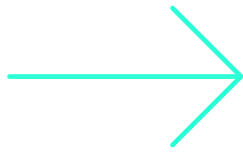




SPRING
WISE **FUTURE**
NOW

**THE TOP 10
NEAR-HORIZON
INNOVATIONS
PUSHING THE
BOUNDARIES
OF FOOD
PRODUCTION**



ABOUT FUTURE NOW AND SPRINGWISE

Solutions require innovation, and the hunt for those that make a real impact is the lifeblood of Springwise. We publish three new innovations every day across our ecosystem and every month, we compile a list of 10 of the most exciting and impactful innovations in our report, Future Now.

If you have any requests for what you'd like to see covered in a future edition of Future Now, get in touch! We'd love to hear your feedback. Email our Content Director at angela@springwise.com

**SPRING
WISE FUTURE
NOW**

NOVEMBER 2023

What is the future of food?

In this edition, we share three key trends we think goes some way to answer the question above: tech-driven alternative proteins, cell-cultivated meat, and proteins produced via fermentation.

Population growth, food security and the climate are key concerns for governments globally, and are fuelling continued development of protein alternatives. In Singapore for example, it has been a key government policy to foster innovation and investment in alternative proteins to bolster domestic food security and rely less on imports. Where they have led, many more countries are now following as the wide, geographic split of this issue's innovations shows.

As consumers, a lot of us still have the 'ick factor' when it comes to cell cultivated, or 'lab-grown' meat. However, Artificial Intelligence (AI), gene-editing and 3D printing are opening up exciting possibilities for growth because of their ability to help produce a product that mimics the taste and texture of real meat.

And, as food production accounts for a quarter of global greenhouse emissions, with cows and other farm animals contributing around 14 per cent of this number, there is a need for a rethink in the way we cattle farming. Fermentation for food production is more resource-efficient overall than rearing animals for meat and could be a way to reduce these emissions.

Read on for inspiration. The route to the best meat-free meatball you've ever tasted could be in these pages.

**Angela Everitt,
Content Director, Springwise**

NOVEMBER 2023
FUTURE OF FOOD

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Photo credit: Canva



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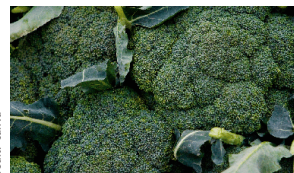


Photo credit: canva



Photo credit: canva

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TECHNOLOGY THAT IS TURBO-CHARGING CHANGE

1



Photo credit: Unsplash

AI for climate-resilient crops

A new platform is able to speed up development of new varieties with results in months, not years

Climate change is affecting the way that farmers grow crops, with changes to growing season length, more extreme weather, and an increasing need for more heat and drought-tolerant crops. The Food and Agriculture Organization of the United Nations estimates up to 14 per cent of food globally is lost every year due to climate change, and this will only get worse in the next few years. In addition to this, countries will need to produce more food to sustain growing populations, as well as build out food security strategies in the face of continuing geopolitical unrest.

Phytoform is a biotech startup working to develop new climate-resilient crops that are better adapted to the changing conditions in climate. The approach involves the use of deep

machine learning and genome editing technologies to identify new, advantageous traits. Then, those traits are implemented directly into crop varieties using CRISPR genome editing.

The company uses a proprietary machine learning technology called CRE.AI.TIVE to identify any small changes in DNA sequences that will have a maximum impact on crops. Using artificial intelligence (AI), Phytoform filters through millions of sequences and implements desired new traits using genome editing. The result is that new plant varieties can be developed in months, rather than years or decades, and at a fraction of the cost.

Takeaway

Phytoform is currently working to bring new tomato and potato plants to market and is expanding its reach to Australia and the UK. The company is also focusing on creating partnerships with organisations at the beginning of the supply chain, such as seed breeders and producers.

Phytoform co-founder William Pelton emphasised how new genetics techniques are a game changer for this industry, saying, “We are lucky to be where we are with genetics. You can do the whole plant genome for a few hundred dollars and synthesize the genome as well.”

The result is commercially relevant traits at a fraction of the time and cost.

2



Photo credit: Upp

Upcycling broccoli waste left in the field into sustainable protein

The system automates the process of recording and analysing food waste

Broccoli is a ‘superfood’ that contains fibre, vitamin C, vitamin K, iron, and potassium. It also boasts more protein than most other vegetables. However, around 70 per cent of the entire broccoli harvest is left in the field. This is because only the small, centre portion of each plant – the florets – is harvested for food, leaving most of the stems and leaves to rot, even though they are perfectly edible.

