The impact of emerging technologies on agriculture

Recent trends
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How to use this report
The report highlights a number of recent trends pertaining to the impact of emerging technologies on agriculture. The primary focus is to provide technology intelligence and decision support regarding the impact and risks – be they opportunities or threats – that emerging technologies and the dynamics of technological change present.

The report consists of two sections, viz.
- The **Executive Summary** briefly discusses the strategic business impact of emerging technologies and dynamics of technological change together with the associated risks, opportunities and threats they present to the agricultural sector and the individual farmer.
- The **Appendix** contains references to recent news articles and feeds, primarily published circa during the last year, emphasising more recent publications.
  - On the one hand, the referenced articles indicate recent trends and developments of real technologies and innovations. The challenge here is to assess their future trajectories and impact.
  - On the other hand, the references to articles are examples of *signals*. An assessment of the strategic risks presented by emerging technologies and the dynamics of technological change requires the search for and interpretation of *signals* which announce the presence and emergence of relevant technologies. These signals are not always obvious, they typically originate from very diverse and different sectors and are often buried in the noise.

This document is **best viewed electronically** when downloaded into a pdf reader on a computer, tablet or smartphone, which enables the hyperlinks to be clicked to gain access to the references and to navigate different sections in the document.

Entries in the report are listed only once, even though they may be relevant to more than one category. The sources cited in this report were active on the date of compilation (March 2019).

Views in the articles referenced are those of the authors (or as stated in the articles), and are not necessarily supported by DeltaHedron. References are to open source articles, generally excluding peer-reviewed and academic journals as well as commercial market survey reports. The content of this document is for general information purposes only and should not be used as a substitute for consultation with professional advisors. Reasonable professional care has been taken in collecting and reporting of the information, but the information in the articles has not been independently verified, validated or audited to verify accuracy or completeness. Mention of specific companies, products or brands does not in any way indicate endorsement. None of the vendors were contacted, nor did any contribute financially or otherwise to this report.

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Scope of this report

This report focuses on the strategic business impact and risks – be they opportunities or threats – presented by emerging technologies to agriculture.

The report is divided into two sections, viz.

- **The Executive Summary** presents a broad context and frames the notion of the strategic business impact and risks presented by emerging technologies and the dynamics of technological change. The point is made that opportunities and risks are two sides of the same coin.

- **The Appendix** contains references to recent news articles, primarily published circa during the last year (with an emphasis on more recent publications), pertaining to a broad range of technology-related aspects relating to agriculture.
  
  o On the one hand, the referenced articles indicate recent trends and developments of real technologies and innovations. The challenge here is to assess their future trajectories and impact.
  
  o On the other hand, the references to articles are examples of *signals*. An assessment of the strategic risks presented by emerging technologies and the dynamics of technological change requires the search for and interpretation of *signals* which announce the presence and emergence of relevant technologies. These signals are not always obvious, they typically originate from very diverse and different sectors and are often buried in the noise.

The intention of this format is to:

- Alert readers to current trends in relevant technologies and their applications.

- From a technology foresighting viewpoint, the references should also be considered as "signals". The challenge is to determine what the signals are trying to tell us.

It is also important to keep in mind that the nature of the evolution and advancement of technologies and the products which they underpin, are dynamic in nature – everything continuously changes with time. Technologies, both emerging and mature, also continuously interact with one another. Sometimes this happens in a synergistic manner, sometimes in a competitive manner and sometimes in a predator-prey mode. All the while, these modes of interaction themselves also change. This in turn influences, and is influenced by, the adoption and substitution patterns of the technologies.

A 'list of technologies' and applications as set out described in the Appendix of this document can hence not be comprehensive nor "timeless". On the one hand the landscape of relevant technologies, even those considered to be emerging technologies, is just too vast. One the other hand, the technologies are also continuously evolving. Even the list in the Appendix of this report will be outdated in the not too distant future.

It is appreciated that this notion complicates the nature of strategic choices and decisions that a company will need to make - but such is the nature of the dynamics of technological change. It is, however, useful to address the matter from a viewpoint of the development and implementation of a "strategic innovation strategy", rather than merely picking "winners and losers" from "today's list" of emerging technologies.

Executive Summary

All companies rely on technology in one way or another to conduct their business, and so do their customers, suppliers, partners and competitors. This is certainly true for agriculture. It is also true that technologies continue to change and evolve – some at a gentle incremental pace and others swiftly and more radically. Emerging technologies also have the ability to completely disrupt not only companies (and farms), but entire industries. The dynamics of technological change have a strategic business impact on organisations and their sectors, including the agricultural sector.

The impact of emerging technologies should be considered and managed as strategic risk, presented as either opportunities and threats – often two sides of the same coin. Those who proactively pursue the opportunities can reap great benefits, whereas the laggards who don't are known to follow their obsolete technologies into obsolescence.
A range of emerging technologies, often in combination with others, are disrupting many sectors. Some refer to this as the Fourth Industrial Revolution and Industry 2.0. Irrespective of the nomenclature, the ‘wave of creative destruction’ (as significant technological innovation is rightly known) is having a major impact on the entire agricultural value chain. On a macro level, emerging technologies are contributing towards better food security, safety and distribution, and combatting food waste and fraud.

Many of the emerging technologies which are impacting on agriculture are also contributors to broader digital transformation, such as artificial intelligence (AI) and machine learning, the cloud, analytics and big data. Others are fuelled by digital advances, including blockchain and cryptocurrencies, augmented and virtual reality as well as 3D printing, robotics and drones, the internet of things (IoT) and sensors, renewable energy, automation and mechanisation. At the same time significant advances are also being made in biotechnology (including gene technologies), and are enabling more resilient crops and enhancing animal health.

The notion of ‘smart’ is becoming ubiquitous. In essence, it implies that the technology or product inherently has the ability to learn, adapt and make decisions. We are all familiar with smartphones. The same concept is applied to the entire gambit of emerging technologies and their applications. This includes smart homes, smart cities and also smart farms.

Farmers not only engage with markets, the demand for their products, legislation and often political influences, but also the weather, climate and environment. Mother Nature can be a great ally, but also a formidable foe. A number of emerging technologies are helping farmers to exploit and mitigate these opportunities and threats. Earth observation and remote sensing by satellites and drones, comprehensive mobile coverage and access to information and intelligence are now within the grasp of individual farmers.

This report presents a broad view of advances in a range of emerging technologies which all have a strategic impact on agriculture. The appendix contains references to recent articles which report on a wide spectrum of emerging technologies and their applications. The challenge for the reader is to consider to what extend they will be relevant to the farm of the future, what risks are present, be they opportunities or threats, and what the impact can/will be.

The news articles should be interpreted as ‘signals’, however faint and non-obvious (at the moment) of how the future can unfold. It is not something that can be ignored. Instead it should be embraced and proactively acted upon by pursuing the opportunities, rather than reactively and belatedly reacting to the threats. Knowing what the future may hold is one thing. Knowing what to do about it, and particularly what to do next, is quite another.
Appendix

"The signals"

This section contains references to recent articles which report on a wide range of emerging technologies, their applications and related issues. The challenge is to consider to what extend they will be relevant to the company in the future and what the impact may be. What are the risks they present, whether opportunities or threats? And what do we do about that?

1. 3D printing and synthetic food

- **3D printing snacks from food waste**
  (Source: 3Ders, 20 Feb 2019)
  "A young entrepreneur in the Netherlands is reducing food waste with 3D printed food. Nearly a third of all food produced around the world goes to waste, and yet people still go hungry. Causing much of this huge amount of waste are the obstacles of food preservation and freshness"

- **‘Lab meat’ closer to supermarkets as us regulators outline oversight**
  (Source: New York Post, 8 Mar 2019)
  "Burgers made by growing cow cells in a lab dish have a clearer path to reaching supermarkets as US regulators outlined how the emerging food category will be monitored"

- **3D printing food: Lab creates 3D food printer that cooks its prints with a laser**
  (Source: 3Ders, 31 Dec 2018)
  "A researcher out of Columbia University created a 3D food printer that cooks its food with a laser. 3D printed food is spreading quickly, but most printed food objects have to go in an oven after they come out of the 3D printer to be cooked"

- **A look at the who, what, how and why of 3D printed food**
  (Source: 3D Print, 28 Aug 2018)
  "3D printed food is still seen as something of a novelty, a way to make candy and other food substances into fun and customized shapes. There are more serious applications of the technology, however, such as creating foods that are easier to eat for people with difficulty swallowing, as well as safer food preparation for people with allergies. There is also a great deal of interest in using 3D printing to create food for astronauts. In a paper entitled “Strategy in 3D Printing of Food,” a group of researchers takes a look at 3D printed food and its various methods and purposes"

- **From printer to pan, 3D printing is being used to make vegan steaks**
  (Source: CBS, 1 Mar 2019)
  "A Spanish company is using 3D printing to create fake steak. NovaMeat, headquartered in Barcelona, uses a 3D printer as its sous-chef. The printer works meticulously to prepare the vegan meat in under 10 minutes. It’s printed with the same texture and appearance as a normal piece of beef"

- **Inside Beyond Meat’s innovative future food lab**
  (Source: Fast Company, 19 Jul 2018)
  "The meat substitute burger company’s diverse R&D team of tech, health, and chem experts want to make Beyond Meat products taste like the real thing"

- **New bio-degradable Growlay 3D printing filament for indoor farming**
  (Source: 3Ders, 2 Jul 2018)
  "The Growlay filament can be used for indoor farming. Layers of Growlay can produce organic structures like small hills and landscapes. Add some water, seeds, or spores of any kind of plant and they will grow on the filament. The key point here with Growlay is the micro-capillary nature of the layered thermoplastic material. You can also grow precious mold cheese in the complex layers of Growlay’s organic-like micro-tunnels"
• Lab creates 3D food printer that cooks its prints with a laser
(Source: 3Ders, 31 Dec 2018)
"A researcher out of Columbia University created a 3D food printer that cooks its food with a laser. 3D printed food is spreading quickly, but most printed food objects have to go in an oven after they come out of the 3D printer to be cooked"

• Lab-grown ‘milk’ worries dairy industry
(Source: Food Processing, 28 Feb 2019)
"The dairy industry, already beset by plant-based milks, may soon have another competitor to worry about: milk produced in a lab"

• Lab-grown meat could be worse for the environment than beef
(Source: MIT Technology Review)
"Lab-grown meat may do more lasting damage to the environment than beef, according to a new study. High impact: Proponents of lab-grown meat say it could one day supplant livestock—particularly cattle, a huge source of greenhouse-gas emissions"

• New start-up is selling the building blocks of fake meat
(Source: Futurism, 1 Mar 2019)
"A Ginkgo Bioworks-owned start-up called Motif Ingredients says that making the building blocks of meat alternatives available to innovators will free them from hard lab work and empower them to dream up the dishes of the future"

• New tech allows operator to change tillage on fly
(Source: Farm Progress, 15 Feb 2019)
"A tillage tool that you can adjust on the go is a big advantage when you are trying to reduce equipment, fuel and labour costs and better manage crop residue"

• New tech can 3D print your food
(Source: DNA India, 27 Apr 2018)
"Scientists have developed a new technique to 3D print food that can allow users to cook according to their preferences. 3D printing of food works much like 3D printing of other materials in that layers of raw material are deposited to build up a final product. In addition to offering customised food options, the ability to 3D print food at home or on an industrial scale could greatly reduce food waste and the cost involved with storage and transportation"

• Oceanz and cooperative door partner to stop food waste with 3D printed vegetables
(Source: 3D Print, 5 Jul 2018)
"There’s been plenty of research conducted, especially in the Netherlands, in terms of 3D printing food, and we’ve seen several 3D printed delectable dishes and desserts like chocolate, popsicles, hummus, pizza, pancakes, and even gluten-free offerings. It’s even possible to create personalized food by adding flavours and nutrients based on people’s physical condition, taste preferences, DNA profile, and phase of life, and 3D print meat alternatives based on sustainable, plant-based materials"

• Researchers produce high quality cannabis at low cost in lab
(Source: Interesting Engineering, 1 Mar 2019)
"Scientists have successfully created the properties of cannabis without growing the plant. Medical use of marijuana is becoming widely accepted as an effective treatment tool for a range of conditions from anxiety to epilepsy. However, the extraction of the cannabinoids is an expensive process and growing the marijuana plants can be environmentally problematic. Scientists from the University of Berkeley have now used simple brewer’s yeast to produce marijuana’s main ingredients, the powerful THC and non-psychoactive CBD. They also created novel cannabinoids not found in the plant itself"
• South Africa’s first food 3D printer turns ugly produce into attractive nutrition
(Source: 3D Print, 8 Jun 2018)
"Think about the last time you went to the grocery store. How did you select your produce? Did you go for the fruit and vegetables that were the nicest-looking, eschewing the pieces with spots or lumps or odd shapes? That’s what many people do – it’s been shown that most shoppers tend to avoid the “ugly” fruits and vegetables, thinking that better-looking foods are better overall. That’s not only untrue, it’s led to a tremendous amount of food waste, as unattractive produce is left on the shelf until it goes bad"

