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Smart farming world

Enabling sustainable growth

As global populations rise, feeding the world won't be the only issue on the mind of society, companies and investors

There is a need to address the negative impact from crops and livestock in agriculture, such as emissions and other ESG factors

Smarter farming technologies, from robotics to big data, and synbio to genetics, can help feed the world more sustainably

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Feeding the world

Smarter farming to feed the world sustainably

Population growth, environment and labour issues in food production…

Food, glorious food! Despite global population growth set to be lower in a post pandemic age, we believe that this factor alone may not be sufficient in alleviating the pressure to feed world sustainably. For example, the negative issues of climate change, environmental and labour factors from agriculture are increasingly at the top of the mind of society, companies and investors.

By 2050, we expect the global population to hit 8.5bn. The UN expects each person to consume 12% more than they did at the turn of the century. We believe this implies that total food consumption may grow by 60% at the midpoint of the century.

In this report, we outline key data point observations, issues and pressure points for feeding the world sustainably. This includes global population growth dynamics, food demand as well as environmental and labour issues. This sets up the thematic motivation for the report and then we move on to look at how various smart farming tools are being used today in making agriculture more sustainable in the longer run.

Understanding smarter farming applications today

What is smart farming? Smart farming naturally includes technologies such as robotics and connectivity, often using Internet-of-Things to track and automate activity on farms. But in the modern day, farms are also starting to use big data, artificial intelligence, drones and blockchains to process and make sense of activity in real-time. However, as the farm becomes smarter, allowing the production of crops, feeds and livestock to increase yields, reduce water use, energy and labour, this digitisation also brings issues of cybersecurity and hacking.

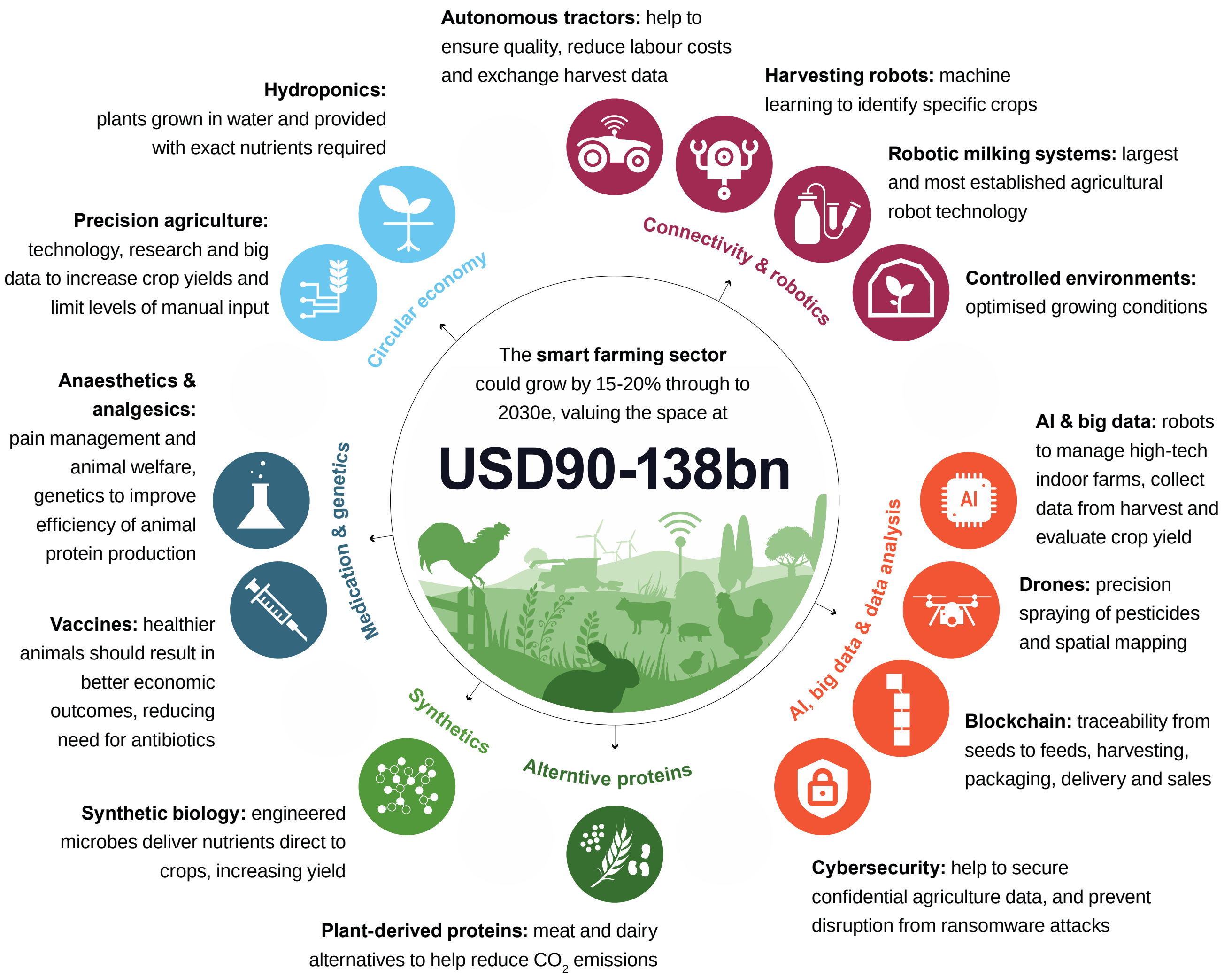
We believe there is value in understanding smart farming beyond the traditional definitions of simply pure digitisation. So we look at how innovations such as vertical farming, hydroponics, alternative protein for human consumption, synthetic biology and animal protein/pain killers can help with reducing water use, emissions and improving ethics in the modern agriculture setting. We also look at the regulations landscape globally to support smarter and sustainable farming.

