

AgTech

Feeding a growing global population

The Food and Agriculture Organization (FAO) of the United Nations forecasts that agricultural production will grow by 15% over the coming decade, whereas global agricultural land use will be broadly flat. The projected expansion in crop output is therefore expected to be achieved through yield improvements and higher production intensity, driven by technological innovation. This report reviews the diverse range of AgTech solutions available and profiles some listed companies in the sector.

Addressing rising demand while meeting environmental concerns

Agricultural commodities are used as food, animal feed, fuel and raw materials for industrial applications. The FAO forecasts a 10% increase in global population over the next decade, which will drive demand for food directly. At the same time, rising affluence in developing economies is expected to result in a shift towards more westernised diets, with greater consumption of meat and dairy produce. This will increase the amount of agricultural output used in feed, resulting in an increase in demand for agricultural products that is substantially greater than population growth. The FAO expects the use of agricultural commodities in biofuel production to remain strong, but not increase. At the same time as meeting increased demand for agricultural outputs, the farming industry needs to find ways of reducing carbon dioxide emissions and nitrate pollution and alternatives to harmful glyphosate herbicides and neonicotinoid pesticides.

Diversity of AgTech solutions

There is wide range of technologies that are beginning to be deployed in the agricultural sector to address the challenges presented above. Some, such as vertical farming, are specific to the agricultural sector. Others are adaptations of technologies already proven in other applications, such as using biotechnology to improve yield or enhance resistance to drought or pathogens, deploying connected devices to support precision farming, using artificial intelligence techniques to interpret the data collected and advanced robotic systems for gathering data or performing traditional farming tasks.

How to play the AgTech opportunity

Although there is plenty of investment in the AgTech sector, there are relatively few pure-play listed companies as the more successful enterprises tend to be acquired by larger, more diversified groups rather than seeking an IPO. Listed companies that have added AgTech capability to enhance their existing portfolios are therefore much more common, so this report includes profiles of some of these stocks. We also include profiles of companies whose technology can be used in many sectors as well as AgTech. While these more diversified stocks may not exhibit the potential growth of focused AgTech players, they are lower risk.





5 February 2020

From the street

'We can identify many sub-themes that are driving continuous change in food production and consumption. Examples include dietary differences between advanced economies and emerging economies, our willingness to integrate food choices with health and wellness goals, and advances in technology to help farmers improve efficiency.' Jeneiv Shah, co-fund manager, Sarasin Food & Agriculture Opportunities fund

Edison themes

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Market drivers

Population dynamics shape consumption of basic foodstuffs

Population increase is the most significant factor behind the projected growth in food use of agricultural commodities, particularly for commodities such as cereals that have high levels of percapita consumption in regions with strong population growth. The world's population continues to grow, albeit at a slower pace than at any time since 1950 because of reduced levels of fertility. The 2019 *World Population Prospects* from the United Nations noted that from an estimated 7.7bn people in 2019, the global population could grow to around 8.5bn in 2030, 9.7bn in 2050 and 10.9bn in 2100. Two-thirds of this projected growth would occur even if child bearing in high-fertility countries today immediately falls to around two births per woman over a lifetime because of the large population of children and youths who will reach reproductive age in the next couple of decades and begin to have children of their own. More than half of the projected increase in the global population up to 2050 is expected to be concentrated in just nine countries: the Democratic Republic of the Congo, Egypt, Ethiopia, India, Indonesia, Nigeria, Pakistan, Tanzania and the US.



Exhibit 1: Global population growth

Source: FAOSTAT: Annual population

Economic growth drives demand for meat, dairy produce, sugar and vegetable oils

Increasing disposable incomes lead to a shift to a more westernised diet, involving a higher proportion of animal foods. The OECD-FAO's *Agricultural Outlook 2019–2028* forecasts the East and South-East Asia region will experience per capita income growth of 60–100% by 2028, resulting in meat consumption (primarily poultry and pork) rising by 5kg per capita in China and 4kg per capita in South-East Asia over the medium term. In South Asia, by contrast, income growth is associated with greater consumption of dairy products, sugar and vegetable oil. Moreover, while per-capita meat consumption will grow more slowly in higher income than lower income economies, this represents a larger absolute increase given the relatively high consumption in regions such as the US. Although per-capita meat consumption of over 2kg per capita, taking the country's intake above 100kg per capita in 2028. This will still be the highest in the world and is equivalent to an additional 4Mt annually. Because agricultural commodities are used for animal feed as well as



human food, rising demand for meat and dairy products puts additional pressure on crop production and drives expansion of production in the livestock sector itself. The use of cereals for feed is expected to grow more quickly than the total agricultural output over the coming decade with the modest increase in US meat consumption accounting for 10% of the global growth of agricultural outputs in food use.