Startup Upp is working to change this. The company is developing an automated harvester that uses artificial intelligence (AI) and computer vision to harvest the centre portion and stems separately. The harvester will then deliver the fresh broccoli for sale and the stems and leaves for upcycling into new products.

These upcycled stems and leaves will be used to produce

protein by-products, as the company is looking to provide an alternative plant-based protein to pea and soya. Upp argues that using broccoli as a protein source is less carbon-intensive than soy or peas because the broccoli is already being grown for other uses.

David Whitewood, CEO of Upp says: “Upp is all about making the most of the crops that we already grow (...) In a future market of bioreactor and lab-grown alt-proteins, plant-based foods with good provenance will attract a premium like organic grass-fed beef does today.”

Upp has recently secured £500,000 (around €560,000) in pre-seed funding, in a round led by Elbow Beach Capital, to develop and commercialise its technology.

Takeaway

Broccoli is a hugely popular vegetable with a thriving global sales market. There is therefore significant potential to derive additional from the remaining 70 per cent of the crop that is not used today.

Soy production, is becoming increasingly unsustainable as demand for the crop rises: to grow soy, land is being converted from forests, savannahs and grasslands, endangering ecosystems. Utilising broccoli for plant-based proteins would make efficient use of material that is currently going to waste and could provide a viable alternative to soy beans.

An alternative to eggs that also produces a useful byproduct

Startup Fabumin creates plant-based egg powder from aquafaba

Eggs come with environmental impacts, with a single egg requiring the use of 30 litres of fresh water and generating 230 grammes of CO₂-equivalent greenhouse gas. Given that the world produces more than 80 million tonnes of eggs each year, these impacts add up. Now, the startup has developed a plant-based egg powder alternative that is produced in a process it likens to “turning waste into gold”.

Aquafaba is the water left over after cooking chickpeas and other legumes, and food technologists hail its versatility and tastiness as an egg substitute. Fabumin created a process for drying aquafaba to make it easy to transport and much less expensive to store. Where liquid aquafaba requires refrigeration and is heavy to

haul long distances, Fabumin’s powder is lightweight and shelf-stable.

The company uses a low-energy drying technique to evaporate the water and then a drying unit for the final product. Fabumin designed the drying system specifically to work with existing legume factory machinery, and an extremely useful byproduct of the process is that up to 80 per cent of the wastewater becomes reusable as clean condensate water.

The company states that one kilogramme of its aquafaba powder is equivalent to 130 eggs. And just like eggs, aquafaba foams, emulsifies, and binds, providing the ideal ingredient for plant-based cooking and baking. As well as being free from market price fluctuations, aquafaba is allergen-free and can provide legume distributors with an additional income stream.

Fabumin’s system includes an optimisation process that increases aquafaba’s emulsifying capability by up to 30 per cent, and the powder is so versatile that it’s usable in cosmetics, cultured meats, and more. As consumers learn to love the liquid gold that is aquafaba, animals and the environment stand to benefit from more sustainable protein production.

4

Researchers have cracked egg whites...

‘Cellular agriculture’ has produced an alternative

Uses for egg whites range from clarifying wine to helping breeding adhere better to fish fingers. In 2020, around 1.6 million tonnes of egg whites were used commercially, often in the form of powder. All these eggs have a significant environmental impact, for which researchers at the University of Helsinki have come up with a potential solution.

The researchers have used ‘cellular agriculture’ to produce ovalbumin – the protein in egg whites, without using any animals. The researchers

inserted the gene carrying the blueprints for ovalbumin into the fungus *Trichoderma reesei*. The fungus then produced and secreted the protein, which was separated out, concentrated, and dried to create a final product.

When tested, the fungus-produced ovalbumin powder had many of the same useful qualities as egg white powder from chickens, such as the ability to foam up. However, the researchers also studied the sustainability of the method, as compared to raising hens for their egg whites. The fungus-derived ovalbumin would greatly reduce land use requirements and greenhouse gas emissions. However, the amount of energy saved would depend on the use of low-carbon energy.

Takeaway

So far, other egg replacement options like tofu, corn flour, and chia seeds have not been able to match the functionality and high protein content of eggs. On the other hand, chickpeas, which are one of the most popular legumes in the world, produce wastewater that performs extremely well as an egg substitute in a range of foods, including in typically tricky meringues, cakes, and mousses. Fabumin’s powdered version of aquafaba provides an easily accessible egg replacement that can be used just like the egg products consumers are familiar with. As such, it could become a healthy, sustainable, and affordable alternative to eggs, with a smaller environmental footprint.