Did you know?

- Global population set to rise to 8.5bn and world set to consume 60% more food by 2050
- Food related GHG emissions are responsible for 26% of global emissions
- Global AgTech to grow from about USD22bn today to nearly USD140bn by 2030
- Digital farming technology increased yields up to 30% recently in trials in India
- Vertical (indoor) farming uses no soil and 95% less water than traditional methods

21st century smart farming

The rise of disruptive technologies …



… and their impact on sustainable growth

Technology/application	Emissions	Crop yield	Land	Water	Animals	Labour	Ethics/social
Connectivity	○	●	●	●	●	●	
Robotics	○	●	●	●	●	●	●
AI, big data & data analysis	●	●	●	●	●	●	●
Drones			●			●	●
Blockchain			●	●	●	●	●
Cybersecurity	○	○	○	○	○	○	●
Alternative proteins	●				●		●
Synthetic biology	●	●	○				
Genetics, medicines	●	●	●	●	●		
Vertical/indoor farming	●	●	●	●		●	●
Circular economy	●		○	○	○		●

Key: ● Direct impact ○ Indirect impact

Source: Finistere Ventures, HSBC

Smarter tech to feed world

- The agriculture sector presents a host of intertwined environmental issues, which can only be exacerbated in the quest to feed the world
- We look at a number of key technologies available today which we believe can make farms and the agriculture sector smarter…
- Hence addressing environmental and other concerns from food production

Working smarter on farms…

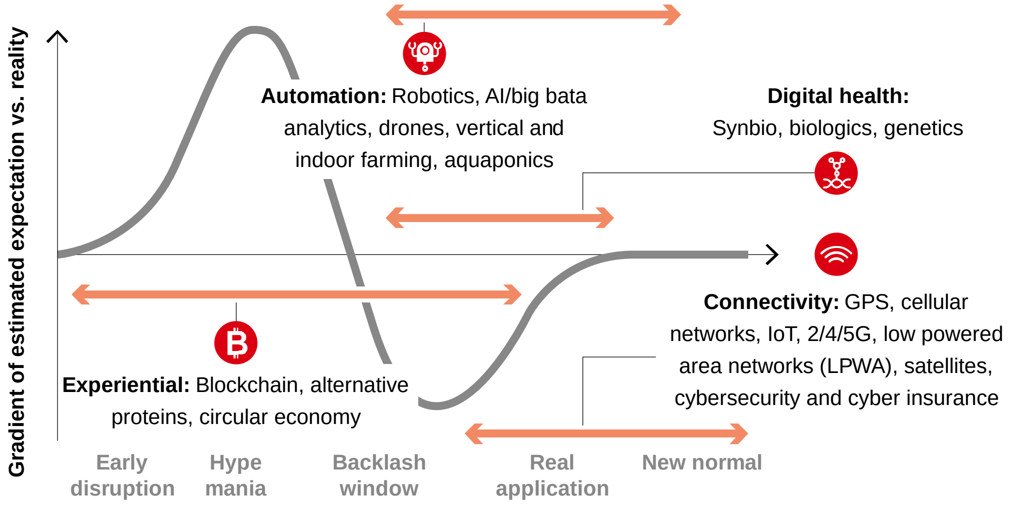
21st century farms…

The rise of disruptive technologies

Smart farming naturally includes technologies such as robotics, with connectivity being a crucial part of the jigsaw. At our expert event on smart farming in 2021, the panellists highlighted how due to farms being in rural areas, good, stable connectivity was a pressing issue to be solved. Good connectivity is needed in these smart farms, so their systems can operate using Internet-of-Things to track and automate activity. Farms are also starting to use big data, artificial intelligence, drones and blockchains to process and make sense of activity in real-time.

However, as the farm becomes smarter, allowing the production of crops, feeds and livestock to increase yields, reduce water use, energy and labour - this digitisation also brings issues of cybersecurity and hacking.

Chart 1. HSBC Disruption Framework: Smarter farming



Source: HSBC

Thinking more farming innovations…

We believe there is value in understanding smart farming beyond the traditional definitions of simply pure digitisation. So we look at how innovations such as vertical farming, hydroponics, alternative protein for human consumption, synthetic biology and animal protein/pain killers can help with reducing water use, emissions and improving ethics in the modern agriculture setting. See Chart 1 for our HSBC Disruptive Framework, to see how commercial the various technologies are today.