Exhibit 2: Ecological	footprint of types	of food production
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Protein type	Feed required per kg of food	Water consumption litres/kg	Carbon dioxide emission, kg/kg	Land use, m²/kg
Beef	25.0kg	22,000-43,000	150	250
Pork	9.1kg	3,500	55	70
Chicken	4.5kg	2,300	40	50
Insect	2.1kg	8	20	20

Source: Food and Agriculture Organization of the United Nations, 2013, van Huis et al., Edible insects: future prospects for food and feed security

Impact of environmental legislation

Since the Second World War, arable farmers have increased yields by applying greater quantities of synthetic fertiliser and using a range of toxic substances to kill insects, worms, moulds and other living organisms that attack plants. Similarly, livestock farmers have boosted animal growth by administering antibiotics in feed and drinking water. These practices have been shown to have a detrimental impact on the environment, resulting in the enactment of legislation to reduce the use of fertiliser, certain pesticides and antibiotics. These legislative changes mean farmers need to find alternative techniques to improve yield. In addition, legislation has a significant impact on the proportion of agricultural output diverted to biofuel production. While legislators seeking to reduce carbon dioxide and methane emissions are focused on the transportation and power-generation industries, agriculture and related industries account for around a quarter of global emissions, so it is likely the restrictions will be imposed in the future.

Demand for biofuel

The use of agricultural commodities in biofuel production is heavily affected by legislation. The FAO expects demand for this application to remain strong, but not increase. Governments in Brazil, the European Union and the US began mandating the use of biofuels for transport in the early 2000s. This resulted in a significant share of maize, sugar cane and vegetable oil being used in the production of renewable fuels and formed a major source of crop demand growth between 2000 and 2015. Further expansion in the European Union and the US is likely to be limited because of concerns about diverting foodstuffs for use in as fuel. However, biodiesel usage is expected to rise by 18% over the coming decade, largely supported by a new mandate in Indonesia that seeks to increase the biodiesel blending rate to 30%. Global use of ethanol is expected to grow around 18% by 2028, with greater use expected mostly in China. This follows the Chinese government setting a target in 2017 to achieve a 10% ethanol blending share for 2020, fulfilled by domestic production from Chinese grown maize and imported cassava.

Restrictions on nitrate pollution

Nitrogen is a vital nutrient that helps plants and crops to grow. However, high concentrations are harmful both to people and to nature. The European Union's Nitrates Directive, which was adopted in December 1991, aims to protect water quality across Europe by preventing nitrates from agricultural sources polluting ground and surface water and by promoting the use of good farming practices. Voluntary codes of good agricultural practice include measures limiting the periods when nitrogen fertilisers can be applied on land to focus on periods when crops require nitrogen, measures limiting the conditions for fertiliser application, for example on steeply sloping ground, to prevent leaching and run-off, requirements for a minimum storage capacity for livestock manure



and the use of crop rotations, soil winter cover and catch crops to prevent nitrate leaching and runoff during wet seasons.



Source: European Commission

The most recent four-year report from the European Union commenting on the success of the directive concluded that while freshwater and groundwater quality had slightly improved over 2012 to 2015 compared with 2008 to 2011, nutrient overload from agriculture continued to be one of the biggest pressures on the aquatic environment. In June 2019, the European Court of Justice ruled that Germany had breached European Union law by allowing an excessive use of manure as a fertiliser. In July the European Commission adopted an infringement decisions package against Germany for continuously breaching the European Union's nitrates directive, requiring the country to comply with the directive or risk billions of euros in fines.

Restrictions on glyphosate plant protection products

Glyphosate is an active substance used in plant protection products to control plants, including Monsanto's Roundup weedkiller. It has been used for several decades and is the most frequently used herbicide worldwide and in the European Union. It is typically applied before crops are sown to eliminate competing plants and thus encourage crop growth. This eliminates or minimises the need to use ploughing machines, thereby reducing soil erosion and carbon emissions. Glyphosate is also used to a lesser extent as a pre-harvest treatment to facilitate better harvesting by regulating plant growth and ripening.

Given concerns raised in the International Agency for Research on Cancer's report on glyphosate, which concluded in 2015 that the substance was probably carcinogenic to humans, and a landmark case in 2018 requiring Monsanto to pay US\$39.2m in compensatory damages and US\$250m in punitive damages for failing to warn consumers that exposure to Roundup weedkiller causes cancer, an increasing number of towns and cities across the globe have passed measures restricting its use. In December 2017 the European Commission narrowly voted to renew the approval of glyphosate for five years, permitting its use in authorised products until December 2022. However, France and Italy have stated they will carry out glyphosate bans by 2020 and Germany



announced in 2018 that it will also issue a glyphosate ban. Banning active ingredients such as glyphosate will require the development of alternative plant protection products and will have an adverse effect on Bayer (**BAYN:GR**), which purchased Monsanto and its portfolio of products including Roundup for US\$63bn in 2018.

Ban on neonicotinoid pesticides

In April 2018 the European Union extended the ban on using three neonicotinoids (clothianidin, imidacloprid and thiamethoxam) on all field crops because of the serious danger they pose to bees and other pollinators. These pesticides are commonly coated on seeds to protect them from soil pests. The legislation means these active agents can only be used in closed greenhouses. Alternatives will need to be found for open field use, particularly because otherwise the ban is likely to encourage use of pesticide sprays, which also kill pollinators.

Reduction of greenhouse gases from agriculture

A recent FAO report estimates that greenhouse gas emissions from agriculture, forestry and other land use are 24% of the global total. Direct emissions from agriculture, mostly from livestock, especially ruminants, and from rice cultivation and manufacture of synthetic fertilisers, account for 11% of global emissions. These are expected to grow by 0.5% each year over the coming decade, compared with 0.7% each year over the past 10 years. This is lower than the growth in agricultural production, indicating a declining carbon intensity as productivity increases. Almost half of the growth in direct emissions is expected to come from cattle, with another 15% coming from small ruminants (sheep and goats). Geographically, most of the increase in direct greenhouse gas emissions from agriculture is projected to come from the developing world, with Africa alone accounting for more than 40% of the increase and Asia (including China and India) accounting for another 45%. The large contribution of the developing world is explained by its higher growth rates of agricultural production and by the extensive, pastoral livestock systems that lead to relatively high greenhouse gas emissions per unit of output. Agriculture also indirectly causes much of the emissions from land use change, for instance when expanding agricultural land use leads to deforestation or to the draining of peatland.