• South African mechanical engineering student creates 3D printer for improving farm and produce quality
(Source: 3D Print, 5 Mar 2019)
"Students in South Africa recently had a chance to enrich their minds through learning more about progressive technology, along with helping push farming in nearby regions further into the future with 3D printing"

• The effects of various additives on 3D printed potatoes
(Source: 3D Print, 24 Jan 2019)
"Potato starch is unique among other starches in that it has large granules and high swelling power thanks to the presence of a high level of phosphate groups that are covalently linked to the C6 and C3 positions of the glucose monomers. Potatoes can be modified in various ways through cooking and the addition of other ingredients, creating various textures and consistencies"

• This biotech start-up is growing vegan pet food in a lab
(Source: Fast Company, 9 Mar 2019)
"While other Silicon Valley start-ups grow chicken from animal cells for future use in chicken nuggets, one Berkeley-based biotech start-up has been experimenting with bioreactor-grown meat for a different audience: mouse treats for cats. The start-up, called Wild Earth, wants to provide sustainable, cruelty-free, and healthy options for pet food at a time when some other brands use animal byproducts and have faced recalls for problems like dog food laced with pentobarbital, a euthanasia drug. It already makes and sells dog treats made from cultured fungi protein. The founders saw an opening for pet food in the growing cellular agriculture sector"

2. Africa – Agricultural, food and developmental issues

• A look at how Africa is tackling foodborne illness
(Source: Deutsche Welle, 6 Feb 2019)
"Contaminated food poses a major health and economic threat to sub-Saharan Africa. While efforts are taken to provide safe food for exports, governments are rejigging the system to do more for domestic markets"

• Africa could be importing $100 billion worth of food in the next 10 years, African Development Bank Vice-President of Agriculture says
(Source: Pulse, 9 Dec 2018)
"African economies are importing net about $35 billion per year of food and that’s going to go up to over $100 billion in the next decade if nothing changes"

• Africa: For a healthier planet and people, we must fix our broken food system
(Source: All Africa, 6 Feb 2019)
"Food is not only the most fundamental of human needs, but also one of the closest connections humans have with the natural environment. Along with the air we breathe and the water we drink, the food we eat is also a leading driver of public health. An immense challenge before us is to provide a growing world population – one that will reach 10 billion by mid-century – with healthy diets from food systems that don’t destroy the planet"
• Africa’s food fraud problem is immense - but we can help  
(Source: The Grocer, 6 Sep 2018)
"Recently, quite a lot of my attention has been focused on the integrity of the food consumed by over 1.2 billion people – and one group of nearly 900 million of them in particular. Where is this? Africa, and particularly sub-Saharan Africa. My interest started with a number of research projects that looked at the levels of contaminated cereals consumed in Somalia and Nigeria. In terms of Somalia, we looked at a range of foods available in the markets of the capital Mogadishu. The results that we produced were quite shocking, even for a country that has been plagued with civil war for several decades. We calculated the risk of developing primary liver cancer just from the consumption of maize was 10 times higher in Somalia than in Europe due to the presence of huge levels of mycotoxins"

• African governments are using technology to get young people interested in farming  
"Donors and African governments hope such tools could also lure youth to farming as the continent struggles with rising hunger, unemployment and migration. Africa has the world’s youngest population – 60% of its 1.2 billion people are under 25 - but only 3 million jobs are created for some 12 million young people who enter the workforce each year according to the African Development Bank"

• African youth decry poor access to agri-business loans  
(Source: EnviroNews Nigeria, 21 Aug 2018)
"Poor access to agricultural loans has become a big challenge to our agricultural businesses due to high interest bank rates and demands for collaterals from financial institutions" said the founder of Rwanda-based Gashora Farm Ltd, a chilli pepper processing company"

• Agrofood economy holds key to a brighter future for young people in developing countries, says new OECD development centre study  
(Source: OECD, 4 Apr 2018)
"Today’s world youth population -aged 10 to 24- is 1.8 billion people strong and represents the largest cohort ever transitioning to adulthood. Eighty-eight% of them live in developing countries. With the right policies in place, they can be influential actors of economic and social progress. Conversely, failing to improve their prospects, in particular for the most disadvantaged, could make the global youth bulge a brake for economic and social development "

• Developing the next horizon of growth in Africa  
(Source: McKinsey, Jan 2019)
"The President of the African Development Bank, discusses the potential for agricultural industrialization, energy inclusion, and infrastructure upgrade to drive prosperity growth"

• Ethiopia teff flour patent not Dutch invention, court rules  
(Source: Quartz, 7 Feb 2019)
"A legal tussle over who owns teff, Ethiopia’s staple grain, has been quietly settled. A three-judge court in the Netherlands ruled a European patent for the products made of teff lacked “inventiveness,” ending a years-long controversy over who owned the ancient grain. The controversial patent, which was originally filed in 2003, a listed Dutchman as the inventor of the teff flour that’s used to make injera flatbread and other traditional Ethiopian food. The Ethiopian embassy in the Netherlands confirmed the ruling, which was first filed in June 2014 and whose verdict was delivered in November"

• Kenyan dryland farmers use new farming method to beat climate change stress  
(Source: Iol, 12 Feb 2019)
"The hand-driven machine moves slowly on the one-acre farm in Machakos to the southeast of Kenya’s capital Nairobi, barely ripping the soil"
• Kenyan farmers trust tradition over tech to predict the weather
  (Source: All Africa, 11 Feb 2019)
  "Many farmers across the country, still uses traditional weather forecasting techniques to decide
  what to plant and when"

• Load shedding in South Africa: How food prices will increase if power cuts continue
  (Source: The South African, 13 Feb 2019)
  "With a severe schedule of load shedding gripping South Africa, attention has quickly turned to the
  long-term damage Eskom’s rolling blackouts will cause. We’ve already weighed up the financial
  implications of these power outages, and it now seems like food prices will take a battering in the
  near future"

• Made in Africa organic chocolate start-up makes its farmers shareholders
  (Source: Food Navigator, 17 Dec 2018)
  "Not only is Fairaf ric the first organic chocolate bar that is manufactured and packed in Ghana, it
  has begun making its cocoa farmers brand co-owners by buying them shares in the company"

• Medium-scale farms are on the rise in Africa - why this is good news
  (Source: The South African, 17 Dec 2018)
  "Over time farms are getting smaller and smaller. Today, over 80% of farms in relatively densely
  populated countries – like Kenya, Ethiopia, Malawi and Rwanda are smaller than one hectare.
  Because they’re so small, few can generate enough income to keep farmers above the poverty line
  and most of them increasingly rely on off-farm incomes"

• Republic of Congo takes unprecedented decision on large-scale agriculture in forest areas
  "WWF has welcomed the decision by the government of the Republic of Congo to regulate the
  opening up of new plantations in the forested areas of the country. According to a Ministerial order
  signed by Congo’s Minister of Agriculture, Fisheries and Animal Husbandry and the Minister of Land
  Tenure in charge of Relations with the National Assembly, all large scale agricultural activities
  beyond five hectares should be oriented to the savannah areas of the country"

• Tanzania: Agro processing
  (Source: Export.gov, 29 Jan 2019)
  "This is a best prospect industry sector for this country. Includes a market overview and trade data.
  Agriculture is a critical economic sector, representing 29.1% of Tanzania’s Gross Domestic Product
  (GDP) and almost three quarters of the productive workforce. Moreover, it is the main source of
  food, industrial raw materials and foreign exchange earnings"

• This farm just got off Eskom’s grid using a floating solar plant
  (Source: Business Tech, 4 Mar 2019)
  "Marlenique, a fruit farm and wedding venue outside of Franschhoek in the Western Cape has
  unveiled a state of the art floating solar PV system. Installed by New South Energy on the farm’s
  dam, the system is the first commercially operated floating solar system on the continent and is
  also the largest – producing 60kW of power. The first phase of the project, which also includes a
  land-based solar installation on the farm, will allow the farm to run 90% of its energy-intensive cold
  storage, irrigation and wedding venue facilities off of the traditional electricity grid. A second
  phase will see the installation of battery packs, taking the farm off the national grid completely"

• Winning in Africa’s agricultural market
  (Source: McKinsey, 16 Feb 2019)
  "Private-sector companies can find practical solutions to enter and grow in Africa’s agricultural
  market. Agriculture in Africa has a massive social and economic footprint. More than 60% of the
  population of sub-Saharan Africa is smallholder farmers, and about 23% of sub-Saharan Africa’s
  GDP comes from agriculture"
• World Bank to invest $95 million for agricultural transformation in Malawi
(Source: Ventures Africa, 31 Jan 2019)
"The World Bank has earmarked a sum of $95 million to fund the Agricultural Commercialization (AGCOM) Project in Malawi over the next six years. The initiative is aimed at transforming the agriculture sector into a highly productive commercial division. The overall objective of AGCOM for Malawi is to increase commercialization of agriculture value chain products and is targeted at livestock, aquaculture, and small and medium crop farmers that are in cooperatives to ensure sustained commercialization"

• Zimbabwe: Farmers secure land and food thanks to ‘eyes in the skies’
(Source: All Africa, 11 Feb 2019)
"She had an idea to help farmers, particularly women, obtain proof of land ownership that they could use as collateral to access credit. It was a smart solution: using geographical information system (GIS) technology to generate useful information for farmers"

3. Agricultural machinery and equipment, and mechanisation

• Boosting farm productivity in Africa through the sustainable use of machines
(Source: Africa Newsroom, 5 Oct 2018)
"The UN Food and Agricultural Organization and the African Union launched a new framework document that aims to increase agricultural efficiency and reduce drudgery by helping countries in Africa to develop strategies for sustainable farm mechanization"

• Drive your tractor with a tablet
(Source: Agriland, 26 Oct 2018)
"Production versions of ‘autonomous’ tractors from Yanmar are due to hit the market shortly. Advanced technology is central to the company’s new 2-Series models. These units have been dubbed ‘Robot Tractors’ by the manufacturer"

• Fully electric Swiss tractor is now a reality
(Source: Agriland, 15 Jan 2019)
"Rigitarac recently launched a new electric tractor – namely the SKE 50. Rated power output is 50kW (68hp). The tractor runs off an 80kWh lithium-ion battery"

• Why Indian tractors sell better than Chinese ones in Africa?
(Source: Global Times, 20 Jan 2019)
"A Chinese businessman who has been trading Chinese manufactured agricultural machinery in Africa for almost 20 years, always sees his Indian counterparts as strong competitors in local market"

• Working together for the sustainable mechanization of farming in Africa
(Source: Food and Agriculture Organisation of the UN)
"FAO and the African Conservation Tillage Network sign a collaboration agreement 7 February 2019, Rome – The Food and Agriculture Organization of the United Nations (FAO) and the African Conservation Tillage (ACT) Network today signed a Memorandum of Understanding to encourage greater access for small-scale farmers to sustainable farm mechanization, such as two-wheeled tractors and other labour-saving machines"

4. AgriTech and FoodTech

• 5 disruptive foodtech start-ups that have changed the food industry in Europe
(Source: Silicon Canals, 4 Feb 2019)
"This article will take you 5 minute(s) to read From fintech to legaltech to food tech, the innovation flows freely in every industry, thanks to technology. The food industry is one of the untapped markets and is now ripe for disruption"
• **Agtech and animal health trends to watch**  
  (Source: Forbes, 14 Feb 2019)  
  "From a polarizing EU court decision to the mainstreaming of the cannabis market, Agtech and animal health are in a constant state of change. Don’t look for that to slow down in the coming year, as evolving global regulations, major industrial consolidation and new online marketplaces continue to grab headlines and influence behaviours. If anything, look for continued acceleration in the pace of change with the creation of expansive new opportunities for investment and innovation"

• **Agtech is not going to be a road to riches**  
  (Source: Stuff, 12 Feb 2019)  
  "No doubt, technology will change how agriculture is conducted. Just as it is changing all aspects of our lives. But that doesn’t mean you can actually make any money out of developing some fancy technology solution for farmers"

• **Farmcrowdy agritech helps small scale farmers in Nigeria**  
  (Source: Tech in Africa, Feb 2018)  
  "Farmcrowdy agritech is a Nigerian based start-up that aims at connecting small-scale farmers to investors. The sponsors can be both local and international who invest in farm cycle. Launched more than one year back, it connects farmers who deal with anything in poultry or cassava. Poultry products take 3-5 months while cassava takes nine months for maturity. Farmers on the ground receive advice and training from agriculture experts. Training and advice on the best agricultural practices are important. Also, different types of crops and production methods are needed. After the harvest, both farmers and sponsors receive a certain percentage of profit"

• **Forget software bugs, this start-up is focused on insects that could change the agriculture industry**  
  (Source: Geek Wire, 23 Nov 2018)  
  "Some of the most intriguing farming in Washington is taking place not among the valleys or rolling hills of the eastern part of the state. It’s happening indoors, in an industrial area of the city of SeaTac, south of Seattle"