Our analysts around the world help us identify some of the key technology trends enabling the farms of the 21st century to not only improve productivity to feed the world but also do it in a sustainable fashion. See Table 1 giving a high level view of which sustainable themes various technologies in this chapter tick.

Table 1. Smart farming matrix: Impact on sustainability growth themes

Technology or application	Emissions	Crop yield	Land	Water	Animals	Labour	Ethics/social
Connectivity	○	●	●	●	●	●	
Robotics	○	●	●	●	●	●	●
AI, big data & data analysis	●	●	●	●	●	●	●
Drones			●			●	●
Blockchain	○		●	●	●	●	●
Cybersecurity	○	○	○	○	○	○	●
Alternative proteins	●				●		●
Synthetic biology	●	●	○				
Genetics, medicines	●	●	●	●	●		
Vertical/indoor farming	●	●	●	●		●	●
Circular economy	●		○	○	○		●

Source: HSBC
Key: ● = Direct impact, ○ = Indirect impact
Key: Connectivity framework = red, Automation = orange. Experiential = blue, Digital health = green

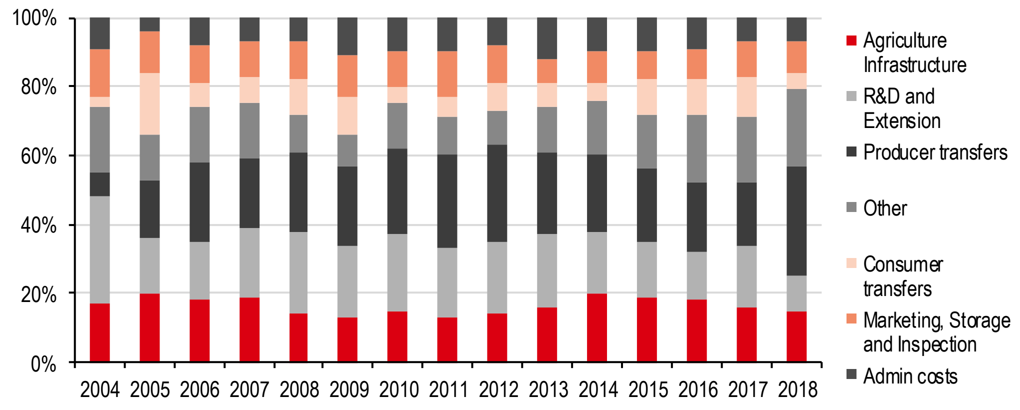
Agriculture is a USD3.5trn industry

Smarter farming market size

Global GDP in 2019 was estimated to be USD87.6trn by the World Bank. It also estimated agriculture's percentage of global GDP to be about 4% in the same year. This implies that global agriculture GDP in 2019 was USD3.5trn.

The chart below shows us that total R&D spend in agriculture was 10% of the total value of the agriculture sector in 2018, with an average of 15% for the previous half decade. We approximate that agriculture R&D spend globally was about USD350bn in 2018.

Chart 2. Agriculture infrastructure and R&D trends



Source: OECD FAO

Smartening agriculture could be a USD90-138bn market by 2030…

In 2020, the smart agriculture and food tech (or AgTech) was estimated to be USD22.3bn in its market cap by venture capital firm Finistere Ventures. This included investments ranging from technology in precision ag to alternative proteins. From 2011 to 2020, this was a CAGR of 56%. So approximately, this means AgTech is about 25% of agricultural R&D spend. We estimate that AgTech could grow by 15-20% through to 2030.

Smarter farms through robots and connectivity

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The future farm essentials: robots in disguise

Digital technologies and robotics can help create fully autonomous solutions that are sustainable, in the sense they can be more resource-efficient, and cost effective because they help reduce overall labour costs.

Robots to make farms more sustainable…

Emerging applications of robots or drones in agriculture include weed control, cloud seeding, planting seeds, harvesting, environmental monitoring and soil analysis. Automation and robotics for smart farming encompass a range of technologies, which include the below:

1. **Autonomous tractors**: allow driverless farming to help ensure quality and lower labour costs. Further, e-tractors exchange data on use and charging needs to optimise energy consumption.
2. **Harvesting robots**: vegetable picking robots, equipped with machine learning to identify and harvest a specific agricultural crop, are enabling automated harvesting.
3. **Robotic milking systems**: allow cattle farmers to automate the milking process. Milking robots are the largest and most established agricultural robot technology.
4. **Drones**: remote-controlled consumer or prosumer drones are used for aerial image acquisition.
5. **Controlled environments**: using building automation solutions for vertical farms, where optimised growing conditions for plants and other foodstuff products are created in a reliable and energy-efficient way. Also known as Controlled Environment Agriculture (CEAS) in this domain.