Exhibit 4: Cattle are a major contributor to greenhouse gas emissions

Source: Jenny Hill

There are several options to mitigate emissions from agriculture. These include carbon pricing, policies to reduce or prevent deforestation, technological options to reduce the emissions intensity of agricultural production practices, changes in diets away from products with a high emissions footprint and initiatives to reduce food loss and waste. So far, no policies directly affecting the emission of agricultural greenhouse gases have been implemented but, given the proportion of the total emissions attributable to the sector, it cannot escape legislative attention indefinitely.



We note that as well as contributing to climate change, agricultural practices need to adapt so crops are resilient to higher temperatures and drought associated with global warming.

Development of technology to address issues

There is wide range of technologies that are beginning to be deployed in the agricultural sector to address the challenges presented above. Whereas some, such as vertical farming, are specific to the agricultural sector, others are adaptations of technologies already proven in other applications. Origin Enterprises estimates that advanced adaptive agronomy techniques have the potential to almost double farm yield compared with the current UK average (see Exhibit 10).

Biotechnology

Biotechnology harnesses cellular and biomolecular processes to develop technologies and products. Within the agricultural sector, genetic modification to improve yield or enhance resistance to drought or pathogens tends to receive the most public attention. However, biotechnology improves crop resistance to insects and other pathogens, thus reducing the amount of pesticide needed. It improves crop yields by triggering plants' defensive mechanisms to stimulate growth, which reduces the amount of fertiliser required. Agricultural biotechnology is a set of tools and disciplines meant to modify organisms for a particular purpose. That purpose can include anything from coaxing greater yields from food crops to building in a natural resistance to certain diseases. Although there are multiple ways to accomplish this, the method that tends to get the most attention from the public is genetic modification.

Connected devices

Connecting electronic devices to each other wirelessly through the internet, the so-called Internet of Things (IoT), has become commonplace in almost every aspect of life in the developed world: health and fitness, home automation, transportation and logistics, smart cities and buildings and the automation of industrial processes, which is often referred to as Industry 4.0. Connected devices are increasingly also being used in agriculture. Typical applications involve using wireless sensor networks to collect data on field variables such as soil humidity, sun radiation, atmospheric conditions, the starch content of plants, weight of livestock or volume of milk produced by an individual dairy cow. This information supports precision farming techniques where farmers apply fertiliser and other inputs selectively depending on how much treatment a specific area of a field requires or how much additional protein an individual dairy cow needs. This approach optimises the use of resources. It also works well with automated systems. Research company BI Intelligence predicts the number of IoT device installations in agriculture will reach 75m by 2020 and the global smart agriculture market size will triple from slightly over US\$5bn in 2016 to US\$15.3bn by 2025.

Big data and analytics

As the precision agriculture market (above) matures and data are more readily available, farmers are expected to increasingly adopt data-driven solutions such as artificial intelligence and machine learning for their ability to aggregate trends, track supplies, assess risk and reward, generate predictive models and increase yields. MarketsandMarkets predict the global agriculture analytics market will more than double from US\$585m in 2018 to US\$1,236m in 2023.



Robotics and automation



Exhibit 5: Autosteering solution for precision farming video

Source: AgJunction

Agricultural robots, or agribots, are expected to help farmers in regions such as the US address the issue of a dwindling workforce by carrying out tasks including crop harvesting, spraying, pruning, weed control, thinning out plants and planting seeds. Moreover, advanced robotic systems will be integrated into a complete system for precision farming, gathering environmental monitoring and soil analysis data, then performing the traditional tasks involved in caring for and harvesting plants as directed following an analysis of the data. According to MarketsandMarkets the agricultural robot market size is projected to grow from US\$7.4bn in 2020 to US\$20.6bn by 2025, a CAGR of 22.8%.

Vertical farms

Vertical farms have been developed to produce food in challenging environments such as dense urban conurbations or desert regions. Produce is grown in vertically stacked layers in a highly controlled environment. The facilities either use lighting that mimics sunlight or augments natural sunlight with artificial lighting. Temperature, humidity and concentration of atmospheric gases are also regulated. The plants may be grown in soil, in a solution of mineral nutrients (hydroponics) or in a mist environment (aeroponics). Nutrients are supplied to each plant via the water in the irrigation system. Software may be used to ensure all plants receive the same amount of light, water and nutrients. Proper management should mean that no herbicides or pesticides are required. Allied Market Research notes the global vertical farming market was valued at US\$2.2bn in 2018 and predicts it will reach US\$12.8bn by 2026, a CAGR of 24.6%.

