustainable demands on bees for pollination.¹¹⁰

R&D and innovations have raised the efficiency of agriculture and farming in developed countries. Now, the emerging solutions that serve the food revolution must advance sustainability too. And these technologies and techniques will have to be adapted and shared with developing nations to manage the global impacts of climate change, water stress and food chain pressures.

¹⁰⁹ https://www.investmentbank.barclays.com/content/dam/barclaysmicrosites/ibpublic/documents/our-insights/insectProtein/Leaflet%20Alt%20Meat_WEB.pdf

¹¹⁰ <https://agfundernews.com/smartway-french-food-waste-startup-snags-11-8m-for-expansion.html>

¹¹¹ <https://bthechange.com/changing-mindsets-and-reducing-food-waste-f65f647b1e3>

¹¹² <https://www.forbes.com/sites/daphneewingchow/2021/05/31/upcycled-food-is-the-coolest-trend-you-probably-never-heard-of>

¹¹³ <https://rubiesintherubble.com>

¹¹⁴ <https://www.upcycledfood.org/certification>

The outline of an integrated strategy to re-shape our food systems has already emerged from the research.

From the US to Africa and Asia, digital tools are already being used or trialled by farmers to monitor the impacts of production, and to allow verification. Sharing a menu of best practices based on the growing bank of research by scientists worldwide would give producers the knowledge and flexibility to choose the most cost-effective mitigation measures. Policymakers can then set targets for environmental indicators and provide incentives – such as credit or tax breaks – by redirecting existing agricultural subsidies, which globally exceed \$3 trillion a year. The true impact and cost of foods could also be communicated up the supply chain and on to consumers, whether by labeling, taxes, or subsidies.

Meanwhile, the appetite for radical innovation in agriculture and food production needs to be sustained through increasing investment from Big Food, venture capital, and governments.

National and sectoral policies must send the necessary signals to producers, investors and consumers that will drive both sustainability and productivity growth in food and beverage markets. At Ayming, we have seen the power of innovation across sectors and countries, especially when supported by well-targeted tax credits and grants. These and other funding mechanisms can spur the public and private R&D that will be essential to accelerate the food revolution.



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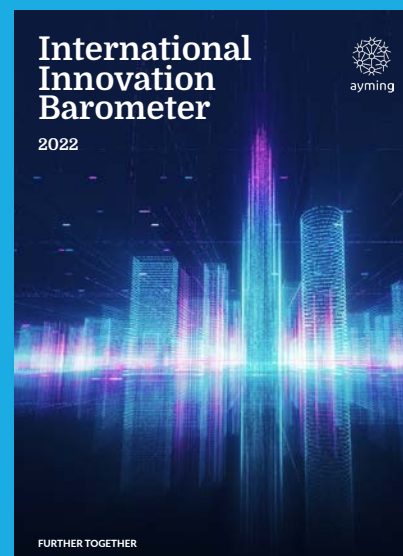


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