5

Photo credit: Stella Rebellious Foods



A new manufacturing technology promises a reduction in alternative protein production

A US startup wants to create more affordable meat-free chicken

The United States approved commercial sales of lab-grown chicken in June, joining Singapore as the world's first two nations where cell-cultured food is available. The main drawback to accessing this new food category is its cost – the new type of chicken in the States will be supplying high-end West Coast restaurants rather than grocery stores.

Plant-based meat alternatives also face the challenge of high costs of production, which often makes the products too expensive for consumers to buy regularly. Having realised that most plant-based meats use off-the-shelf manufacturing equipment, former aerospace engineer Christie Lagally put her expertise to work to improve the efficiency of the production process.

Lagally is the founder of Rebellious Foods, a foodtech company creating vegan chicken and developing automated plant-protein meat manufacturing systems and processes. The patented technology cleans up the manufacturing processes, reducing inefficiencies and manual processes and replacing them with smart automation systems.

The company's chicken is available as tenders, patties, and nuggets, and the system – called Mock Two – is designed specifically to produce those sizes and shapes. Because much of it is automated, the new production process can run continuously, making it possible to increase the volume of output without a parallel rise in labour and machine costs.

Takeaway

Once at industrial scale levels of production, Rebellious Foods' manufacturing technology could produce enough plant-based chicken to make products competitive with animal meat versions. Investors recognising the significance that the technology could have on the global market for healthier proteins recently contributed \$9.5 million (around €8.6 million) in an equity round of funding.

Cultured meat that's free of any animal components

This startup is opening up the market with 100 per cent vegan lab-grown meat

In February 2021, Believer Meats made headlines when it announced it had reduced the cost of a single cultured chicken breast to \$7.50. Today, the company has managed to bring the cost down to \$1.70. The company achieved this thanks to their innovative approach and methodology. Instead of using stem cells, Believer Meats uses much faster-growing fibroblasts, which can grow as muscle or fat. In addition to increasing speed of production, the method can produce cell densities that are ten times higher than the industry standard.

Believer Meats also uses a growth medium (the nutrient-rich substance in which the cells are grown) that is completely free of any animal components. Instead of animal protein, the company uses a growth medium containing plant-

based proteins from items such as chickpeas and soy. Not only does this eliminate some of the objections to cultured meat from vegans and vegetarians, it also reduces the cost of the medium. Believer Meats also claims its stainless-steel fermenters continuously remove ammonia-based waste products from the growth medium, which allows the company to recycle more than 70 per cent of the nutrients in the growth medium.

With the prices brought down, the next step for the company is to scale up its technology to supply the mass market. Believer Meats is currently constructing its first U.S. commercial production facility in Wilson, North Carolina, with an anticipated opening in Q2 2024. Once operational, the 200,000-square-foot facility will be the largest cultivated meat production centre in the world with the capacity to produce at least 10,000 metric tons of cultivated meat.

7

A climate-friendly pork alternative

The product is cultivated using microalgae

The pork sector's carbon footprint, along with other red and processed meats, accounts for 7.1 gigatonnes of CO₂ equivalent every year. That's 14.5 per cent of all anthropogenic greenhouse gas emissions. On the other hand, cultivated meat production emits 52 per cent fewer carbon emissions for pork.

Czech food tech startup Mewery is developing a low-carbon cultivated pork that is grown with a microalgae base. To create its meat-free pork, Mewery uses cells harmlessly

taken from a living animal. It then imitates the conditions that make cells grow and divide into muscle and fat cells before feeding the cells with nutrients and growth factors to cultivate larger amounts.

What makes Mewery's approach different is the fact that it uses a growth factor made of microalgae. This stands in contrast to many processes for producing cultivated meat, which use fetal bovine serum (FBS). FBS is both expensive and ethically unsuitable to many consumers. At the end of this process, Mewery can harvest the pork product without having killed a single animal. The company hopes to bring its first products to market in 2026, pending regulatory approval.

Takeaway

Jack Ellis is Senior Associate Agriculture & Food at Cleantech Group, a research-based company that offers analysis on global cleantech innovation. In his opinion, in addition to the cost of lab-grown meat being prohibitive, another obstacle to wider take up by consumers is the how it looks. "Most people don't think they are an exact replica of meat in terms of taste and texture." However, advances in tech promise to change this, with companies such as Project Eaden adapting spinning technologies from the textile and fashion industries, and Nova Meat, which is using 3D printing.

FERMENTATION

8

Photo credit: Farmless



USING FERMENTATION TO CREATE FOOD WITHOUT FARMLAND

This method of production can be used anywhere in the world

The full potential for innovation in using microbial fermentation for food remains untapped, making the growth potential for alternative protein produced in this way potentially large.