AgTech stocks: Pure play versus diversification

There are relatively few pure-play listed AgTech companies. There is plenty of investment in the sector, for example in June 2019 Berlin-based portable vertical farm startup, InFarm, disclosed a Series B fundraising of US\$100m whereas retail giant **Ocado (OCDO:LN)** announced it had purchased a 58% stake in Jones Food Company, Europe's largest operating vertical farm as part of its US\$22m programme of investment in the sector. Venture Capital platform AgFunder calculates the total investment globally was US\$6.9bn globally in 2018. However, companies with successful technology tend to be acquired by larger, more diversified companies. For example in November 2019 **Raven Industries (RAVN:US)**, a US manufacturer of precision agriculture products, high-altitude balloons, plastic film and sheeting and radar systems, acquired Smart Ag, a driverless tractor technology, and the majority of autonomous farm equipment manufacturer Dot Technology Corp, in both cases for undisclosed amounts. We profile below several pure-play AgTech companies (AgJunction, Anpario, CropLogic, Eden Research and Plant Healthcare) and five European companies involved in the agricultural supply market (BayWa, Carr's Group, ForFarmers,



Origin Enterprises and Wynnstay Group) that have complemented their portfolio with AgTech solutions. We also profile four companies, Evogene, Koninklijke DSM, Nynomic and Stemmer Imaging, which offer technology that is used in other sectors as well as AgTech.

Company	Description	Market cap (\$m)	Last reported full year revenue (\$m)	EBIT margin (%)	FCF margin (%)	Net debt (cash)/ net assets (%)	Free float (%)	
Pure-play AgTech								
Agjunction	Autosteering solutions for precision farming	30	65	(3)	(1)	(61)	81	
Anpario	Natural animal feed additives	98	36	16	6	(38)	75	
CropLogic	Soil moisture management solutions	9	2	(199)	(189)	4	74	
Eden Research	Sustainable solutions for crop protection, animal health and consumer products	22	4	(18)	(15)	(30)	86	
Plant Health Care	Proprietary biological products for agriculture	32	8	(99)	(89)	(38)	33	
Agricultural supply	, agricultural machinery and retail companies that	have added AgTec	h capability					
BASF	Multi-national chemical company	61,869	71,882	10	1	52	100	
Bayer	Multinational pharmaceutical and life sciences company	79,158	45,401	16	0	79	100	
BayWa	German company operating in the agriculture, building materials and energy sectors	1,076	19,068	1	0	292	43	
Carr's Group	Agriculture division serves farmers in the UK, US, Germany and New Zealand. Engineering division offers remote handling equipment and fabrications to the global nuclear and oil and gas industries.	191	525	5	2	18	85	
Corteva	American agricultural chemical and seed company that was the agricultural unit of DowDuPont prior to being spun off as an independent public company	21,644	13,846	4	N/A	-7	100	
Deere & Co	American manufacturer of agricultural, construction, and forestry machinery	49,922	39,281	14	2	363	100	
Evogene	Computational biotechnology company	38	2	(11)	(9)	(63)	88	
ForFarmers	Internationally operating animal feed company	692	2,758	3	1	4	36	
Ocado Group	British online supermarket	11,207	2,039	(2)	(8)	(9)	61	
Origin Enterprises	Agri-services group providing specialist on-farm agronomy services and the supply of crop technologies and inputs	517	1,991	4	2	22	98	
Wynnstay Group	Manufacturer and supplier of agricultural products to farmers and the wider rural community across the UK	73	638	2	2	-4	99	
Technology companies with involvement in AgTech sector								
Koninklijke DSM	Dutch multinational active in the fields of health, nutrition and material	22,072	10,628	14	5	1	100	
Nynomic	Contact-less optical high-tech measurement systems for a wide range of applications	119	75	15	2	42	100	
Raven Industries	U.S manufacturer of precision agriculture products, high-altitude balloons, plastic film and sheeting, and radar systems	1,121	407	14	8	(21)	99	
Stemmer Imaging	Machine vision technology provider	188	124	7	4	(63)	46	
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Exhibit 6: Listed companies featured in this report

Source: Refinitiv. Note: Priced at 3 February 2020.

Pure-play AgTech stocks

AgJunction (AJX:CN)

AgJunction is one of the pioneers of GPS-guided autosteering for precision agriculture applications. It has around 200 patents and patents pending. By steering a tractor along a pre-defined path, it makes sure the application of seed or spray is even and no areas are missed or have a double application, thus improving productivity. In addition, farmers can supervise row cleaners and other equipment rather than concentrating on steering. The technology is sold directly to farmers through its Wheelman products, which are supplied as easy-to-install kits costing c US\$4k. The company also sells autosteering components to over 30 OEMs for fitting on new tractors and to VARs. This price point of its Wheelman product opens up the market so that smaller farms with between 10 and 1,000 acres can afford the technology. Management estimates this represents a market of around 10m farms globally and believes it is the only company to offer autosteering at this price point.



Anpario (ANP:LN)

Anpario develops, manufactures and distributes natural animal feed additives for animal health, nutrition and biosecurity. It was formed by the acquisition of three international companies between 2006 and 2012. Around one-third of its revenues are derived from organic acid supplements, typically based on formic and propionic acids, that are harmful to acidophobic bacteria such as salmonella and E. coli but do not affect beneficial bacteria such as lactobacilli and butyrivibrio, which help break down food. This leads to improved feed efficiency. With feed representing around 80% of costs for pig and poultry producers, adding Anpario's proprietary formulations of organic acid to feed gives on average a 5:1 return on investment for the producer.