Agri bots USD19bn by 2026e

Agricultural technology news site AgriTech Tomorrow pegs the global agricultural robot market size at USD19bn in 2026e, rising at a CAGR of 10% (based on a December 2020 study).

A November 2021 UK government study estimated that the agriculture robot density in the UK (measured in robots per million hours worked) would increase from below 1.0 by 2025 to around 8.0 by 2030 and further to 21.6 by 2035. The study also predicted that in the agriculture sector up to 30% of tasks could technically be automated by 2035, equivalent to an estimated GBP4.5bn of GVA, driving productivity increases of 0.9% relative to baseline by 2035, adding an estimated 0.7% to GVA relative to baseline.

Is investment cost a barrier to entry?

High initial investment costs are a barrier to growth for the agricultural robot market. Other identified barriers in the agricultural sector include drone regulation; digital skills shortages; and problems with research and testing.

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The 21st century connected farm…

Farming optimisation and productivity gains are increasingly important given the uncertain conditions that dictate the output, including climatic conditions or pest control, to name a few. It is also key when considering the finite (and increasingly under constraint) resources such as water.

Farming benefits from technology through three dimensions: first, by predicting the environmental parameters (rain, temperature, wind), second, by measuring parameters on the ground (crops, livestock, inventories) and third by collecting and analysing data to build a decision model, which in turn would improve productivity on the ground. From a technology standpoint, we observe a combination of satellite and mobile technologies including 5G supported drones:

Internet of Cows?

- **Satellites:** provide the underlying data to observe and model climatic conditions but also, through spectral analysis, help to predict the output of a specific crop and determine actions to fix underperforming plots. GPS (Global Positioning System), from their 20km-away orbit, can help a farming device to move with precision or to define precisely the boundaries of a field.
- **Mobile**: cellular networks can support farming using IoT (Internet of Things) technology. Smart farming devices can monitor climatic conditions on the ground (sensors indicate if a field needs watering or fertilizer) or help in making decisions on when to feed and milk animals for example.

5G IoT for sensors and mobility

Satellite technology as a support for smart farming is well known, but the development of 5G technology could take farming to another dimension. The IoT ecosystem is currently supported by 2/3/4G technologies but also by low powered wide area networks (LPWA) that can support Machine to Machine and IoT devices that don't require high data loads.

5G technology will expand the capacity of IoT. The standalone version of 5G (also called Release 16, an end-to-end 5G architecture from core to access, with a cloud-native configuration) can support one million IoT devices per square km, with improved power and connectivity controls.

Drone as a Service or Robot picking fruits?

Another feature of 5G is ultra-reliable and low latency communications. This feature could be vital for automated flying drones (checking crops and livestock) but also to support mobile vehicles with robotic arms that could pick fruit for example: the connectivity would allow the sensors/camera to identify the stage of development and the actions to take thanks to computing power sitting at the edge of the network).

Software is playing a key role: the amount of data collected by satellites and mobile sensors can be processed and supported by AI and ML processes, leading to higher productivity eventually.

New(er) fundamental tech: Digital farming, big data/AI, drones, blockchains and cybersecurity

Digital farming

Digital farming is primarily about the use of data-driven insights to optimise farm management, but also includes online marketplace for farm products. With AI and cloud computing systems, the data generated at different levels through precision farming tools can be integrated to generate region or field or even each plant specific insights to advise the farmers on the right time of sowing and tilling, what crop to sow, how much and what fertilizers to apply and more. For instance, field specific crop and soil conditions available through precision farming can be combined with geospatial/satellite data and pricing information. These data can be used in predicting weather, pest attacks and price information. The benefits are higher output and cost savings to farmers.

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Some of the advisory services are offered via mobile based apps free of charge which facilitate easy adoption among the farming community. Paid services are available at a relatively lower cost (say USD5-10/acre) with limited investments in hardware by farmers. The simplicity and low cost of such mobile based services means that adoption of this type of technology is likely to be much faster.

Return on investment for farmers…

The return on investments on the use of digital agriculture services, in general, seems compelling. For example, Accenture has said that there is a USD55-110/acre increase in profits due to digital agriculture. This is larger than the overall profitability per acre, which is about USD250-300/acre for corn and soybeans in the US, while the cost for digital ag service is as low as USD5-10/acre, depending upon the level of service.

Table 2. Return on Investment on Farm Edge's comprehensive package at USD6/acre

Services	Details	ROI (USD/acre)	Acres tested
Variable Rate Technology	Targeted response in select areas within the field that aids higher yields and optimum input use	31.84	9.5m
Nitrogen-Manager	Reduces nitrogen use by 10% and increases yields by 5%	36.30	663k
Moisture Manager	Decision making on irrigation, nutrition needs and yield forecasting	27.3-49.3	172k
Analytics	Seed selection, planting dates, input efficiency etc	5-120	6.4m
Field mapping	Maps Soil and crop health, harvest, scouting etc	3.25	6.4m
Weather sensors	Hyper local weather information	1.26	12.8m
Predictive modelling	Disease and pest modelling and planning field operations	7.75	11.9m
Equipment tacking	Measuring productivity and fuel performance, speed regulation and helps in predictive maintenance	3.0	12.8m

Source: Farmers Edge

The charges by Farming Business Network, a co-op in North America, is lower, with a flat USD700 per user per year. As can be seen in the table below, the ROI for digital services range from USD3-120/acre based on the case studies observed in over 6-13m acres by Farmers Edge. The advantage is that some of these services can be accessed simply through mobile apps, and a typical full package service would just require investments in basic hardware like guidance systems and low cost sensors, that are already used widely in developed markets.