Amsterdam-based agtech company Farmless sees the potential in the market and has set itself the goal of producing affordable alternative proteins at a “planetary scale.” Using renewable energy sources to power the fermentation process of microbes, Farmless seeks an entirely new style of agriculture, one in which land is no longer needed.

Farmless’ process creates food packed with amino-acid complete proteins, fibre, essential vitamins, carbohydrates, and unsaturated fats. It does this by turning existing supply

chains of liquid feedstock into the basis for its fermentation system. The company uses a naturally occurring single-cell organism that ferments at a rapid rate, and then through careful selection of different microbes for different results, produces proteins and foods that can be customised to include almost any combination of macronutrients.

Farmless’ method of production is designed to work anywhere in the world, making it possible to grow healthy proteins with minimal carbon emissions. Using fermentation to grow protein also eliminates the need to use pesticides and other dangerous chemicals on food, reducing even more the environmental damage usually incurred through the cultivation of animal-based proteins.

Takeaway

As well as utilising vast volumes of precious water resources and generating 26 per cent of global greenhouse gas emissions, agriculture also uses half of all habitable land on Earth. Making food production more resource-efficient, Farmless only requires one five-hundredth of the amount of land needed for animal protein production.

More and more businesses like Farmless are nearing industrial manufacturing capabilities and are set to play an increasingly central role in transforming the agriculture industry in time to meet 2050 climate goals.

FERMENTATION

9

A sustainable alternative to palm oil using food waste and fermentation

The product is suitable for use in both food and cosmetics

According to a market report by the International Institute for Sustainable Development and the State of Sustainability Initiatives, the conundrum facing palm oil producers is that “while the sector is a main driver of climate change through deforestation and land-use change,” the crop is “the most widely produced edible oil, meeting 40 per cent of global demand for vegetable oil on less than six per cent of all land dedicated to producing vegetable oils.” Half of all supermarket products, including items such as packaged food, animal feed, shampoo, and lipstick contain palm oil.

However, while the crop has been a significant driver of deforestation, particularly in Southeast Asia, it has a very high yield compared to other vegetable oils, meaning that it requires far less land to meet the world’s demand for vegetable

oil than the existing alternatives. The oil’s versatility means that it is used in many different food and cosmetic products, making it very difficult to find a sustainable replacement. Fermentation may be the key to meeting that challenge. UK foodtech company Clean Food Group uses food waste and large-scale fermentation to create sustainable oils and fats. Designed to replace traditionally grown products, the fermented versions grow on non-GMO yeast chosen for its speed and customisation capacity.

Having recently raised £2.3 million to scale its operations, the company has already completed a 1,000-litre fermentation test. The results from the latest trials will be used to create the oils and fats that will be submitted for regulatory food and cosmetics approvals late in 2023. Clean Food Group plans to complete commercial scale trials and its Series A funding round in 2024.

The company is working with industrial food specialists Alianza Team and Doehler Group to scale production capacity to industrial quantities as well as develop the products that will undergo compliance testing.

10

Microbial protein for people on modified diets

An additive serves the needs of sick or older generations

Singaporean startup Pullulo has developed an innovative microbial protein that is highly nutritious, affordable to produce, allergen-free, non-GMO, and vegan. It is also less susceptible to supply chain disruptions. The protein can be added to a wide variety of products – such as purees, 3D-printed food, soups, and stews – to give them a higher protein content. This is ideal for people with health problems that prevent them from eating standard meals.

In order to create a more sustainable product, Pullulo uses waste from surplus and discarded raw fruits and vegetables to produce its microbial proteins.

The startup points out that the process of using microbes to generate protein also consumes carbon dioxide, allowing the company to support decarbonisation initiatives and continue scaling without harming the environment.

Takeaway

Fermentation is a process that dates back thousands of years and uses microbes, such as yeast or fungi, to break down a compound and create a by-product. As consumers, we’re more than familiar with by-products such as alcoholic drinks, cheese or yoghurt. But the idea of using this process to create protein we can use to create meat is still new to many consumers. However, this has not stopped investors seeing the potential. According to the Good Food Institute, fermentation companies focused on alternative proteins raised \$1.7 billion in 2021, three times as much as in 2020.

NOVEMBER 2023
THE FUTURE OF FOOD
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**FEATURED
INNOVATIONS**

1 Phytoform
phytoformlabs.com

2 Upp
upp.farm

3 Fabumin
fabumin.com

4 University of Helsinki
helsinki.fi/en

5 Rebellyous
rebellyous.com

6 Believer Meats
believermeats.com

7 Mewery
mewery.io

8 Farmless
farmless.com

9 Clean Food Group
cleanfood.group

10 Pullulo
pullulo.com.sg