Exhibit 7: Improving animal gut health video



Source: Anpario

Almost a third of Anpario's revenues are derived from phytogenic additives. These are natural antimicrobials based on oregano oil, which contains the active ingredient carvacrol. This supports animals' natural defence mechanisms and immune function, bringing a range of benefits, from heavier calves at weaning, more eggs per hen, bigger eggs and reduced morbidity in piglets. Almost a third of its revenues are derived from toxin binders that reduce the level of toxins produced by moulds found in animal feed. Anpario's proprietary powdered mineral carriers are fundamental to the delivery and efficacy of its products as they ensure steady release of the active ingredients throughout an animal's gastrointestinal tract.

Anpario's products are sold in over 80 countries worldwide through a combination of direct sales (c 30%) and distributors (c 70%). Anpario is highly operationally geared, with utilisation of its manufacturing plant in Worksop around only 40%, so c 20% of any incremental revenues would become additional operating profit. Management's goal is to generate average sales growth of 10% per year through developing new feed additives, higher penetration of the US market and intensified activity in dairy and aquaculture. Selected acquisitions to complement the product portfolio or enhance existing sales channels could also play a part.

CropLogic (CLI:AU)

CropLogic specialises in soil moisture management solutions. It was founded in 2010 to commercialise IP developed at the New Zealand Institute for Plant and Food Research. Its solutions provide actionable in-field information that is accurate, concise and easy to use. Its sensor probes continuously record soil moisture conditions across a farm. For a farm of a thousand acres it would be difficult to obtain this information by manually inspecting every part of each field. The data collected on soil moisture irrigation, rain events and evapotranspiration rate are analysed and presented in a mobile phone app or a dashboard on a desktop, enabling farmers to modify their irrigation strategies to optimise crop yields. CropLogic also supplies software displaying high-resolution infrared, vegetative index and normal colour aerial images of fields. This shows how healthy a crop is, supports the farmer's decision-making process and has been proven across a variety of crops including row crops, vines and orchard fruits.



In June 2017 CropLogic acquired Professional Ag Services, an agronomy services company headquartered in Washington State that also has clients in Idaho and Oregon. At the time of the acquisition, ProAg Services had 100,000 acres under management including 60,000 acres of high-margin, crops so the acquisition provided CropLogic with access to farmers in three key agricultural states. The migration of ProAg's clients from labour-intensive manual soil moisture reading processes to CropLogic's digital, remote and satellite connected soil moisture reading system continued over the year that ended March 2019. The number of CropLogic's in-field monitoring systems rose from 87 units in FY18 to 483 in FY19. CropLogic recently established a 500-acre cannabidiol (CBD) producing industrial hemp trial farm in Central Oregon. This initiative potentially enables the group to take advantage of high returns on this crop and positions it to be a first mover in providing agronomy and AgTech services to this emerging agricultural segment.

Eden Research (EDEN:LN)

Eden Research has developed a micro-encapsulation technology branded as Sustaine. This protects active material until it is required and provides a mechanism for slow release of the active material. The company is focused on biopesticides based on terpenes, which are naturally occurring chemicals produced by plants, for application to high-value crops such as grapevines. Management sees significant longer-term potential beyond these markets, for example in conventional pesticides and the animal health and consumer sectors.

The rate of product sales growth is directly linked to regulatory approvals. Until recently, Eden's product sales were based primarily on sales of its first product, a terpene-based fungicide for grapevines marketed under the brand name Mevalone in the southern European Union zone. In July 2019 the French authorities granted a 120-day 'emergency use' authorisation for Mevalone, for treating storage diseases in apples. This represents the first authorisation for the use of Mevalone in apples and for the treatment of post-harvest storage diseases. Apple producers can apply Mevalone immediately before harvest, unlike conventional pesticides where there must be a gap. Eden's second product, the nematicide formulation Cedroz, has received its initial approval from Malta, which acts on behalf of other European Union member states in this regard. Eden's commercial partner. Eastman Chemical Company, made the first commercial sales of Cedroz in May 2019 following emergency use authorisation in Italy for the treatment of nematodes on tomatoes and other crops. In October 2019 Cedroz received full authorisation for use in Belgium on a range of greenhouse crops, which is the first full approval by an European Union member state. Like Mevalone, Cedroz may be applied right up to harvest, if required. In January 2020, Eden announced a one-year exclusive evaluation agreement with Corteva for products using Sustaine for seed treatment applications.

Plant Health Care (PHC:LN)

Plant Health Care's business is driven by sales of Harpin α S, which is a patented biological product. Harpin proteins are produced naturally by many plant pathogens so many of the plants attacked by those pathogens have developed receptors on their seeds, roots or leaves that detect harpin and respond to its presence by growing more vigorously. Harpin α S may be applied to major field crops such as corn, soybeans, cotton and rice, as well as speciality crops such as fruits and vegetables. The use of Harpin α S to treat sugar cane in Brazil is increasing and should benefit from receipt in January 2020 of a licence to import unlimited amounts of Harpin α S into the country, while the launch into the 90m acre US corn market was well received, with c 0.35m acres treated in H119. The agreement with Wilbur Ellis for the distribution of Harpin α S for treating specialty crops in the US has already led to increased sales for those crops. Altogether, distribution agreements give Harpin α S access to crops grown on more than 70m acres. This success has encouraged the company to rebalance its resources to focus on accelerating the rate of profitable organic growth from sales of Harpin α S.