Barriers to adoption and key players

Full-suite services such as field-specific advisory require investment in hardware that could be a challenge in most EM markets where the small size of landholding and upfront capex costs do not justify the economics. Hence these markets are likely to be more focussed on basic services that also limit the benefits to farmers. High speed internet connectivity in farms, a pre-requisite for the smooth functioning of connected systems, is another barrier even in developed countries where the 5G rollout is still in the early stage.

Regulations and policies that restrict or limit the use of UAVs/drones could increase the cost of data collection and limit the offering of services. The key challenge for companies that are investing in digital farming is the way to monetise of data. Those that are using the data to improvise their core business or to upsell/cross sell products are more likely to succeed than the companies that offer fee based services. Hence, many start-ups and companies are developing open source platforms to gather necessary data input. Again, regulations that restrict use of data can be a headwind in the path to monetize the data.

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Drones

Specialised drones are used for image sensing and pesticide spraying which will result in cost savings to farmers through increasing labour efficiency and reducing pesticide use. China, which is a leader in drone manufacturing, has seen exponential growth in drone use for agriculture over the last two years. We think drones will see an increasing adoption in the future due to the following reasons:

- **High efficiency and labour cost savings**: Drones are much more efficient than manually spraying of pesticides, a practice that is followed in many emerging markets such as India, Brazil and Indonesia. Drones are much more cost and input efficient than a conventional sprayer and can reach difficult terrain that cannot be easily accessed by machines.
- **Low pesticide use**: According to various drone companies and testimonies by farmers as reported in news articles, drones can save pesticides use by 30-80% depending upon the crop.
- **Service-based model aiding easy adoption**: A farmer can hire a drone rather than spending upfront on buying a new drone. Also, it helps overcome issues related to a lack of training. In China, farmers can hire a drone and a pilot at CNY15 per hectare for spraying, considerably lower than labour costs.
- **Aerial mapping instead of manual scouting**: Drones with multispectral and hyper spectral sensors can capture information on soil moisture, crop health, pest impact, and nutrient absorption/deficiency. The data collected can provide insight on preventive measures and issues can be addressed in a timely manner that prevent yield losses, and are more efficient than manual scouting.

Key barriers and drone players

Regulations and policies that restrict or limit the use of UAVs/drones are the key barriers. Many countries require a drone to be operated by a trained professional who holds the requisite license, which could increase the cost of operations. China's DJI, PrecisionHawk in the US and TSX listed AgEagle are notable players in drone manufacturing.

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Blockchains

Blockchain technology empowers the traceability of all kinds of information in the food supply chain from seeding and farming to harvesting, packaging, delivering and selling. Key benefits include:

- Ensuring the safety of food;
- Improving efficiency as the tracing can be done in seconds; and
- Enhancing famers' income as they can get fair pricing for high quality food.

In Asia we observe that internet companies with cloud services all provide this service to farmers, including Alibaba, JD and Tencent.

Cybersecurity and farm theft

Smarter farms mean more digital threats…

The increased adoption of technology in any sector doesn't come without its challenges, especially when it comes to cybersecurity. A 2018 report from the US Department of Homeland Security looked at a range of cyber threats that face the "precision agriculture" section, as this space adopts "new digital technologies in crop and livestock production". It found various cyber threats to agriculture supply chains including: theft of confidential agriculture data, corrupting data to disrupt crop and livestock, damage sensor networks to harm health of animals and more.

Furthermore, the FBI said in 2016 that agriculture is becoming "increasingly vulnerable to cyber-attacks as farmers become more reliant on digitized data", this includes threats via ransomware. 2021 saw a very high profile ransomware attack on JBS, which controls about 25% of the cattle processing in the United States. Last year also saw a Minnesota agriculture company called Crystal Valley Cooperative become the target of a ransomware attack, which took its operating systems offline. It left the company unable to mix fertilizers or carry out orders for livestock feed.[1]

Application of smart farming: alternative proteins

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Introduction to the technology

What is alternative protein?

Alternative proteins cover the whole range of foods where plant-derived proteins are used to replace those traditionally derived from animals. The category can broadly be split into two main components: meat and dairy alternatives. Versions of these products e.g. tofu and rice milk have been part of the diet in certain regions for many years but, in recent years, technological advances have led to a huge expansion in the range and quality of products.