• **How agtech is disrupting African farming**  
  (Source: Digital Journal, 28 Jul 2018)  
  "How agtech is disrupting African farming. Agtech offers new solution for farming, centred on improving efficiency with new technology. This is most notable across Africa. A new report has identified two agritech start-ups continent-wide. A new report comes from Disrupt Africa, and it looks at the impact of agtech on the continent, considering connected technology and data driven solutions designed to improve productivity and to protect crops from wildlife, pests and variations to climate. The data driven approach signals that farming is no longer just about big, steel machines and farmers’ intuition"

• **The 25 most innovative agtech start-ups in 2018**  
  (Source: Forbes, 27 Jun 2018)  
  "The problems facing America’s farmers in 2018 are as diverse as their crop varieties: Labour shortages. Soil health. Food spoilage. Trade wars. Lack of access to data on seed pricing, yield information, and even commodity forecasting. The good news? There is a veritable army of technologists and entrepreneurs working hard to solve these issues—and an army of investors seeking to fund them. In 2017 alone, ag-tech funding through investment or acquisition increased 32% to $2.6 billion, and half of the top 20 deals in the space exceeded $50 million. One of the year’s highlights included the multi-billion-dollar multinational DowDuPont’s acquisition of software start-up Granular for $300 million"

• **Uganda leads the way in agritech innovation to change lives**  
  (Source: Ventures Africa, Oct 2018)  
  "With the advent of digitization, the world continues to witness a paradigm shift to a future powered by technology, and Africa isn’t left out. One of these innovative changes is the use of..."
technology to transform agriculture across the continent, an idea that has birth a renewed interest in Africa’s agricultural sector

• Why farmers should work with agtech start-up companies
(Source: Brownfield Ag News, 7 Mar 2019)
"Whether you’re a laggard or on the bleeding edge of technology, an Illinois farmer says it is important for farmers to work with ag tech start-up companies. “It’s more about helping direct start-ups in the right direction as soon as they have a product that is commercially available. Go back out to start-ups and say ‘Is there a need?’ or ‘Do they have farmers involved?’.” Ken has farmed corn and soybeans west of Champaign, Illinois for 40 years. He tells Brownfield advice for farmers wanting to get involved with modern technology. “You know, the technology is proven. Go slowly, spend money wisely. It will help improve the efficiency and profitability of their operation.”"

5. Animal farming and livestock

• Big meat and dairy are heating up our planet
(Source: Resilience, 26 Jul 2018)
"What do Smithfield, Tyson and Cargill have in common? Besides being three of the largest meat producers in the United States and the world, each of them has committed to reducing its climate footprint. But are they? Who is monitoring these companies to hold them accountable?"

• Bill Gates warns of the dangers of cow farts and climate change
(Source: Business Insider, 12 Feb 2019)
"Bill Gates has a $1 billion fund, collected from a who’s who of fellow billionaires, ready to invest in start-ups and research to solve climate change. , in his annual letter with his wife, Melinda, he said that fixing climate change involves way more than renewable electric energy, though he’s encouraged by progress there. Manufacturing and agriculture are overlooked problem areas, he said. He’s looking for climate-friendly ways to make concrete and steel, as well as ideas on dealing with methane produced by cows “when they belch and pass gas.”"

• Can we end animal farming by the end of the century?
(Source: Fast Company, 6 Nov 2018)
"By 2050, more than half of meat, dairy, and eggs in high-income countries could be animal-free"

• Cargill brings facial recognition capability to farmers through strategic equity investment
(Source: Cargill, 31 Jan 2018)
"Cargill and Cainthus, a Dublin-based machine vision company, are reshaping how animal producers make decisions for their livestock through a strategic partnership that will bring facial recognition technology to dairy farms across the world"

• Changes in agriculture could cut sector non-carbon dioxide greenhouse gas emissions
(Source: Manufacturing)
"The agricultural sector is the world’s largest source of non-CO2 greenhouse gas emissions, and IIASA-led research has found that changing agricultural practices and a shift in diet away from meat and dairy products could reduce the sector’s emissions by up to 50% by 2050, compared to a situation without mitigation efforts"

• Climate change: Pledge to cut emissions from dairy farms
(Source: BBC, 11 Mar 2019)
"A dairy firm is pledging to make its operations carbon-neutral from cow to supermarket by 2050, including more than 2,000 farms in the UK. This will require “radical changes” over the coming decades, including developing new technologies, the dairy co-operative, Arla Foods, said. It admitted the target was “ambitious”, but said it was achievable. However, the Vegan Society said there was no way to make dairy a climate-friendly product. Gases which help to heat the atmosphere and contribute to climate change are a by-product of the dairy industry. They include direct emissions of methane, a potent greenhouse gas, from cows, and carbon dioxide and nitrous oxide from the likes of packaging, transportation and fertilisers"
• Facial recognition can help dairymen monitor herd  
(Source: Farm and Dairy, 8 Feb 2018)  
"By using this visual imaging analysis, you can ID where, how and what an individual cow eats. You can see the bossy ones, and how cows react to their environment. You can pool data by barns, by how long each cow drinks, feeds or milks. And since cows can train themselves (there’s always that one outlier, though, right?), you can change how cows eat, where they eat and how long they spend eating"

• Fake milk is real news, as synthetic alternatives threaten traditional dairy farms  
(Source: CNBC, 20 Feb 2019)  
"The old question “Got milk?” has a complicated answer these days, because it all depends on what you mean by “milk.” Consumers could soon be faced with confusion in the dairy aisle as they wonder if the milk they’re drinking came from a cow — or was made in a lab. Perfect Day Foods is one company creating a synthetic milk alternative. It’s similar to milk in that it consists of casein and whey, the proteins found in milk. However, a cow was never used to produce their product. Instead, the animal-free dairy product is made in a lab using genetically engineered yeast programmed with DNA to produce the same proteins found in cow’s milk"

• Farms are going carbon-neutral—and cows are leading the way  
(Source: Brink News, 6 Sep 2018)  
"Going carbon-neutral is an ambitious goal for even the greenest food business—and exponentially more so for a 37,000-cow dairy farm"

• How smart tech and the digital age is benefiting the dairy industry  
(Source: Forbes, 2 Jan 2019)  
"It is estimated that in the last 25 years, global milk production has increased by 61% (average 2% per annum) and there would be an increase up to 177 million metric tons by 2025. However, the fast growing population and the ubiquitous movement of people away from rural farming areas mean the fewer farmers will either have to increase the amount of milk each cow produces or improve efficiency in milk production"

• Litigation is not a substitute for innovation  
(Source: Forbes, 12 Feb 2019)  
"The Cattleman’s Association and other ranchers are using regulation and litigation to stop non-meat, lab-produced products from labelling their offerings as meat. They fear the same disruption as the dairy industry, now proliferated with products such as Almond Milk, Cashew Milk, Soy Milk, Oat Milk and Coconut Milk, and associated brand extensions into non-dairy styles of yogurt, cream cheese, ricotta, mozzarella and other vegan cheese substitutes. However, huge producers such as Tyson and Cargill are betting on the popularity of plant-based meats with large investments"

• Milk adulteration a growing health hazard in countries  
(Source: Technology Times, 4 Mar 2019)  
"Milk and dairy product adulteration came into global concern after breakthrough of melamine contamination in Chinese infant milk products in 2008. However, history of milk adulteration is very old"

• Nearly a fifth of the EU’s budget goes on livestock farming, says Greenpeace  
(Source: The Guardian, Feb 2019)  
"Nearly a fifth of the EU’s total budget – more than £24bn of taxpayer money – goes to support livestock farming across Europe, according to new research by Greenpeace. At a time when scientists are calling for significant reductions in meat consumption, the report’s authors say taxpayers’ money should be redirected away from grain-fed, industrial animal farming"

• On-farm pig face recognition technology  
(Source: The Epoch Times, 13 Feb 2019)  
"Chinese internet companies are trying to develop new technologies to solve food safety problems involving pork products. Most recently, they have come up with “artificial intelligence (AI) pig
raising.” There are about 430 million farm-raised pigs in China, according to China’s National Bureau of Statistics, accounting for more than half of all farm pigs in the world"

- **The global market for dairy products, 2019-2022**
  (Source: AP News, 12 Feb 2019)
  "The report provides separate comprehensive analytics for the US, Canada, Japan, Europe, Asia-Pacific, Middle East and Africa, and Latin America. Annual estimates and forecasts are provided for the period 2015 through 2022"

- **There’s now a way to tell if milk is from 100% grass-fed cows**
  (Source: Dairy Herd, 27 Feb 2019)
  "Consumers have been shelling out premiums for organic dairy products from grass-fed cows. But for the most part, there wasn’t a way to tell whether those cows had eaten a few blades of grass or an exclusive grass diet. Now, Organic Valley and Maple Hill have come up with a third-party certification standard for grass-fed products, one of the fastest-growing categories in dairy. To obtain the seal, cows must have a 100% grass diet with zero grains, and have plenty of pasture for grazing. There’s also a full supply chain verification. Only certified organic farms can participate"

6. **Artificial intelligence (AI) and machine learning**

- **4 ways artificial intelligence will drive digital transformation in agriculture**
  (Source: Forbes, 7 Feb 2019)
  "The United Nations reports that about 1/3 of the food produced globally each year is lost or wasted, and I’d reckon that number is not too surprising. Those of us in the United States see evidence of waste each time we go out to eat or do a weekly purge of jam-packed refrigerators"

- **Artificial intelligence in agriculture market to witness huge growth in future 2025**
  (Source: Email Wire, 19 Dec 2018)
  "The report focuses on global major leading players with information such as company profiles, product picture and specification size will increase to Million US$ by 2025, from Million US$ in 2017, at a CAGR of during the forecast period"

- **Artificial intelligence is being trained to recognize giraffes**
  "Many researchers need to identify and collect data on specific individuals in their work, for example, to estimate survival, reproduction, and movement," says an associate research professor of biology at Penn State and principal scientist of the Wild Nature Institute. “Instead of tags and other human-applied markings that could interfere with the animal’s behaviour, many researchers take photographs of the animal’s unique markings. We have pattern recognition software to help analyse these photos, but the photos all have to be manually prepared for analysis. Because we often have hundreds of photos to go through, this creates a serious bottleneck.”"

- **Greenhouse artificial intelligence company continues to grow**
  (Source: Precision Agriculture, 21 Feb 2019)
  "IUNU, the computer vision company that helps growers apply artificial intelligence and machine learning in the greenhouse, has raised $7.5 million from BootstrapLabs and NCT Ventures, among others, according to an article on GreenhouseGrower.com. IUNU has grown significantly in the last year, with a more than 800% increase in square footage since the first quarter of 2018, with operations now in Canada and the U.S"

- **How does artificial intelligence really work in agriculture?**
  (Source: Precision Agriculture, 30 Jan 2019)
  "How far are we from a computer being able to decide what variety or hybrid should be planted in a field, how it is fertilized, and prescribe crop protection chemicals needed? The promise of artificial intelligence (AI) has been a popular discussion in the media, not only for agriculture but for a variety of applications. But what is AI, how does it work in farming plus what does it mean and how does it impact agriculture?"
• IBM Watson for agriculture  
  (Source: R&D Magazine)  
  "IBM has announced the Watson Decision Platform for Agriculture. This platform gathers data from 
  multiple sources, such as weather, IoT enabled tractors and irrigators, satellite imagery, and more, 
  and provides a single, overarching, predictive view of data as it relates to a farm in an easy-to-use 
  app. For the individual grower, this means support for making more informed decisions to help 
  improve yield. For example, using AI-enabled visual recognition capabilities, growers can identify 
  certain types and severity levels of pest and disease damage and determine where to spray 
  pesticides. Or a grower can forecast water usage, thereby reducing waste and helping to save 
  money"

• Is artificial intelligence a special ingredient to help make food taste better? IBM and 
  McCormick think so  
  (Source: USA Today, 4 Feb 2019)  
  "Sure, we're accustomed to artificial flavours influencing how our food tastes, but artificial 
  intelligence getting baked in now? The use of artificial intelligence just might provide the key 
  ingredients that make that next meal taste better"

• Machine learning detects importance of land stewardship in conservation policy  
  (Source: Science Daily, 13 Feb 2019)  
  "At the southern tip of the Himalayas, farmers in the Kangra region of India's Himachal Pradesh 
  graze cattle among rolling hills and forests. The forests, under management by the state or farmer 
  cooperatives, are thriving"

• Microsoft lays artificial intelligence sensors for smart farming, cutting-edge healthcare in India  
  (Source: Sify, 20 Jan 2019)  
  "We are working with farmers, state governments, the Ministry of Electronics and Information 
  Technology and the Ministry of Agriculture and Farmers Welfare to create an ecosystem for AI into 
  farming"

• The field of artificial intelligence growing in agriculture  
  (Source: Precision Agriculture, 24 Jan 2019)  
  "A Washington State University (WSU) scientist was recently named a 2019 Pioneer for his work in 
  artificial intelligence and internet of things by Connected World magazine, according to an article 
  on GrowingProduce.com"