Exhibit 8: Using biologicals to elicit natural plant responses

Source: Plant Health Care

Despite this shift in focus, preparations for the launch of its first PREtec peptide are progressing to plan. PREtec peptides are proteins that induce resistance to pests and diseases, thus improving the tolerance of plants to drought or to accelerate root growth, resulting in higher yield. Plant Health Care's lead peptide product, PHC279 has recently been reported to provide an excellent yield increase in soybeans in Brazil. Reports also refer to promising results in soy and corn in the US, as well as in a range of other crops. Management estimates that the potential market for PREtec peptides is more than US\$5bn, with the first launches slated for 2021.

Agtech complementing existing activities

Most listed companies with an AgTech offering have either developed the capability in-house or acquired it to enhance their existing portfolio. Considering global giants, Bayer's (BAYN:GR) 2018 purchase of Monsanto augmented its digital agriculture offer with Monsanto's Climate Corp software for analysing weather, soil and field data as well as giving greater penetration of the seeds and genetically modified crops markets. Chemical company BASF's (BAS:GR) Xarvio software provides models predicting plant yield for different applications of plant protection products and fertiliser, enabling farmers to create seasonal planting plans, including detailed instructions for precise application of herbicides, thus optimising profit. BASF is working with privately held German multinational engineering and technology company Robert Bosch on a smart spraying system that can differentiate a weed from a crop plant and applies herbicides in a targeted manner. Deere & Co (DE:US), an American corporation that manufactures John Deere branded agricultural, construction and forestry machinery, has developed its own precision agriculture offer. Corteva (CTVA:US) also offers integrated and greatly expanded solutions that combine genetics, chemistry and precision agriculture. We profile four less well-known companies, BayWa, ForFarmers, Origin Enterprises and Wynnstay Group which have also enhanced their existing agricultural portfolio with AgTech solutions.

BayWa (BYW:GR)

Two-thirds of <u>BayWa's</u> revenues come from the trade of agricultural produce and equipment within Europe and globally. It also trades oil and lubricants in Germany and Austria, has an international renewable energy business focused on solar and wind farms and is a retailer of building materials in Germany. In 2015 BayWa acquired FarmFacts, an established developer of desktop or cloud-based digital farming solutions encompassing the entire agricultural value chain. The software is suitable for small and mid-sized farms, not just for large ones. The broad software portfolio provides products and packages from crop planning, fertilization, crop protection to harvesting as well as managing leases and organising workflows. Advanced functions for procurement of farm input, sourcing insurance and financing for crops will be implemented. Farmers using Next Field



functionality can download digital maps of the fields and overlay these positional data with information from soil samples, real-time data from in-field sensors and weather stations and current and historic data from satellite images to give a complete picture of what is happening at a sub-field level. This information is used to determine the optimal application of fertiliser for each part of a plot, ensuring fertiliser is not wasted on low-yielding areas, that high-yielding areas receive enough fertiliser and the total amount applied meets with German legislation. FarmFacts notes this module generates up to 22% cost-saving on fertiliser. The information is also used to control crop sowing, grassland care and irrigation. FarmFacts has partnered with six manufacturers of agricultural equipment (AGCO, Krone, Kuhn, Lemken, Pöttinger and Rauch) to ensure transferability of data between its farm management software and cultivation equipment, enabling, for example, precise application of fertiliser.



Exhibit 9: BayWa's digital farming solution video

Source: FarmFacts

In addition to the software, FarmFacts provides sensors, soil sampling and analysis, satellite imagery and drone services, agronomy advisory services and a mechanism for monetising carbon capture in the soil.

In 2016 BayWa formed what it believes was the first corporate Ag-Tech incubator in Europe that provides services and resources for selected high-potential start-ups. Companies supported during 2018 include UK based Crop Intellect and French based Vitirover Solutions. Crop Intellect has developed a proprietary product for increasing calcium absorption, thus resulting in stronger plant cell walls and better resistance to stress. Vitirover has developed a small solar-powered autonomous vehicle that controls weeds without using glyphosate.

Carr's Group (CARR:LN)

Carr's Agriculture division contributed 72% of group EBITA during FY19, the Engineering division 28%. The Agriculture division is increasingly focused on proprietary, high-margin products such as molasses-based feed blocks and a patented system of delivering mineral supplements via boluses. These improve livestock performance and thus farmers' profitability and are sold to farmers in the US, mainland Europe and New Zealand as well as the UK. These products raise margins overall, give scope for developing overseas markets and support long-term relationships with customers by providing a complete nutritional package for livestock based on advice from agronomists. Carr's flagship Crystalyx feedblocks work by stimulating an animal's rumen, helping it consume up to 15% more forage and to digest what it eats up to 10% more efficiently. Research conducted at



Aberystwyth University has confirmed that the improved animal performance when Crystalyx is fed leads to a reduction in methane output per kilogram of liveweight gain of almost 20%. In addition, growing heifers fed Crystalyx Cattle Booster while at grass reach bulling weight approximately six weeks earlier than control heifers fed on grass alone, further reducing their lifetime methane emissions.