Within dairy we have seen the emergence of nut and oat milks but it is on the meat side where the changes have been most starting. Products such as the Beyond and Impossible Burgers offer virtually the taste and texture of meat but are entirely plant derived. Advances in fermentation technology will also increasingly allow products derived from fungi to faithfully replicate meat.

How it will influence the farming industry

Changing farming by changing type of inputs

The growth of plant-derived proteins will influence the farming industry in a number of ways. For a start it will lead to increased demand for a number of specific inputs which are used heavily in the current generation of plant-derived products with pea protein and oat among the prime examples. Moreover, the types of fungi best used in fermentation products are usually particular varieties which can require very specific conditions to thrive and the cultivation of these could rely increasingly on smart/precision farming techniques.

And reducing emissions…

On the flip-side, consumers' shifts away from animal protein on environmental grounds (mainly in developed markets) places an increasing onus on the agricultural industry to find ways of reducing its emissions as a means of winning back certain consumers.

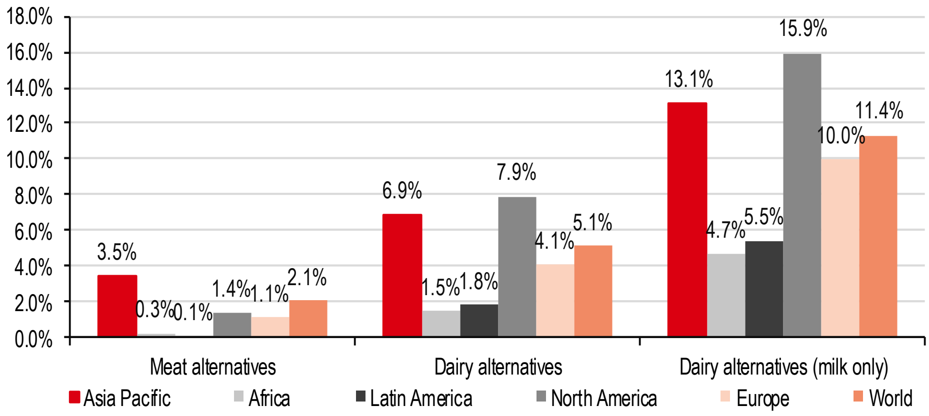
1 "Minnesota grain handler targeted in ransomware attack", Agweb, September 2021.

Current penetration and growth forecasts

Alternative proteins could grow from USD40bn to USD140bn by 2030…

Penetration of plant-based products is still very low (chart 3) with figures ranging from 0-3.5% for meat and around 5-16% for plant-based milks (and lower for plant-based dairy as a whole).

Chart 3. Global market share of plant-based products (2020)



Source: HSBC, Euromonitor

Main barriers to adoption

Will cost or processed nature deter consumers?

After a very strong 2019 and 2020 the alternative proteins category faced more difficult conditions in 2021, particularly on the meat side. Having tempted a lot of new consumers as the technology emerged, certain novel products found it hard to hold onto them while attracting additional converts also became tougher.

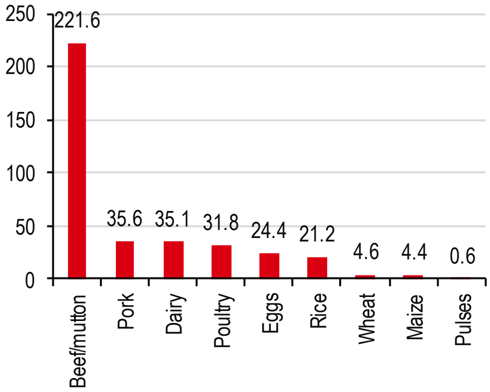
We attribute this to some of the drawbacks the category currently faces. For a start the products are generally much more expensive than the traditional animal derived proteins. While, particularly on the meat side, they face some resistance from their highly processed nature and the long lists of ingredients they contain. Fungi-derived fermentation products in particular offer the promise of much more concise ingredient lists.

The power to reduce CO_2 emissions

Up to 70% less CO2 than traditional dairy…

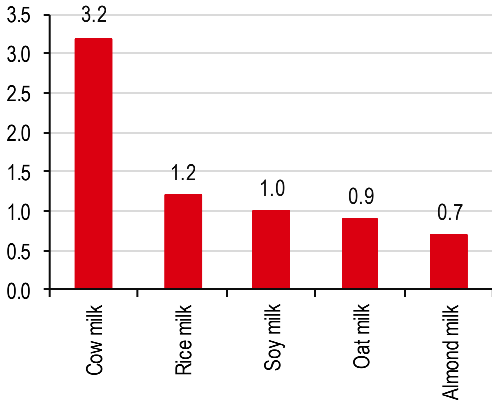
As outlined, one of the main attractions to consumers of plant-derived protein alternatives is their lower CO_2 footprint. Particularly on the meat side, the emissions savings through switching to plant-derived products are extremely large. Even in dairy, the average plant-based milk has CO_2 emissions c70% below that of traditional dairy

Chart 4. GHG intensity of different foods (CO_2 eq./kg protein)



Source: Our World in Data, Clark and Tilman 2017

Chart 5. GHG intensity of milk/milk substitutes (kgCO_2 eq./lit)



Source: BBC citing Poore & Nemecek, 2018.