• The incredible ways John Deere is using artificial intelligence to transform farming  
  (Source: Forbes, 9 May 2018)  
  "Computer vision specialist Blue River Technology has developed a solution for exactly that, using 
  advanced machine learning algorithms to enable robots to make decisions, based on visual data 
  (just as we would do ourselves) about whether or not a plant is a pest, and then deliver an 
  accurate, measured blast of chemical pesticides to tackle the unwanted pests. Given that 
  traditionally such decisions are made on a field-by-field basis, rather than plant-by-plant basis, the 
  opportunities for efficiency are clear. Farm equipment and services giant John Deere saw the 
  potential of this development and acquired the start-up late last year and added it to the catalogue 
  of high tech, data-powered services it already offers its customers"

• This start-up built a treasure trove of crop data by putting artificial intelligence in the hands of 
  Indian farmers  
  (Source: Forbes, Oct 2018)  
  "He knew there was something wrong with his chilli plants when he noticed they were smaller than 
  average, and the leaves were starting to curl. Last year the former academic, who’d taken a bold 
  leap into farming in his 30s, asked his neighbouring farmers for advice one morning at the border 
  between his seven acres of land and theirs"
7. **Aquaponics and hydroponics**

- **Greenhouse disrupting food systems with aquaponics**  
  (Source: US News, 2 Mar 2019)  
  "Aquaponics is a combination of aquaculture and hydroponics. Water in which fish are raised is then used to fill greenhouse tanks to grow plants. The fish waste provides nutrients for the plants, and the water recirculates between the tanks. Like hydroponics, aquaponics systems require less land and water than conventional crop production methods, increase growth rates and allow for year-round production. Once the fish and vegetable systems at Superior Fresh were filled with water, the operation uses between six and eight gallons of water a minute, much of which is used to replace water that has evaporated from the system"

- **Pesticide-free hydroponic farming brand element farms now seeking funding on WeFunder**  
  (Source: Crowdfund Insider, 12 Mar 2019)  
  "Element Farms, an indoor hydroponic farming company capable of growing safe, pesticide-free spinach at scale year-round, has launched its investment round on equity crowdfunding platform WeFunder. Founded in 2016, Element Farms describes itself as a produce company driven by technology"

- **Will hydroponics be the future of farming?**  
  (Source: iAfrica, 7 Feb 2019)  
  "While industrialised farming techniques have meant a more plentiful supply of cheaper, fresher food – most notably in the developed world – they can also be a threat to the environment, promoting waste, putting too much strain on resources and causing pollution. That’s one of the findings of a report published by the Ellen MacArthur Foundation at the World Economic Forum Annual Meeting in Davos. The report highlights the importance of cities in the production and consumption of food: "80% of all food is expected to be consumed in cities by 2050, they have to be central to this story. Today they often act as black holes, sucking in resources but wasting many of them – the final stop in the take-make-waste approach.""

8. **Augmented reality, virtual reality and simulators**

- **A ‘Farming Simulator 19’ esports league will crown Europe’s best virtual farmer**  
  (Source: Digital Trends, 23 Jan 2019)  
  "Nearly every genre of video game can be turned into an esport, with everything from Tetris to the cult hit Catherine finding a competitive audience, but the latest game to jump into the ring took us by surprise"

- **‘Farming Simulator 19’ trailer shows off serious farming action**  
  (Source: True Achievements, July 2018)  
  "The lucky people at Gamescom have had the chance to don a flat cap, enter a tractor and play Farming Simulator 19. For everyone else, we have a brand new trailer to share with you, which highlights some of the game’s new features. With horses you can ride, new crops to harvest and a whole bunch of new farming vehicles, there’s plenty to get excited about here"

- **How augmented and virtual reality will reshape the food industry**  
  (Source: Huffington Post, 15 Jan 2018)  
  "Augmented reality content can be found on everything from wine bottles to IKEA’s catalogue and virtual reality experiences are much more detailed, with rich layers of interactivity from hand controllers to gaze triggers, and a VR film has even won an Oscar. With Apple and Google both debuting augmented reality platforms (ARKit and ARCore, respectively), Facebook heavily invested in its Oculus headset and Amazon unveiling augmented shopping features, AR and VR is primed to change many parts of our everyday lives"
9. Bigger picture

- ‘Our world is entering a Fourth Agricultural Revolution’, says UK Environment Secretary
  (Source: Food Navigator, 4 Jan 2019)
  "The UK Environment Secretary has urged industry to embrace the potential of a fourth agricultural revolution"

- How agriculture contributes to economic development
  (Source: Futurism, 19 Apr 2018)
  "Agriculture has always played a pivotal role in shaping the economy of countries. Since it fulfils the basic necessities of the people, all nations across the globe make special provision to improve the productivity. Even the ancient civilization has given it due importance. The agriculture sector not only provides food but also a means of employment to millions. It contributes to resolving socio-political issues and building a civilized society. Countries where the real capital income is less, more emphasis is given on developing the agricultural sector and its related industries since it can become the driving force to boost the economy. Whether under developing or developed, agriculture is still the basic occupation of the world"

- It is technically feasible to double the yield of EU agriculture by 2050, says researcher
  (Source: Food Navigator, 9 Jan 2019)
  "The CropBooster-P roadmap will detail how ‘future proof’ crops can be developed to feed future populations – a predicted 9.7 billion people by 2050. The €3m project, which was commissioned by the EU, was launched on 1 November 2018 and will run through to 31 October 31 2021"

10. Biotech, gene technology and biodiversity

- 7 general myths and misconceptions about GMO foods
  (Source: Interesting Engineering, 25 Feb 2019)
  "GMO, or genetically modified organism, derived food gets a bad rap. But is this fair? Since the dawn of farming within human civilization, mankind has been playing with the genetics of plants and animals for millennia"

- Altered food, GMOs, genetically modified food
  (Source: National Geographic, 26 Jan 2019)
  "Scientists continue to find new ways to insert genes for specific traits into plant and animal DNA. A field of promise—and a subject of debate—genetic engineering is changing the food we eat and the world we live in"

- Animal, plant biology improves electronic and energy conversion devices
  (Source: R&D Magazine, 25 Jan 2019)
  "Inspired by the unique structural elements of animal and plant biological cell membranes, Purdue University researchers have scaled up the production of nanoscale electronics by replicating the living molecular precision and “growing” a circuit of solar cells for use on electronic surfaces"

- As more countries adopt crop biotechnology, farm families and the environment benefit
  (Source: Biotech Now, June 2018)
  "Biotech crops in the last 22 years have brought enormous benefits to the environment, health of humans and animals, and contributions to the improvement of socio economic conditions of farmers and the general public, according to a new report issued today by the International Service for the Acquisition of Agri-biotech Applications (ISAAA). The ISAAA report shows the global biotech crop area increased in 2017 by 3% or 4.7 million hectares or 11.6 million acres; Global economic gains contributed by biotech crops in the last 21 years (1996-2016) have amounted to US $186.1 billion economic benefits to more than 16 to 17 million farmers, 95% of whom come from developing countries"
• **Biodiesel benefits animal agriculture, too**  
  (Source: Biodiesel Magazine, 29 Dec 2019)  
  "Biodiesel is good for livestock, too. A discussion regarding biodiesel’s positive effect on livestock by increasing the value of animal fat and decreasing soymeal costs for livestock producers, and a perspective on how a growing biodiesel market positively impacts the beef industry"

• **Biodiversity centre in bid to prevent GM maize trials**  
  (Source: Iol, 11 Feb 2019)  
  "The African Centre for Biodiversity (ACB) has lodged an objection against Pioneer Hi-Bred’s application for field trials of a gene-silencing genetically-modified (GM) maize. ACB said it refused to allow South African citizens and the environment to be used as “guinea pigs” for the untested and unproven technology"

• **CRISPR crops given GMO status**  
  (Source: Disruption Hub, 4 Oct 2018)  
  "EU court rules that gene edited crops are genetically modified organisms. What does this mean for the European plant biotech industry? In 2001, the European Parliament passed the GMO (Genetically Modified Organism) Directive enabling EU member states to ban the growth or importation of genetically modified (GM) crops. The reasoning behind this? GM plants are created by inserting foreign DNA into the genome of the organism, usually to provide beneficial characteristics such as resistance to pests, higher yields and improved flavour. However, this process raises concerns amongst some parties that these ‘unnatural’ organisms will negatively impact the environment, as well as pose a threat to human health"

• **Could genetic engineering save chocolate from extinction?**  
  "The world’s chocolate supply is being threatened by disease and climate change"

• **CRISPR chocolate would help farmers in developing countries**  
  (Source: American Council on Science and Health, 14 May 2018)  
  "Some people are anti-GMO because they don’t like the idea of their food being genetically manipulated. But, what about food that is altered using the gene editing technology known as CRISPR-Cas9? And, what if the genetic change is one that would help the livelihood of farmers in developing countries? Lastly, what if the food that we’re talking about is chocolate...? CRISPR-Cas9 chocolate may very well be coming down the pike"

• **Future of food under ‘severe threat’ as species diversity disappears**  
  (Source: The Poultry Site, 25 Feb 2019)  
  "The future of food supplies is under “severe threat” because of the number of animal and plant species fast disappearing, a United Nations report said, as the world grapples with how to feed a growing population. People are depending on fewer species for food, said the U.N.’s Food and Agriculture Organization (FAO), leaving production systems susceptible to shocks like pests or disease, droughts and other extreme weather events due to climate change"

• **Future of us citrus may hinge on consumer acceptance of genetically modified food**  
  (Source: Science Daily, 13 Feb 2019)  
  "A tiny insect, no bigger than the head of a pin, is threatening to topple the multibillion-dollar citrus industry in the U.S. by infecting millions of acres of orchards with an incurable bacterium called citrus greening disease"

• **Gene-edited farm animals are coming, but will the public eat them?**  
  (Source: The Star, 18 Dec 2018)  
  "Three cows clomped, single-file, through a chute to line up for sonograms — ultrasound “preg checks” — to reveal if they were expecting calves next summer"

• **General Mills on why biodiversity is key to success**  
  (Source: FoodTech Connect, 7 Jan 2019)  
  "The future of food is a biodiverse, sitting at the intersection of taste and sustainability. Biodiversity
ensures the food industry can delight eaters with new and exciting foods from a diverse set of cultures, while also safeguarding our ecosystems and the genetic diversity required to ensure crops can evolve to better face threats like pests and disease, climate change and extreme weather"

- **Genetically modified food opponents know less than they think, research finds**
  (Source: Phys, 14 Jan 2019)
  "The paper, published in Nature Human Behaviour, was a collaboration between researchers at the Leeds School of Business at the University of Colorado Boulder, Washington University in St. Louis, the University of Toronto and the University of Pennsylvania"

- **How to build rural innovation ecosystems**
  (Source: Innovation Excellence, 5 Feb 2019)
  "The 2016 election revealed a dramatic gap between two Americas—one based in large, diverse, thriving metropolitan regions; the other found in more homogeneous small towns and rural areas struggling under the weight of economic stagnation and social decline. Amazon choosing NY and Washington to build headquarters is an example. Economic development experts agree that regional economic development depends on creating ecosystems that support entrepreneurs and new value creation. However, the assets, culture and needs of one community differs substantially from the next, particularly those smaller sized or rural communities that face demographic, infrastructure, capital formation and housings challenges unlike those in major metropolitan areas"

- **New “speed cloning” could help genetically engineer disease-resistant crops even faster**
  (Source: Modern Farmer, 22 Feb 2019)
  "Scientists have gotten pretty good, over the past few decades, at splicing in beneficial genes to crops. By using techniques like CRISPR gene editing, agricultural scientists can create GMO crops for all kinds of scenarios: sure, mostly enhanced yield or resistance to pesticides, but also the capability of surviving in drought or higher temperatures or poor soil"

- **New biotech missions to focus on drug resistance, fortified crops**
  (Source: The Hindu Business Line, 26 Feb 2019)
  "The Indian Minister for Science and Technology announced new missions in five important areas including antibacterial resistance, fortified crops and affordable vaccines for endemic diseases"

- **The agricultural biotechnology market will register a CAGR of almost 11% by 2022**
  (Source: PR Newswire, 14 Jan 2019)
  "The demand for food is rising due to the increase in the global population"

- **The role of heirloom crops vs genetic engineering in future food systems**
  (Source: Ag Funder News, 26 Feb 2019)
  "The food system is a tale of two halves today. On one side, consumers want to go back in time to eat locally-sourced, clean, simple, organic produce, including a growing taste for vintage varieties of certain fruits and vegetables. Technically called landrace or heirloom varieties, the most familiar are tomatoes, but we’re also seeing a return to pre-genetically engineered varieties of commodity crops including popcorn. On the flip side, technological advancements are making genetic engineering (GE) more commonplace as the discovery of new genetic tools, most famously CRISPR Cas-9 gene editing, has brought down the cost and accessibility of the technology"

- **The world’s most popular coffee species are going extinct**
  (Source: Geek, 16 Jan 2019)
  "Coffee lovers, here’s one more reason to savour that morning cup o’ joe. Research shows 60% of coffee species found in the wild could soon go extinct. In a new study published in the journal Science Advances, researchers at Kew Royal Botanic Gardens say factors putting the future of coffee at risk include climate change, deforestation, droughts, and plant diseases. According to the study, a collaboration between scientists from the UK and Ethiopia, out of 124 types of wild coffee, 75 are at risk of extinction. About 35 of the 124 species grow in areas with no conservation protections"
• This biotech uses genomics to breed super peas
  (Source: Labiotech, 8 Feb 2019)
  "With its genomics and computer modelling technology, Equi-Nom helps plant producers to breed pulses that contain more protein without any genetic modification"