ForFarmers (FFARM:NA)

ForFarmers is the largest producer of animal feed in Europe, serving farmers in the Netherlands, Germany, Belgium, Poland and the UK. It has adapted its portfolio of products and services for farmers to address many of the issues facing the industry, which we have reviewed earlier in this note. For example, it has developed a nutritional package called Feed2Milk, which uses software to predict how feeds and forage including new varieties of grass and maize and feeds are broken down in a dairy cow's rumen and intestine, helping the farmer and any supporting animal nutrition advisers put in place the most effective nutritional solution. Results from trials showed an average increase of 1.8 litres/cow/day, worth £14/cow/month. There was also an improvement in feed efficiency with an average 0.04kg/litre reduction in feed rate representing an average saving of £6/cow/month in feed costs. It is part of a consortium led by Wageningen University that is participating in a €8.5m European Union-funded programme lasting four years, which aims to replace part of the protein in animal feed with insect-derived protein by 2025. It is also developing feed solutions that help farmers use phosphate more efficiently, reducing the amount that ends up in the environment and is helping farmers measure and reduce their phosphate production at maximum milk production per cow by introducing a phosphate calculator. These initiatives are part of ForFarmers' Total Feed approach that offers a package of feed combined with advisory services to farmers improve their return on farm through healthy animals and greater work efficiency.

In 2018 ForFarmers launched Agroscoop in the UK. This data analysis and benchmarking tool for pig producers that was developed in association with Agrosoft, a company focused on writing software for the pig industry. Agroscoop gives pig producers, especially those with multi-site businesses, a greater understanding of current herd performance and highlights various potential areas for improvement. The ability to take remedial action rapidly is particularly important when producers are trying to reduce reliance on antibiotics. The tool is free for ForFarmers' customers, providing data that can be shared with ForFarmers' nutritional advisory team, enabling them to give better-informed guidance. The Total Feed approach promotes deployment of monitoring tools in all livestock sectors.

Origin Enterprises (OGN:ID)

Origin Enterprises is an agri-services group with over 2,500 staff across Ireland and the UK, where it is the largest supplier of crop protection products, seed and fertiliser in Poland, Romania, Ukraine, Belgium and Brazil. Around half of its revenues are attributable to business-to-business sales of crop nutrition and speciality inputs such as prescription-blended fertilisers. The other half is derived from the provision of independent and innovative advice, inputs and related services to arable, fruit and vegetable growers in the UK, Poland, Romania and Ukraine, which collectively have a total of over 12m hectares under cultivation. Advice is provided on optimising crop yield, quality and economic returns while ensuring environmental and regulatory compliance requirements are met.

This advice is supported by Origin's R&D team and 73 demonstration farms that develop customised crop production systems suitable for specific soil types and local climactic conditions. This agronomist-led advisory model is based on the premise of increasing yields on the existing agricultural land base while protecting biodiversity and the environment. This involves monitoring crops to observe the levels of both pests and beneficial species that can provide natural control mechanisms and using pest prediction models and economic thresholds to recommend



interventions. These include crop rotations, choice of crop variety, appropriate cultivation methods, target product dose rates and environmental biotechnology.



Exhibit 10: Improving farm productivity with precision agriculture

The Digital Agricultural Services segment complements the agronomy offering by providing improved data for the farmer and agronomist to discuss and act upon. In its simplest form, the system involves logging and automatically transferring geo-referenced field-walking observations to farm records through a phone or tablet with GPS and the specialist Contour app. Growers and their agronomists use the app to record and share information such as soil acidity from analysis of soil samples and pictures on areas of poor grass or crop growth, weed patches or pests. These records can be related to field performance yield maps to plan future improvements. Farmers opting for more services can add optical satellite imagery from every part of each field, which provides data on soil moisture levels, level of crop cover or presence of weeds in stubble; radar-based crop growth monitoring and yield predictions; weather-based local pest and disease modelling; access to a library of precision farming; and R&D data and sophisticated soil mapping tools. The technology is already in use on over 0.5m hectares in the UK alone, and over 1.0m hectares across Europe and Africa with a goal of 4.0m hectares by 2023.

Wynnstay Group (WYN:LN)

Wynnstay Group manufactures and supplies agricultural products to farmers and the wider rural community across the UK. Importantly, it provides inputs for arable farmers as well as livestock and poultry farmers. The group supplies product both direct to farms and through its own network of dedicated agricultural depots. One of the elements of Wynnstay's agtech offer is an electronic egg filled with sensors that mimics the route on a farm taken by freshly laid eggs, identifying where in the process eggs are subjected to forces that may potentially cause cracking and enabling the farmer to reduce the risk of cracking. This third-party device improves the return of poultry farmers by reducing the number of sub-standard eggs that are sold at substantially reduced margins. Wynnstay provides the technology as a package including feed and advisory services for poultry producers.

Another element of the offer is high-sugar grass. The high sugar content of the forage means there is an increase in microbial activity within an animal's rumen, allowing it to absorb more protein. This

Source: Origin Enterprises



means that livestock emit less methane and excrete less nitrogen. The high sugar grass varieties are bred by a third party. The majority of the seed Wynnstay sells is grown on farms in Herefordshire and processed at its seed processing plant in Shropshire. In addition, Wynnstay can customise the amount of protein in dairy feed to take into account the amount of protein obtained from forage. This typically enables the amount of protein in feed to be reduced, cutting out excess protein that would be excreted and add to nitrogen related pollution.

AgTech one of many sectors served

Our final section includes those companies whose technology is deployed engaged in many sectors, one of which is AgTech. We profile four companies, Evogene, Koninklijke DSM, Nynomic and Stemmer Imaging, each of which serves many different sectors in addition to AgTech.