Application of smart farming: Nitrogen fixation and the synthetic biology solution

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The fertiliser problem

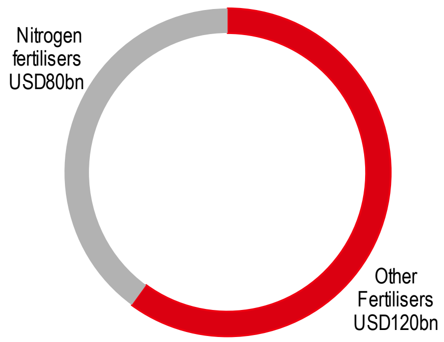
Nitrogen is essential in the growth and development of plants and while c78% of the atmosphere is made up of nitrogen, that is not available in usable form to plants.

Nitrogen fertilisers responsible for c3% of global GHGs

The synbio solution

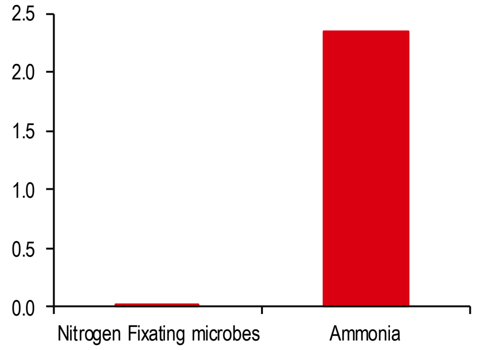
Synthetic biology platforms can engineer and design microbes that replicate the behaviour of naturally occurring nitrogen fixating microbes – as seen in legumes – and transfer the desired nutrient to any targeted crop – thus providing plants access to usable nitrogen and increasing crop yields. These genetically modified microbes outperform both organic microbes and industrial fertilisers. Unlike natural microbes, their influence is not limited to a specific type of crop. Also, unlike fertilisers, engineered microbes do not have a GHG footprint, do not utilise fossil fuels in the manufacturing process and do not cause run-off water pollution. The delivery mechanism is via seeds, with the engineered microbes coated onto seeds before they are sown.

Chart 6. Global fertiliser industry market value (2020 – cUSD200bn)



Source: IHS Chemicals, HSBC

Chart 7. Carbon emission comparison: Ammonia vs nitrogen fixating microbes (kgCO_2/kg)



Source: IEA, Pivot Bio

Scaling synbio still an issue…

Key challenges

We believe that scaling might be the biggest hurdle for synbio nitrogen fertilisers as the majority of these projects are currently in the research phase and are yet to scale commercially. Also, despite not falling under the genetically modified (GM) food classification, there remains a possibility of poor consumer adoption since the process uses bioengineered organisms. Additionally, crops, soil conditions, weather, temperature, water availability, seed distribution and farming practices are significantly different from place to place. Hence designing microbes that can work across multiple different environments poses a big challenge.

Applications of smart farming: Medications, genetics and GM

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Medicines to better Animal Health

Animal health medicine is a USD40bn+ market: Zoetis, one of the largest listed animal health companies, cites the size of the animal medicines and vaccines sector at approximately USD40bn. This total market is split between companion animal products (CAP, i.e. products for pets) and farm animal products (FAP, i.e. products for farm animals). Growth in both segments is expected to be quite robust with a number of companies and consultancies expecting multi-year industry growth of around 4-7%.

Genetics to improve the efficiency of animal protein production

What is the technology?

Companies breed for elite traits using the genome of individual animals to inform breeding decisions. Breeding decisions are taken to maximise the prevalence and intensity of positive traits and vice versa. In practice this means elite animals exhibit more protein per unit of feed, better health and lower emissions than non-elite animals.

Going forward, gene editing may become more prevalent

Gene editing goes one step further than genomic selection. Using CRISPR technology, genes that already exist in a species' genome are turned on or off to achieve desired results. For example, a gene edit which successfully confers resistance to a specific virus would be highly attractive from an economic and welfare point of view.

Barriers to adoption

Much like the use of medicines and vaccines, the barrier to increased utilisation of elite genetics is typically cost and awareness. In many parts of the world, farming remains relatively backyard and informal. As average farm sizes increase however, and production consolidates and becomes more technical, the trend is clearly towards a focus on greater efficiency which would include incorporating elite third party genetics into the production cycle.

Genetically Modified (GM) crops

GM is not a new technology

Modifying traits of crops can be seen occurring thousands of years ago and has bought benefits to both the economy, environment and society. They have been able to increase yields significantly, adapt to climate change and serve growing populations with both food and commodities such as cotton. They provide an opportunity to reduce pesticide use, minimising the impact on the environment. Additionally, the application to the energy sector remains a promising avenue for the GM crop. With rising biofuel adaptions, modified energy crops can assist the green transition to cleaner energy.