• What are the political drivers for GMOs in developing countries?
  (Source: Devex, 1 May 2018)
  "In developing nations across the globe, governments are grappling with questions of what role, if any, genetically modified organisms should play in helping address a range of agriculture, nutrition, and climate challenges. What happens when we remove multinationals and corporate profit from the GMO debate? Concerns have been raised over the environmental and health impacts of GMOs, as well as their impact on traditional farming methods and issues around seed patents, and farmers having to be dependent on corporations"

• Will cannabis producers ditch greenhouses for bioreactors?
  (Source: Motley Fool, 1 Mar 2019)
  "While the brewing industry represents an important source of capital for the fledgling cannabis market, brewing science may represent an important source of future production capacity of cannabinoid compounds. Major cannabis producers ranging from Cronos to OrganiGram Holdings have partnered with analytical biotech labs exploring how to ditch inefficient plants grown in greenhouses in favour of genetically engineered microbes brewed in bioreactors. It could prove to be an important relationship for both industries if it works, so a pioneering expert weighed in on whether bioreactors might disrupt the cannabis ecosystem"

• Yeast can now produce weed to make cannabis bread that gets you baked
  (Source: Metro, 4 Mar 2019)
  "Scientists have ‘hacked’ yeast to make it produce the chemicals found in cannabis which get humans stoned. Yeast is most commonly used in the fermentation of beer and bread. Now it could be put to work producing weed loaves which will get you totally baked. A team at the University of California has engineered yeast so it churns out cannabinoids including THC and CBD"

11. Blockchain, tracking of food and food fraud
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• 3 innovative ways blockchain will build trust in the food industry
  (Source: Forbes, 26 Apr 2018)
  "There is a way to increase trust in the food industry. Blockchain solutions are already up and running in other industries like pharma and gold production—and they are ready to be applied to the food space"

• An Australian blockchain experiment: Tracking global almond shipments
  (Source: Bitcoin Magazine, 30 Jul 2018)
  "Following a successful 2016 trial of blockchain technology in an interbank open account transaction, the Commonwealth Bank of Australia (CBA) has partnered with five international and Australian companies to ship 17 tonnes of almonds from Melbourne, Australia, to Hamburg, Germany, using a new distributed ledger platform built on the Ethereum blockchain"

• Ant Financial is launching a blockchain app to tackle food fraud
  (Source: Coin Desk, 28 Aug 2018)
  "Ant Financial, a payments affiliate of e-commerce giant Alibaba, is poised to launch its own blockchain-as-a-service platform next month, alongside a rice-tracking application intended to tackle counterfeit products. The firm has partnered with the municipal government of the Chinese city of Wuchang to deploy a consortium blockchain for tracking the entire production process of locally grown rice. Located in China’s north eastern Heilongjiang province, Wuchang is known for the high quality of a specific type of local rice. However, over the past years, news reports have revealed that packages delivered from the region were sometimes mixed with rice of lower quality"
• Blockchain in agriculture industry to receive overwhelming hike and leading key players are:
  IBM, Agrichain, TE-food, Ripe Technology and Pavocoin
  (Source: Empowered News, 2 Feb 2019)
  "Global Blockchain in Agriculture Market report analyses the market status, market share, growth rate, future trends, market drivers, opportunities, challenges, risks, entry barriers, sales channels, distributors and Porter's Five Forces"

• Blockchain tech could ‘transform’ beef supply chain
  (Source: Agriland, 7 Dec 2018)
  "Professional service network and accounting organisation Deloitte has said that a data technology innovation known as blockchain could "transform" the Irish beef supply chain. The firm claims that traditional supply chains need to be changed in order to meet the requirements of an increasing global demand for beef"

• Blockchain tech shaping up to be large part of future of agriculture
  (Source: Hutch News)
  "The technology that made cryptocurrencies like Bitcoin possible is now gaining ground in agriculture. Those two things may seem worlds apart, but stakeholders in the ag industry are now looking at blockchain technology to connect buyers and suppliers that are worlds apart"

• Blockchain, machine learning and IBM are disrupting Kenya’s agriculture and farming
  (Source: Quartz, 18 May 2018)
  "In many emerging markets, food retailers along with smallholder farmers, struggle to secure loans and develop a credit history. And without the proper financing, many of them fail to scale their businesses. To tackle this, IBM has been working with the Kenya-based food logistics startup Twiga Foods to facilitate micro-lending options for food vendors"

• Bovine-tracking wearables
  (Source: Trend Hunter, 4 Mar 2019)
  "A team of entrepreneurs from Sweden have created an innovative new horse tracking app that is designed to make it easier than ever for owners of the majestic animals to keep tabs on their animals’ whereabouts. The system makes use of a wearable device, dubbed Hoofstep, that is embedded into the animal’s head and keeps track of its movements. The data is then sent to a static base station which then conveys it to a companion smartphone app. What’s more, this horse tracking app even uses machine learning to get accustomed to the horse’s movement patterns so that it can notify owners if a horse appears to be moving erratically. Currently the subject of a crowdfunding campaign on Kickstarter, the HoofStep horse tracking app is a fine example of the pastoral applications of location-tracking technology"

• Can blockchain help rebuild consumer trust in the food industry?
  (Source: Lloyd’s Register, 8 Jan 2019)
  "For the food supply chain, the big challenge today is how to restore trust when so many people are involved with differing ethical and regulatory approaches in so many places. Can technology improve traceability? Traceability is one of the main issues facing the industry. If we put ourselves in the position of a high-end restaurant, how much reassurance do they currently have about the ‘chain of custody’ in their own supply chain, from source to kitchen?"

• Can blockchain technology make agriculture safer?
  (Source: Forbes, 30 Nov 2018)
  "Most of what we’ve heard about blockchain technology has been in the realm of cryptocurrencies such as Bitcoin. But this new technology will have wide-ranging business applications as true peer-to-peer networks become more widespread"

• Carrefour will use blockchain to let curious mammals know where their milk came from
  (Source: The Next Web, 6 Mar 2019)
  "French supermarket giant Carrefour has activated the next phase of plans to “blockchainify” its produce. This time, it’s allowing buyers of its branded milk to trace its provenance with some neat distributed ledger tech"
• First US beef shipment traced through blockchain to Taiwan
  (Source: Feedstuffs, 2 Mar 2019)
  "Wyoming-raised beef tracked with blockchain code in RFID-tagged cases to dining establishment in Taiwan"

• French President calls on Europe to use blockchain to innovate the agriculture industry
  (Source: Coin Telegraph, 25 Feb 2019)
  "French President Emmanuel Macron has advocated the use of blockchain to innovate supply chain management in the European agriculture industry"

• From farm to plate, blockchain dishes up simple food tracking
  (Source: Financial Times, 6 June 2018)
  "Blockchain may have started life as the technology underlying cryptocurrencies such as bitcoin but it is quietly starting to revolutionise a far more prosaic sector: the world of food and drink. The industry has long been ripe for a shake-up. Supply chains are lengthy and complex, entailing multiple parties and, in many cases, several jurisdictions. Blockchain is attracting interest as a way to track and monitor food through the supply network, ensuring its origin and that it has not been tampered with en route."

• From lab-grown meat to blockchain, Alltech accelerator selects 10 global start-ups at the cutting edge of agtech
  (Source: Ag Funder News, 5 Feb 2019)
  "With more than 250 applications from 53 countries, The Pearse Lyons Accelerator, which is now in its third year, continues to attract some of the top AgTech start-ups from around the world"

• How can blockchain improve food safety and traceability?
  (Source: Yahoo Finance, 28 Feb 2019)
  "The food industry is continuously encountering issues with the safety of its products and counterfeiting. Blockchain technology is aiming to fully transform the food industry by fixing these issues and increasing efficiency and transparency throughout the entire system"

• How Wyoming is using blockchain to ensure ranchers get price premiums for sustainably-raised beef
  (Source: Ag Funder News, 6 Mar 2019)
  "BeefChain uses RFID and IoT tech to create an auditable provenance for grass-fed, pasture-raised meat to help ranchers Packaging materials solution company Avery Dennison’s retail branding arm (RBIS) and the Wyoming Business Council have tapped blockchain start-up BeefChain to help ranchers who use certain management practices like rotational grazing or grass-finishing to reap the price-point benefits that consumers are willing to pay for sustainably-raised beef"

• IBM completes blockchain trial tracking a 28-ton shipment of oranges
  (Source: Crypto News Hub, 1 Feb 2019)
  "IBM has completed a trial of blockchain technology to track a shipment of mandarin oranges from China to Singapore. IBM has completed a trial of blockchain technology to track a shipment of mandarin oranges from China to Singapore"

• IBM’s blockchain patents: From food-tracking and shipping to internet of things and security solutions
  (Source: Coin Telegraph, Oct 2018)
  "The adoption of blockchain technology is slowly taking shape across a multitude of industries. At the forefront of the amalgamation of payment systems and logistics is US tech giant International Business Machines Corporation (IBM), which has established itself as a leader in terms of blockchain-based products and offerings"

• Reaping the fruits of blockchain: How orange grove is linked to shopping basket
  (Source: Food Navigator, 1 Mar 2019)
  "Blockchain is an open and secure digital ledger that enables a permanent record of transactions. The technology has been leveraged by a great number of industries, from pharmaceuticals to..."
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finance – most famously used by cryptocurrency Bitcoin – to ensure security and promote consumer trust"

• The agricultural supply chain can massively benefit from blockchain
(Source: Forbes, 29 Aug 2019)
"A U.S. consumer goes to the grocery store and buys chicken for his evening meal. He “trusts” that the chicken is safe, that it has been inspected by USDA experts and is okay to eat. But he knows nothing about the origin of that chicken, how it was grown, or whose “hands” it went through on its way to that grocery store shelf"

• The life story of your supermarket chicken: Food tracking goes high-tech
"From poultry monitors to berry-tracking blockchains, the food industry is adopting technology to meet our growing demand for information about what we eat. Supply-chain expert Robyn Metcalfe investigates"

• Walmart now uses blockchain to trace food, will others follow?
(Source: Tech Republic, 26 Sep 2018)
"Walmart and Sam’s Club are looking to the blockchain to begin tracing the origin of the foods sold in their stores. The stores will work with IBM to begin tracking leafy greens such as romaine lettuce. The company is testing blockchain technology in response to food safety scares including E. coli outbreaks in lettuce and Salmonella instances in a variety of foods. Walmart is asking its leafy greens suppliers to use the blockchain to track these products on a more granular level"

• Why blockchain will be used to improve distribution food safety, quality, and traceability
(Source: Food Safety Magazine, 5 Feb 2019)
"With the passage of the Food Safety and Modernization Act (FSMA) comes the final rules on the Sanitary Transportation of Human and Animal Foods. Combined with the FSMA Preventive Control rules designed to establish food safety requirements throughout the food supply chain, serious documentation challenges face the food logistics sector"

12. Crop farming, soil management and irrigation

• A tech revolution will help farmers harvest sunshine with their crops
(Source: Wired, 12 Jan 2019)
"In the heart of the Sonoran Desert in Arizona, lush rows of tomatoes, peppers, carrots, chard and peas are growing in the arid extremes, protected by an array of solar panels which shade the crops and keep moisture in the soil. This is one of a number of test grounds for the principle of agrivoltaics, a way of fusing food with clean-energy production that will change the way we farm in 2019"

• A very small number of crops are dominating globally: That’s bad news for sustainable agriculture
(Source: Science Daily, 6 Feb 2019)
"A new study finds that globally we’re growing more of the same kinds of crops, and this presents major challenges for agricultural sustainability on a global scale"

• Aerobotics to provide tree crop analytics to Eastern Cape farms
(Source: IT Web, 20 Dec 2018)
"Aerobotics has partnered with The Co-op to help 1 300 Eastern Cape farms mitigate damage to their crops from pests and diseases. Using drone and satellite data, Cape Town-based Aerobotics provides farmers with pest and disease management systems for tree crop protection"

• Brazil eyes smaller crops
(Source: Farm Progress, 12 Feb 2019)
"Dry weather takes toll on corn, soybean crops"
• Crop insurance goes digital
  (Source: Ag Web, 4 Mar 2019)
  "While a crop insurance claim is something most farmers don’t wish to make, sometimes they’re inevitable. Several data technology companies are partnering with crop insurance providers to provide streamlined reporting and better risk management modelling"

• Food of the future: Science might make soil unnecessary in the next 100 years
  (Source: Newsweek, 30 Dec 2018)
  "This is a modal window. No compatible source was found for this media. It takes a lot to make a room of soil scientists gasp"

• Forget the past, carbon-rich soil may be the ticket to sustainable agriculture
  (Source: East Bay Times, 3 Mar 2019)
  "Poncia’s Stemple Creek Ranch might be a model for future farmers with its sustainable agricultural practices to keep carbon in the soil and out of the atmosphere. Along with less greenhouse gas emissions, carbon-rich soil means healthier and more productive plants, according to a rangeland ecologist. Now, farmers like him have the wherewithal to become better stewards of the land with the support of a collaboration of researchers known as the Marin Carbon Project. Ultimately, these researchers want to help slow climate change by introducing new, sustainable standards to American agriculture"

• Handheld sensor helps farmers monitor crops with precision
  (Source: The Engineer, 2 Nov 2018)
  "Farmers could monitor their crops more precisely with a hyperspectral handheld sensor that is claimed to provide up-to-the-minute data on plant physiology. The device, developed by an assistant professor in Purdue University’s Department of Agricultural and Biological Engineering, scans a plant for features including moisture, nutrient and chlorophyll levels"

• Improving food nutrition and security, soil health: The U.N. encourages modified farming systems
  (Source: Natural News, 1 Oct 2018)
  "Global food production has been a significant issue for years. The Food and Agriculture Organization of the United Nations (FAO), in its "The future of food and agriculture – Trends and challenges" report for 2018, lists the challenges that face modern agriculture"

• In Ghana, farmers try to boost ailing cocoa production
  (Source: Deutsche Welle, 12 Feb 2019)
  "Cocoa farming is the first step in making the world’s most popular sweet treat: chocolate. But in one top cocoa producing nation, yields have been plummeting for years. What can be done to boost production in Ghana?"