Evogene (EVGN:US)

Evogene uses computational biotechnology to develop novel products for life science-based industries, focusing on human health, agriculture and industrial applications. These products are based on its innovative Computational Predictive Biology (CPB) platform, which reduces the time and cost of life science product development and, importantly, increases the probability of a successful outcome. The CPB platform is being used to develop novel product pipelines, both independently and with partners, for human microbiome-based therapeutics, medical cannabis, agbiologicals, ag-chemicals, seed traits and ag-solutions for castor oil production. Evogene has established a corporate structure in which each market area is organised as a separate subsidiary or division with clear business targets, with the CPB platform providing a key technological differentiator. The group has three businesses operating in the agricultural sector:

- AgPlenus: development of novel herbicides and insecticides;
- Lavie-bio: bio-stimulants and bio-pesticides; and
- Ag-Seeds: focus on insect control seed traits, yield and abiotic stress and disease resistance seed traits.

Exhibit 11: Executive interview with Lavie Bio



Source: Edison Investment Research

Koninklijke DSM (DSM:NA)

This Dutch multinational's products include non-artificial sweetener ingredients, yeasts that improve ethanol yield when manufacturing biofuels and adhesives for manufacturing recyclable carpet. It offers a comprehensive range of science-based animal nutrition solutions that are based on a very broad portfolio of nutritional ingredients including vitamins, enzymes, eubiotics, carotenoids, lipids and minerals. These nutritional ingredients improve animal health and enable farmers to abandon the use of antibiotic growth promotors. DSM's products also reduce the environmental impact of



farming, primarily because fewer resources are needed to produce the same amount of animal protein.

In addition, DSM has developed a <u>feed additive</u> for cows and other ruminants that suppresses the enzyme triggering methane production in a cow's rumen and consistently reduces enteric methane emissions by approximately 30%. It has developed eubiotics for the swine industry, which reduce emissions of ammonia. It has also developed an additive that improves the digestibility of protein in broiler diets. This enables the crude protein content of the diet to be reduced by up to 8% while maintaining growth performance. This additive has a beneficial impact on crop land use and results in lower ammonia production and a 35% reduction in the nitrogen content of manure, which means that less land is required to dispose of the manure. For farmers raising broilers in the Netherlands, where strict environmental regulations regarding nitrate pollution are in force, using the additive enables them to raise output by about 5% without increasing the land use for manure application.

Nynomic (M7U:GR)

Nynomic is an integrated provider of photonics solutions based on a common technology platform. It uses non-contact optical technology to create customised systems for OEMs, which are deployed in the clean tech, green tech and life science sectors.

Exhibit 12: Using non-contact measurement to determine ripeness

Exhibit 13: Using optical sensors to determine the nitrogen nutrient content of soils



Source: Spectral Engines

Source: Spectral Engines

The group's AgTech offering was significantly strengthened in August 2019 through the acquisition of the business operations of LemnaTec, a specialist in the development of hardware and software systems for automated, high-throughput digital plant phenotyping. LemnaTec's systems use non-invasive, contact-free sensors to measure external characteristics such as the size, shape and colour of plants to determine in real time how quickly their shoots or roots are growing. The systems also record physiological parameters such as the water and nutrient content of the leaves or photosynthesis rates. This information is used to breed new variants of plants that are adaptable to climate change, particularly to drought and extreme weather conditions. The systems can be deployed in open fields and greenhouses as well as in the laboratory and are used by corporations such as BASF, Bayer Crop Science and Corteva, as well as international research institutions and universities. LemnaTec also provides analytical methods for detecting plant diseases and infestation by insects and other pests. Its solutions for digital seed testing are used in the seed industry and by gene banks to determine germination rate, germination quality and seed quality.

In November 2019 the group's Finnish subsidiary, Spectral Engines, launched a hand-held consumer device for real-time non-contact measurement of the tetrahydrocannabinol and CBD levels in hemp and cannabis. The handheld device transmits the spectral data to the cloud where it



processed using artificial intelligence algorithms and the results are displayed on the user's smartphone. The handheld device is based on a micro-electro-mechanical systems sensor designed in-house. This solution for consumer applications will potentially be adapted by other companies within the group to equip other steps in the production chain with identical measurement technology and data evaluation, eliminating time-consuming laboratory tests.

Stemmer Imaging (S9I:GR)

Stemmer Imaging is Europe's leading independent provider of machine vision technology solutions to science and industry, selling both directly and indirectly, via system integrators or OEMs. The company has been working closely with a number of fresh produce growers on development projects aimed at automating produce harvesting. These combine and adapt existing robot and 2D and 3D vision technologies to harvest just the part of the crop that meets supermarket criteria, saving on subsequent sorting. Importantly, the vision system also generates size and shape data on the crop that is not harvested so the grower can combine that with short-term weather forecasts to see if more of the remaining crop is likely to ripen sufficiently in the coming weeks to meet the criteria, thus reducing waste. The vision system handles natural variations in the size and shape of fruit and vegetables through Stemmer Imaging's CVB Manto software. This is an advanced pattern recognition tool that uses a neural technology to learn how to identify the patterns of interest from a set of training images, then makes a classification choice for each inspection image it receives and calculates a confidence factor for the classification.



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