Worries of GM crops exist but play a role in sustainable farming…

However, challenges with the technology remain, and can hinder their adoption globally. Environmental hazards of GM crops include gaining a competitive advantage and reducing the prevalence of other species, reducing biodiversity. Safety to human health also poses a challenge due to lack of large-scale studies and the risk of unintended consequences to health, such as antibiotic resistance. Although these challenges remain, GM crops have a role to play in the transition to more sustainable farming.

Vertical farming

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Vertical farming (aka indoor farming) is the practice of growing plants/crops in vertically stacked layers in warehouse, containers, rooftops or even skyscrapers. These farming techniques stimulate plant growth through artificial control of lights. The plants are grown without soil and use 95% less water. Moreover, these farming techniques do not use pesticides as the problem of weeds/insects is non-existent in a controlled environment. Fertilizer/nutrient use are reduced by as much as 60%. Given the proximity to demand centres, vertical farming can save significant costs on cold storage and transportation (c30% of cost for horticulture such as lettuce vs c10-15% for grains).

Vertical farms have an environmental benefit as they reduce stress on limited resources such as land and water. As per Aerofarms, vertical farming in one acre of land can produce as much food as a 390-acre traditional farm does and can be grown in urban areas on low cost real estate. The success of vertical farming depends on overcoming cost and technological barriers.

Technology and cost economics are the key barriers

Leafy greens in vertical farming

Currently, lettuce and other leafy greens are the most popularly grown plants in vertical farms as they are easy to grow. The technology for indoor production of berries, aubergines and other fruits and vegetables in the vertical, are in the developmental stage. Further, offsetting the benefits are comparatively higher set-up costs and an increase in operating expenses. Electricity to power up LEDs is the single largest operating cost. Higher operating and capex costs relative to conventional farming makes the model viable only in specific cases that are catering to niche markets where the produce can be sold at a premium and there is a need for reliable supply, for example - supply to airlines and restaurants. Aero farms took 9 years to make meagre profits, according to Forbes, while many vertical farming companies have also closed their business due to high costs involved. On the bright side, investment interest in the space has picked up recently that could foster new technologies and help bring down the costs.

Vertical farming expected to be worth USD20bn by 2026

Market size and recent deals

BIS research estimates the market size of vertical farming at USD5.5bn in 2020 and expects to reach a CAGR of 24% through 2026 to reach nearly USD20bn. High growth potential and its sustainability credentials have attracted growing investments in the space. According to Pitchbook, cUSD1.9bn was invested in vertical farming start-up companies in 2020, almost 3x higher than 2019 levels.

Circular economy

Creating a closed loop to reduce waste and resource inputs

The standard model for an economy is a linear one, where raw materials are extracted from the earth, processed into goods which are used, and then disposed of as waste. A circular economy is a closed loop in value chains where materials intended for waste are reused/recycled to create new products, minimising resource inputs, while reducing emissions. This concept is gaining traction due to growing populations in the face of finite resources, and the growing focus on sustainable living.

Agriculture uses 70% of global freshwater

The agricultural industry is responsible for roughly 70% of global water use. Utilising a circular system can assist in reducing this number, and the potential to reuse irrigation water. This would not only save water, but if treated properly, can provide valuable nutrients.

Utilising waste for fertiliser and biofuels

A third of food is wasted each year, contributing to the inefficiencies of the agricultural sector, ultimately exacerbating land management, water use and emissions problems. In a more circular economy, this waste can be deployed for other resources.

The key to making sure resources such as water aren't wasted through the agricultural supply chain is to encourage more circularity in the industry. This can be somewhat addressed in the first stage in the supply chain. Precision farming and Hydroponics are two developments the industry can adopt to help achieve this for the value chain and a more sustainable approach to agriculture:

- **Precision agriculture** – This is the use of technology, research and big data to increase crop yields while limiting the levels of inputs to ensure the correct amount of substances are used in the right areas and times. Inputs such as water, pesticides and fertilisers can be limited and directed to where they are required most. This reduces the impact agriculture has on the environment via its water use, emissions and waste, as well as pollution via the over use of harmful substances.
- **Hydroponics** – A type of agriculture that doesn't require soil, whereby plants are grown in water and provided with the exact amount and type of nutrients required. Modern hydroponics utilise data and automation to increase yields by taking control of which conditions the crop grows in. This is sustainable and reduces waste via managed water usage and provides less risk of pollution elsewhere. However, this type of farming has its risks. These include large amounts of energy usage (due to it typically occurring indoors) and the economic cost incurred for the infrastructure required, therefore, not suitable for smaller farms with lower budgets. Coupled with hydroponics is **aquaponics**, which varies by the use of fish to provide a natural source of nutrients instead of adding the fertilisers directly to the system. The plants naturally filter the water and create a circular system benefiting both plant and fish.

This is an abridged version of a report by the same title published on 03-Mar-22.

The full note is available to clients of HSBC Global Research and contains a further look at the topic at hand.

Please contact your HSBC representative or email AskResearch@hsbc.com for more information.

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