• Irrigation: Key to feeding sub-Saharan Africa’s growing population
  (Source: Agri Links, 22 Feb 2019)
  "Can Sub-Saharan Africa feed itself? This is a question that has been asked for decades, but no satisfying answer has yet been found and is unlikely to be found in the near to medium-term future. Why? The region is adding more than one billion people over the next 30 years, in just over a single generation. Most of the added population will reside in urban areas and demand more access to dairy and meat products, as well as to cereals, vegetables and fruits, fats, oils and sugars than did the previous generation, which resided largely in rural areas"

• Local rocks can yield more crops
  (Source: Science Blog, 12 Feb 2019)
  "Nitrogen, phosphorous, and potassium are the three elements that support the productivity of all plants used for agriculture, and are the constituents of commercial fertilizers that farmers use throughout the world"
• Modern farming is harming the planet - Tech-driven permaculture could heal it
(Source: World Economic Forum, 28 Feb 2019)
"Healthy soil leads to healthy humans. One of the foremost thinkers of organic agriculture and composting, explored this link in the early 20th century. He recognized soil as a living organism, not just as an exploitable commodity, as we do nowadays. Current agriculture, which consists of monocultures and extensive use of fertilizer, pesticide and herbicide, has caused a significant loss of biodiversity, has decreased soil quality and has polluted the environment. Due to rising awareness of these issues, researchers are now exploring alternatives, such as vertical indoor farms, hydroponics and cultured meat. However, there is a clear divide in approaches towards future agriculture. Technologists rely on a predominately tech-centric approach, while organic farmers rely on natural methods such as polycultures, mixed farming with livestock and crops, and composting. Even though the two camps do not have much in common, the pareto-optimal solution for humanity and the environment may lie in the middle – tech-enhanced permaculture"

• Modified photosynthesis increases crop yield
(Source: Market Business News, 6 Jan 2019)
"Scientists have found a way to increase crop yield without plants having to use more energy or resources. It involves modifying the process of photosynthesis so that it does the same job more efficiently"

• More flexible crop insurance options for 2019
(Source: Brownfield Ag News, 15 Feb 2019)
"News "It allows the producer that uses the enterprise unit discount system, and he’s using it in one county, maybe he has some adjoining acreage in another county but that acreage doesn’t qualify on its own for an enterprise unit—he now has the option of bringing those acres into his other county’s enterprise unit and everything will fit under one enterprise unit."

• New biochemical pathway that may develop more resilient crop varieties
(Source: Science Daily, 21 Feb 2019)
"Researchers have discovered a new biochemical pathway in plants which they have named Chlorad"

• New method of fertilizer production can better suit the needs of farms in Africa and around the globe
(Source: Phys, 12 Feb 2019)
"Nitrogen, phosphorous, and potassium are the three elements that support the productivity of all plants used for agriculture, and are the constituents of commercial fertilizers that farmers use throughout the world. Potassium (also referred to as potash) is largely produced in the Northern Hemisphere, where is abundant. In fact, the potash market is dominated by just a few producers, largely in Canada, Russia, and Belarus. As a result, potash (and fertilizers in general) can be accessed relatively affordably by farmers in northern regions, where it also happens to be a closer match for the soil nutrient needs of their farms and crops."

• Orange corn could open doors to new nutritional products
(Source: Farm Progress, 4 Mar 2019)
"Corn developed over 20 years by a Purdue professor is finding a home in the market"

• Partnership aims to bring autonomy to crop production
(Source: Farm Progress, 27 Feb 2019)
"In November 2018, Valmont Industries hosted an Ag Tech Summit, where irrigation professionals, ag tech companies and public officials from the U.S. and Israel gathered to discuss ways in which tech start-ups based in Israel could work closer with U.S.-based irrigation companies such as Valley Irrigation — and ways in which centre pivots could be used for purposes beyond irrigation"

• Plant immunity map could help breed more resilient crops
(Source: Market Business News, 14 Jan 2019)
"Scientists have mapped the molecular pathways of plant immunity. The breakthrough could help to breed crops that resist pests and diseases more effectively. When plants sustain damage from an
infection or injury, they release a molecule called adenosine 5-triphosphate (ATP) that triggers defence responses”

- ‘Plant tattoo’ can help farmers select crop varieties to survive drought
  (Source: IEEE, 3 Apr 2018)
  "Severe droughts have devastating ramifications. They destroy crops, sometimes leading to food shortages and price hikes. They also can put a financial strain on farmers, who pay for more water to irrigate their fields. To help lessen a drought’s effects, sensors called plant tattoos were developed. They can estimate how well various crops retain water during a shortage. The tiny sensors—a few hundred micrometres in diameter—are made of multiple layers of graphene-oxide, arranged in a pattern of dark circles and dots that gives them the appearance of tattoos”

- Recycled gypsum as an agricultural product: This common ingredient in drywall can increase yields, improve soil
  (Source: Science Daily, 6 Feb 2019)
  “Gypsum, a source of calcium and sulfur, can benefit crops and soils. When recovered from power plant smokestacks, it brings the additional benefits of recycling”

- Right green for crop, environment, wallet: Light sensor tools help growers make sense of nitrogen
  (Source: Science Daily, 16 Jan 2019)
  "Researchers found an efficient approach to managing nitrogen in agriculture and reducing its environmental impact. It’s all about being green”

- Smart farming optimizes transport of perishable crops
  (Source: The Cutting Edge, 17 Feb 2019)
  "Researchers at the University of Illinois have developed a mathematical model that determines the optimal time for transporting a grower’s hand-picked crops from the field to cold storage"

- Soil and crop management practices to minimize the impact of waterlogging on crop productivity
  (Source: Frontiers in Plant Science, 12 Feb 2019)
  "Waterlogging remains a significant constraint to cereal production across the globe in areas with high rainfall and/or poor drainage. Improving tolerance of plants to waterlogging is the most economical way of tackling the problem. However, under severe waterlogging combined agronomic, engineering and genetic solutions will be more effective. A wide range of agronomic and engineering solutions are currently being used by grain growers to reduce losses from waterlogging"

- Sony launches agriculture solution for crop management
  (Source: PR Newswire, 27 Feb 2019)
  "Sony is taking its expertise in sensing and processing technology and applying it to the agriculture business with the introduction of its Smart Agriculture Solution"

- Swiss researchers see promise in natural pest control methods for corn
  (Source: Swiss Info, 2 Mar 2019)
  "Researchers at the University of Neuchâtel have discovered two effective natural methods for fighting one of the most destructive pests ravaging corn in North America and spreading across Europe. This could unlock opportunities to reduce pesticide dependence"

- Taranis launches industry-first automated crop emergence and stand count solution
  (Source: SUAS News, 24 Jan 2019)
  "Precision agriculture intelligence leader Taranis, today announced the launch of its new solution that calculates and monitors the planting of seeds. Taranis is the first platform to offer farmers and agronomists a scalable answer to plot management strategy"
• This cranberry grower created a smartphone app for his irrigation system
(Source: Modern Farmer, 20 Dec 2018)
"A 33-year-old cranberry grower from Wisconsin created a smartphone app for his irrigation system that allows him to control and monitor it remotely"

• This new technology can help farmers save their crops from disease
(Source: Modern Farmer, 26 Nov 2018)
"If a farmer finds orange pustules on a crop of corn, how long does it take to determine whether it’s southern rust or another disease? That reaction time has big implications for the world’s food supply"

• UK scientists create faster method to make crops resistant to disease
(Source: Labiotech, 5 Feb 2019)
"A British research group has reduced the time it takes for crop breeders to breed disease resistance genes into their stock from over a decade to several months. Modern crops have been bred to be larger and grow faster"

• Valmont and Prospera technologies form partnership to provide autonomous crop management technology
(Source: Precision Agriculture, 25 Feb 2019)
"Valmont Industries, Inc., a leading global provider of engineered products and services for infrastructure and irrigation equipment for agriculture and the parent company of Valley Irrigation, and Prospera Technologies Inc., a leading Israeli machine vision and artificial intelligence (AI) company specializing in ag data, have announced their global partnership"

13. Data, digitalisation and analytics

• Breedr raises £2m led by LocalGlobe for its livestock data and trading platform
(Source: TechCrunch, 14 Mar 2019)
"Breedr, a U.K. start-up that wants to help farmers make better use of their livestock data to improve profitability, has raised £2.2 million in funding. The seed round is led by London-based LocalGlobe, with participation from Mons Investment and a number of angel investors"

• Data becomes cash crop for big agriculture
(Source: Precision Agriculture, 13 Mar 2019)
"For six generations, Ben’s family has tended corn and soybeans outside Jesup, a town of 2,500 on the windswept plains of eastern Iowa. But today he’s harvesting a valuable new crop from his 12,000 acres: information"

• How to overcome the many challenges associated with agricultural data
(Source: Ag Funder News, 14 Feb 2019)
"Unlike the common perception of agriculture being “data-poor,” agronomists and growers are in fact “drowning” in data. With new satellite imagery coming every three days, on-farm sensors sending updates 24/7 and application maps piling up on their machinery hard drives after every tractor run, there is more agricultural data added daily to a modern farm’s archive than a human operator can be expected to analyse. Yet, all this data is a source of valuable insights and can be a factual basis for on-farm management decisions, such as the efficient and economical application of fertilizer, timing of spraying operations, and allocation of workers’ time. All of these decisions need to be made daily in a timely and efficient manner for them to have a meaningful impact on farm operations, but this is at odds with the large volume of un-analysed data coming in each day"

• Is your farm working toward digitizing data?
(Source: AgWeb, 31 Jan 2018)
"Farmers are used to wearing many hats. Throughout a typical day, week, month or year they might assume the role of biologist, economist, heavy-equipment operator, systems engineer and other titles all part of “simply being a farmer.” But the hat farmers need to get most comfortable wearing real quick is a “technologist.”"
• New study uses big data to analyse the international food trade
  (Source: Science Daily, 28 Feb 2019)
  "As the world population swells, the inequitable distribution of food around the globe is prompting profound moral questions. Is the unequal distribution of food in rich and poor countries, for instance, merely a consequence of geography, with rich countries having more fertile lands?"

• Proagrica highlights top 4 data trends for agribusiness in 2019
  (Source: Precision Agriculture, 21 Jan 2019)
  "As another year passes, business leaders are wise to examine their current operations and consider their position in the marketplace. 2019 will undoubtedly see further emergence of new data technologies. Businesses that adapt are well-placed to use these technologies in order to thrive. Businesses that do not or are slow to react are likely to face mounting challenges from their customer base and lose out on productivity gains"

• Stumbling to digitization: Agriculture is not alone
  (Source: Precision Agriculture, 31 Jan 2019)
  "My revelatory moment came near the end of a keynote presentation at last summer’s International Conference of Precision Agriculture in Montreal, QC, Canada. The University of Montreal, a global leader in deep learning research, had just concluded a breath-taking tour of the coming impact of predictive analytics on healthcare and (by extension) agriculture — which really are not all that dissimilar, are they?"

• Top digital transformations in agriculture
  (Source: Tech Sling, 5 Jan 2019)
  "If we are to believe the proverb strength in numbers, planet Earth will be one very strong place in some 30 years or so. But would it really? As Food and Agriculture Organization of the United Nations reports, Earth’s overall population should be reaching more than 9 billion by the year 2050, and the question has to be asked: will we be prepared to deal with that many hungry mouths when even now we can’t provide enough food for the poor?"

• Wesfarmers treating data and analytics as a new business strategy
  (Source: ZD Net, 19 Feb 2019)
  "Wesfarmers is hoping to transform the way its organisation uses data, making data analytics a business strategy instead of a side effect. Speaking on a panel about data-driven cultural change during the Gartner Data and Analytics Summit in Sydney , Wesfarmers the general manager of Advance Analytics said that while data and analytics has historically served to complement an organisation’s business strategy, a shift has occurred where data and analytics has become the business strategy itself"

14. Drones

• ‘Lambulance’ drones helping farmers in lambing season
  (Source: Drone Below, 14 Nov 2018)
  "ABC New Australia has reported (video below) on a novel use of drone technology to make light work of a traditionally labour intensive task of checking on lambs during lambing season. The researchers at Tasmanian Institute of Agriculture (TIA) have developed a “Lambulance” drone"

• AgEagle looks to skies to improve sustainable farming practices using drones
  (Source: Drone Below, 28 Jun 2018)
  "Drones are becoming commonplace in agriculture, providing farmers with the opportunity to apply techniques and methods with more precision: hence the term precision agriculture. However, one company is now assisting ag professionals with the opportunity to make use of the same aerial data gathered by drones to improve sustainable practices. Undertaking sustainable practices is increasingly becoming a topic of importance for major companies, with 85% of companies in the S&P 500 reporting on sustainable initiatives this year, equating to a 65% increase from seven years ago"
• **Agricultural ‘superdrone’ hits market at over $100,000**
  (Source: Drone Below, 17 Aug 2018)
  "Working for the land to provide high food productivity these days requires advanced aerial technologies, and agribusiness is benefiting from advances in aeronautics. At Brazil’s Agrishow in Ribeirão Preto, a ‘superdrone’ was launched that could be a game-changer for Brazil’s agricultural industry"

• **Agriculture drone manufacturers in China**
  (Source: DIY Drones, 15 May 2018)
  "Drones are now more and more used in agriculture. As a large country of agriculture, China also developed a lot of agriculture drone manufacturers for growing demand of agriculture drones"

• **Agriculture drone market demand analysis, development factors, overview with manufacturers**
  (Source: My News Desk, 11 Mar 2019)
  "The companies working in this industry are planning, designing, and manufacturing systems which are gathering the data and are including them into business model that is expected to propel the industry growth"

• **Agriculture robots seek, find and destroy**
  (Source: Agweb, 2 Jan 2018)
  "Artificial intelligence is finding unbounded opportunity in agriculture as drone technology makes automation increasingly enticing for producers. Researchers in Oklahoma are using aerial and ground drones as a wedded pair to attack invasive eastern redcedar trees, a scourge of Great Plains producers. As the technology unfolds, the framework carries a host of possibility for all areas of agriculture"

• **Agriculture, security and first responders drive $15 billion commercial drone market**
  (Source: Drone Life, 28 Jan 2019)
  "A new report forecasts that the commercial drone market will exceed $15.1 billion by 2027. The Strategy Analytics Advanced Defence Systems (ADS) service report, “Commercial UAS Market Outlook 2017-2027” predicts that 49% of demand for commercial drone platforms by 2027 will be in the agriculture, commercial security and first responder sectors"

• **Australia: Autonomous drone technology improves irrigation practices**
  (Source: Precision Agriculture, 20 Feb 2019)
  "Monash University engineers are working with Australian farmers to help them improve irrigation practices, reduce water use, and maximize crop harvest by using autonomous drone technology"

• **Bees that wear tiny sensor-filled backpacks could monitor farms all day long**
  (Source: MIT Technology Review, 13 Dec 2018)
  "Roboticists often look to the natural world for inspiration. But what about piggybacking technology onto nature itself? Engineers have created a sensing system that effectively turns bumblebees into living drones"

• **Bring out the laser! On-farm drone and laser trials to begin**
  (Source: Agriland, 6 Mar 2018)
  "Long gone are the days of guessing which nutrients are low in your soil or whether your silage is good enough for the high-yielders, but could precise, real-time data – or close to it – form part of grass management too? For a group of 30 Northern Irish farmers taking part in the GrassCheck programme that’s already the reality"

• **Could barking drones be the end of the line for sheep dogs?**
  (Source: Stuff, 11 Feb 2019)
  "The hills could soon be alive with the sound of barking drones. Drones are a popular tool on New Zealand farms where they are used for everything from checking on stock to surveying and spraying. The latest model even lets farmers record their dogs barking and play the sound while
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using the drone during mustering. But Fido probably shouldn’t feel threatened just yet, as farmers say drone technology is unlikely to replace working dogs

• Delair unveils Delair Ag, an end-to-end drone solution for large-scale surveying and crop mapping in agriculture and forestry
(Source: SUAS News, 18 Feb 2019)
"Delair, a leading supplier of commercial drone solutions, today announced the commercial availability of Delair Ag, a comprehensive drone solution specifically designed for agriculture and forestry. Built around the Delair UX11 Ag, a new fixed-wing drone optimized for the agriculture industry, and Delair Aerial Intelligence(delair.ai), industry’s most powerful aerial intelligence platform, Delair Ag provides a complete, integrated and easy-to-use workflow to collect, manage, analyse and share agriculture data"

• Drone images help farmers to predict crop yields in Malawi
(Source: Reliefweb, 22 Nov 2018)
"On a hot and windy day in Kasungu, a drone operator prepares his flying machine for an important project. Joined by officers from the government’s Department of Agriculture and staff from three United Nations agencies, the operator steers the drone high into the clear blue sky"

• Drone technology has a multitude of applications for farmers
(Source: Stackyard, 7 Feb 2018)
"The use of drone technology for farming and land management is becoming increasingly relevant and widespread, but further regulation now in the offing"

• Drones in precision agriculture
(Source: Drone Below, 19 Jul 2018)
"As the development of programming and artificial intelligence expands their applications, so do the means to replace tasks traditionally undertaken manually. Drones for example, programmed intelligently, can save a farmer the repetitive and cumbersome task of examining each plant or tree individually and using the same techniques to optimize growth; a farmer can sit back and research the means of optimizing agriculture, while the drones do the heavy lifting"

• Dropcopter is pollinating orchards with drones as bee colonies decline
(Source: Ag Funder News, 18 Feb 2019)
"Pollination is one of the biggest concerns for specialty crop growers, especially as bee populations continue to decline. California-based Dropcopter is using drone technology to help achieve more accurate and precise pollination of orchard crops with its automated program while giving bees a break. Pollen-wielding drones with automated multi rotors can dust orchard crops like apples, almonds, and cherries providing a 15% boost in fertility, according to the company. Their technology is also applicable to wind pollinated crops like pistachios and walnuts. For apples, they also report a two-fold increase in the price per bushel, and can cut down on the labour required during harvest allowing harvest to take place once rather than two-to-three times as pollination takes place, says Dropcopter"

• Enhancing ecological field experiments by using multispectral sensing via drone
(Source: Drone Below, 16 Jan 2019)
"Although many climate research experiments are providing valuable data, long-term measurements are not always affordable. Over the last decades, several facilities have secured long-term experiments, but few studies have incorporated spatial and scale effects. Most of them have been implemented in experimental agricultural fields but none for ecological studies. This is why a group of researchers are focusing on scale effects, assessing the use of remote sensing images from space or airborne platforms such as drones or unmanned aerial vehicles (UAVs)"

• Farmer develops multi-purpose drone
(Source: Orissa Post, 8 Jan 2019)
"A farmer in a village in Rayagada district has derived the true meaning and spirit from the adage “Necessity is the mother of invention.” Spraying of fertilizers in the field is an arduous task. He has
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Successfully developed a multi-purpose drone that not only sprays pesticides and fertilizers in acres of land but also does the job of sowing seeds

- **Fertilize by drone, till by text: Making tech work for Africa's farmers**
  (Source: Christian Science Monitor, 16 Nov 2018)
  "A large white drone buzzes above rows of pineapple plants, methodically spraying fertilizer into green stems that will soon produce juicy fruits for export. The drone hovers a few feet in the air, covering in 15 minutes the same ground that usually takes five workers an hour"

- **How does my garden grow? With drones, sensors, and AI all in a row**
  (Source: IEEE Spectrum, 19 Dec 2018)
  "A decade ago, a group of crop scientists set out to grow the same plants in the same way. They started with the same breeds and adhered to strict growing protocols, but nonetheless harvested a motley crop of plants that varied in leaf size, skin-cell density, and metabolic ability"

- **How drones can help ignite a farming gig economy in the developing world**
  (Source: Brink News, 29 Mar 2018)
  "Drones will have a particularly powerful effect on the developing world, where mostly smallholder farmers face enormous challenges producing quality food and selling it for a decent price. Combining their technological efficiency and accuracy with the emerging gig economy will help these farmers step into the future"

- **How drones can manage the food supply chain and tell you if what you eat is sustainable**
  (Source: Qrius, 1 Oct 2018)
  "Drones are more than just cool-looking flying objects. Their real value lies in their ability to quickly and efficiently gather and analyse information on assets, geography, infrastructure, environmental trends and other important data that can be used to drive actional business insights. So we have to ask: what could be more critical than information on the world’s food supply?"

- **How farmers are using drones to keep crops healthy and increase profits**
  (Source: Wesa FM, 12 Feb 2019)
  "A Pittsburgh-based tech company is using drones and infrared technology to help diagnose diseases and pests in their crops before it’s too late. Skycision’s goal is to help farmers improve their profitability"

- **Parrot Drones increases support to African agriculture**
  (Source: Drone Below, 28 Feb 2018)
  "A shared-cost initiative between Parrot Drones and the Technical Centre for Agriculture and Rural Cooperation (CTA) has been launched for the deployment of drones for agriculture in sub-Saharan Africa. The CTA, a joint institution between the African, Caribbean and Pacific (ACP) Group of States and the European Union, aims to increase prosperity in its participant nations through food security and sound resource management. The partnership follows Parrot’s introduction in October 2017 of their Bluegrass thermal imaging drone specifically designed for precision agriculture"

- **Pesticide-spraying drones**
  (Source: Trend Hunter, 21 Feb 2019)
  "A Latvian entrepreneur has invented an innovative new agricultural drone that is designed to make it easier than ever for large farms to be sprayed down with pesticides at a significantly lower cost"

- **Pollen Scout drone service will help farms and vineyards improve crop quality**
  (Source: Drone Below, 17 Aug 2018)
  "A new drone system for assisting farmers in the management of farms and vineyards was unveiled today at the Auction of Washington Wines in Woodinville, WA, by Pollen Systems Corporation. The potential for such services is certainly large – according to the international organization OIV (Organisation Internationale de la Vigne et du Vin), nearly 20 million acres of planted vines exist worldwide. Pollen Scout, is a drone-aided service and self-service portal that helps farmers and vineyard owners keep an eye on crop growth, irrigation issues, and monitor and resolve pest and disease problems"
• Researchers take drones to Malawi to teach precision agriculture
  (Source: Drone Below, 9 Mar 2018)
  "A pioneering team of researchers have taken part in an initiative to use drones to tackle hunger in Africa. The aim of the research project, called "Precision Agriculture for Smallholder Systems in Africa," is part of "Feed the Future," was to help farmers boost crop production. The project is part of the U.S. government’s global hunger and food security initiative, as a response to threats posed by climate change"

• South African drone firm plans move to us with eye on agriculture market following $2m investment
  (Source: Moguldom, 5 Mar 2019)
  "South African drone company Aerobotics has raised $2 million for a total of $4 million in funding, and plans to use the money to empower farmers and grow its U.S. market"

• South African drone start-up targets the US agriculture market
  (Source: Moguldom, 6 Aug 2018)
  "South African drone start-up Aerobotics has revealed plans to expand their operations into the U.S. agriculture market. The drone and data analytics firm has sent two executives to the U.S. to meet with farmers and stakeholders in the country, and they have hired a U.S.-based representative for the company"

• Tunisia trains first set of drone pilots for agricultural productivity
  (Source: African Development Bank, 14 Dec 2018)
  "Eight pilots have successfully passed their drone flight training in Tunisia following a two-week intensive training period organized by the Ministry of Agriculture of Tunisia, the African Development Bank and Busan Techno Park"

• Turning tractors into robots
  (Source: Producer, 25 Oct 2018)
  "A package from North Star Robotics enables farmers to more easily embrace autonomous operation of farm equipment Spotting driverless-tractors working a Canadian field will be commonplace in the near future"

• Yamaha looks to launch drone for agricultural use
  (Source: Japan Times, 25 Oct 2018)
  "Yamaha Motor Co. said that it will launch its first drone for agricultural use in March 2019. The company aims to sell 500 units of the YMR-08 in 2019 and 1,000 units in 2021 amid growing demand for labour savings when it comes to the spraying of pesticides, due to a decline in the number of farmers"

15. Environment, climate, sustainability and pollution

• Achieving sustainable agriculture requires an integrated approach
  (Source: Food and Agriculture Organisation of the UN, 5 Feb 2019)
  "FAO launches comprehensive publication that points the way to how we can improve our food systems- "We have reached the limit of the paradigm of the green revolution," the FAO Director-General said"

• As awareness grows about food’s role in climate change, what solutions exist?
  (Source: Civil Eats, 19 Feb 2019)
  "After a decade of work to connect food and climate, four experts say the link is being made, but much work remains to be done"

• Botswana’s agricultural industry suffers in the face of climate change
  (Source: Political Analysis, 30 Feb 2019)
  "Botswana is facing a food shortage, with the current ploughing season experiencing dry spells coupled with above-normal rainfall in some parts of the country. Speaking at a workshop aimed at encouraging farmers to adopt measures to minimise the impact of climate change, the Deputy
Director in the Department of Crop Production revealed that Botswana is struggling to meet its food security need of 300,000 metric tonnes of grain

- **Do you know the carbon footprint of your food choices?**
  (Source: Science Daily, 17 Dec 2018)
  "Consumers greatly underestimate the energy consumption and greenhouse gas emissions associated with their food choices, but they’ll favour items with a lower carbon footprint if they’re given clear information on the label, according to new research"

- **Empowering West African women through sustainable agriculture**
  (Source: Modern Farmer, 10 Aug 2018)
  "General Mills partnered with CARE, a non-profit organization with more than seven decades of experience working to end poverty and catalyse lasting positive change in communities around the world through a focus on empowering women and girls. With funding from General Mills, CARE is working in the cocoa growing communities"

- **Farm manure boosts greenhouse gas emissions**
  (Source: Science Daily, 22 Jan 2019)
  "Researchers have shown, for the first time, that manure used to fertilize croplands in spring and summer can dramatically increase greenhouse gas emissions in winter. While it’s known that farmers’ decisions to add nutrients to their fields affects greenhouse gas emissions during the growing season, the study is the first to show that these choices have long-lasting effects, especially as winters warm and soils thaw more frequently"

- **Food labels should include climate impact**
  (Source: Positive, 5 Feb 2019)
  "Food is labelled to show its ingredients and allergens – why not also the impact it has on the climate? asks Denmark. The Danish government is considering forcing food manufactures and supermarkets to label their products according to the impact they have on the environment and on climate. Officials have begun discussing proposals to introduce such a labelling system, and say they have been working with the European Union to develop a climate label for 10 years"

- **For US farmers, sustainability is the future of profitability**
  (Source: Medium, 13 Feb 2019)
  "In farm country, “climate change” can be a dirty word. Whether you’re standing in a chilly shop in Nebraska, sweltering in a Virginia bean field, or walking a California vineyard, mentioning greenhouse gases or rapidly changing global weather patterns is a good way to get a farmer to clam up"

- **High-tech agriculture: Farmers risk being ‘locked in’ to unsustainable practices**
  (Source: The Conversation, 5 Mar 2019)
  "Since World War II, Europe’s agricultural sector has been very receptive to new technology, and the result has been staggering productivity gains – for four generations, farmers have produced more than their parents did"

- **How addressing energy used in food processing contributes to more sustainable agriculture**
  (Source: Green Biz, 25 Jul 2018)
  "Addressing energy efficiency in food processing technologies is an essential ingredient for solving the global energy efficiency challenge. Industrial food processing technologies need to embrace the cleantech revolution to reduce their carbon footprint and contribute to a more sustainable (and viable) world. With an expected world population of about 9.8 billion by 2050 (compared with roughly 7.6 billion today), the carbon impact of the agri-food industry will increase dramatically. Developing countries — where food processing standards are still mainly affected by sanitary regulations and progressively by environmental considerations — will represent about 98% of the 2.1 billion person increase in global population growth. So, tackling such a concern appears even more pressing. As of 2016, the United Nations’ Food and Agriculture Organization (FAO) estimated that 60% more food will need to be produced by 2050 [PDF] to feed the world population"
• How Africa can up its game on water management for agriculture
  (Source: Relief Web, 24 Aug 2018)
  "Global agriculture is facing unprecedented challenges. It’s estimated that the world’s population
  will reach 9.1 billion by 2050 with an ever expanding middle class. Current food production levels
  will have to be increased by 70% to meet future nutrition requirements. At the same time, the
  challenges posed by climate change, water, nutrients and energy are converging"

• How investing in regenerative agriculture can help stem climate change profitably
  (Source: Forbes, 12 Dec 2018)
  "Investing in regenerative agriculture has the potential to address not only the food supply but also
  climate change, peace and conflict resolution and the water supply to boot. This impact investing
  strategy could be the biggest lever for creating positive change available to investors today"

• How sustainable food production can change developing countries
  (Source: The Ecologist, Jun 2018)
  "Food scarcity is an issue that affects people around the world. Developing countries often struggle
  the most with food scarcity, but sustainable farming techniques could change their food system
  and lead to economic development and environmental protection"

• Intensive farming 'least bad option' for food and environment
  (Source: BBC, 14 Sep 2018)
  "Intensive, high-yielding agriculture may be the best way to meet growing demand for food while
  conserving biodiversity, say researchers. But their study says the approach makes sense only if it is
  linked to more wilderness being spared the plough. Intensive farming is said to create high levels of
  pollution and damage the environment more than organic farming. However, this report suggests
  that contrary to perceptions, this is not necessarily the case. Organic groups though have rejected
  the report's findings"

• It’s time to plant the seeds of sustainable growth in agriculture
  (Source: Boston Consulting Group, 4 Sep 2018)
  "Sustainable farming is getting a new lease on life. The deterioration of the environment and the
  depletion of resources—both of which are already limiting the amount of food produced by the
  world’s farmlands—are motivating regulators, consumers, food companies, and farmers to compel
  agricultural companies to adopt sustainable methods and processes. Despite companies’ lingering
  complacency, these stakeholders are driving a transformation that seemed impossible only a few
  years ago"

• Land O’Lakes launches software platform to help farmers boost sustainability
  (Source: Forbes, 31 Jan 2019)
  "More Americans than ever say they want sustainable food. According to a 2018 survey conducted
  by the International Food Information Council, 59% of American consumers said they care about
  whether their food is grown sustainably. But much like “GMO” or “natural,” sustainability can be a
  murky term with no clear definition. Now, two stalwarts of the ‘Big Food’ landscape are working to
  clear up that murkiness with a “Turbo-Tax style” software platform aimed at getting farmers to
  grow their crops more sustainably"

• New research could improve weather forecasting for farmers
  (Source: Modern Farmer, 19 Jun 2018)
  "It turns out that how big a raindrop is a good indicator of weather. Specifically, the size of
  individual raindrops within a cloud can be used to more accurately predict the amount of rain that
  will fall. Raindrop size can be used in other ways, too. Smaller raindrops, for example, evaporate
  faster than larger raindrops. Evaporation, as we all remember from elementary school science,
  creates a cooling effect"

• Organically farmed food worse for climate than conventionally farmed food
  (Source: Market Business News, 16 Dec 2018)
  "Organically farmed food is worse for our planet’s climate than conventionally farmed food, says a
  team of researchers. The main reason is that organic food requires more land"
• **Our food system is pushing nature to the brink. Here’s what we need to do**
  (Source: World Economic Forum, Feb 2019)
  "At the World Economic Forum Annual Meeting in Davos, two of the key frames of discussion were how to help our planet and how to shape the Fourth Industrial Revolution. As entire socio-economic structures are disrupted, more cooperative approaches across sectors and geographies will be required to bridge the gaps and build a sustainable future. The food system is one global structure ripe for transformation"

• **Sustainable agricultural mechanization - A framework for Africa**
  (Source: FOA, 5 Oct 2018)
  "FAO and the African Union launched a new framework document that aims to increase agricultural efficiency and reduce drudgery by helping countries in Africa to develop strategies for sustainable farm mechanization"

• **Sustainable agriculture, 'more crop per drop' should be mantra in India**
  (Source: Outlook India, 11 Feb 2019)
  "The Vice-President emphasised on the importance of sustainable agriculture as a part of sustainable development and said more efficient systems of irrigation with "more crop per drop" mantra should be used "

• **The inconvenient truth about the environmental impact of organic farming**
  (Source: New Atlas, 14 Dec 2018)
  "An international study into the impact of agricultural land use on climate change has found organic food production is worse for the climate than conventional farming, due to the fact that it needs greater areas of land to grow produce"

• **To save agriculture from climate change, we need better weather forecasting**
  (Source: Fast Company, 17 Dec 2018)
  "For farmers, increasing weather volatility due to climate change is a source of serious concern. Across the world, shifting weather patterns and extreme conditions like drought and heavy rainfall have resulted in inconsistent yields, which in turn is already leading to spikes in hunger across the globe"

• **When yesterday’s agriculture feeds today’s water pollution**
  (Source: Science Daily, 8 Oct 2018)
  "A study led by researchers at Université de Montréal quantifies for the first time the maximum amount of nutrients -- specifically, phosphorus -- that can accumulate in a watershed before additional pollution is discharged into downriver ecosystems"

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16. **Emerging technologies and innovation**

• **5 lessons farmers can learn from Google**
  (Source: Ag Web, 12 Mar 2019)
  "Google is one of the world’s innovation powerhouses. During a time in agriculture where change is around every corner, farmers can learn some vital lessons from the global company. Steve Lerch, former Google account executive for advocacy and associations, shares five such lessons"

• **5 ways to leverage early-season technology**
  (Source: Farm Progress, 14 Feb 2019)
  "Using ag technology tools early in the season can help you understand the opportunities your farm holds and alert you to problems. Tech tools can identify fields that have the most return-on-investment and yield potential, so you can allocate resources appropriately"

• **Disruptive farmers grow a new ag business model**
  (Source: Forbes, 19 Jan 2019)
  "The world is going to run out of food. Don’t worry, the best minds are on it. They are using better seeds, lighting and irrigation systems to reimagine farming"
• EU high court rejection of copyrights for food tastes worries rights holders  
  (Source: IP Watch, 15 Nov 2018)  
  "A food’s taste cannot be pinned down with enough precision and objectivity to make it copyrightable under EU law, the European Court of Justice (ECJ) said on 13 November. The decision creates a new standard that could be applied to all European copyright works, but would likely be the same under US law, intellectual property lawyers said"

• Farmer 3.0: Attributes of the future’s farmers  
  (Source: Ag Web, 26 Feb 2019)  
  "Strategic planning. Risk management. Yield prediction"

• How the gig economy can transform farms in the developing world  
  "Think of a modern farm. You might imagine neat rows of crops, shiny new tractors, perhaps mechanized irrigation systems. But you’d be only partly right. For truly modern agriculture, we need to look to the skies. Because that’s where drone technology will work its magic. Drones will have a particularly powerful impact in the developing world, whose mostly smallholder farmers face enormous challenges producing quality food and selling it for a decent price"

• How this modern agriculture technology company is changing farming  
  (Source: Technology-in-business, 4 Jan 2019)  
  "Indigo’s CEO on how the company is changing the way plants are being farmed and consumed, and his key to success"

• John Deere creates futuristic farm forward video  
  (Source: Precision Agriculture, 21 Feb 2019)  
  "John Deere’s new Farm Forward video is a vision of how technology could drive increased productivity to feed a growing population. It was created to inspire conversations and help farmers visualize what the future of their farm will be"

• Nigeria’s Hello tractor in artificial intelligence, blockchain partnership with IBM research  
  (Source: Disrupt Africa, 12 Dec 2018)  
  "Nigerian agritech start-up Hello Tractor has partnered IBM Research to pilot an agriculture digital wallet and decision-making tool that provides demand and supply visibility for farmers, tractor fleet providers and banks"

• Oversight of emerging technologies will affect farmers and consumers  
  (Source: Daily Caller, 10 Oct 2018)  
  "There also are a lot of unanswered questions about cultured products – the newer and, so far, less commercially viable technology. What are the animal sources of cell lines? What inputs are used to replicate cells? How are animals “fed”? If antibiotics are used in source animals, how can manufacturers be allowed to call the resulting products “clean”?”

• Technological innovation critical to ‘fourth revolution’ in farming  
  (Source: Global News, 17 June 2018)  
  "Get ready for the ‘internet of cows.’ Generations of farmers have relied on knowledge and family expertise to grow food, but the sector is set for a surge of disruption at the hands of made-in-Canada artificial intelligence-powered systems. AI is now helping farmers across the country to increase yields, save costs and minimize environmental damage. Instead of spreading fertilizer across acres of fields or spraying entire orchards with herbicides, they can now target their efforts for maximum effect"

• Technological innovation is a game-changer for agricultural statistics  
  (Source: Brink News, 18 Oct 2018)  
  "Improving the welfare of Asian farmers depends on strategically investing in collecting “good data.” Most of Asia’s impoverished communities live in rural areas and rely on agriculture as their main source of income. Enhanced agricultural productivity would go a long way toward reducing rural poverty and boosting the incomes of small-scale farmers. It is also key to achieving
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Sustainable Development Goal no. 2, zero hunger. This will require major investments in new types of data collection

- The Fourth Industrial Revolution must not leave farming behind
  "The Fourth Industrial Revolution has disrupted industry after industry. Better information flows, lower transaction costs and faster communication have made doing business easier and more efficient, and have proven to be major drivers of economic growth. It is easy to imagine that traditional smallholder value chains are somehow immune - that the remoteness of small farms cuts them off from the tsunami of change that has rocked the hotel, taxi, education and banking industries"

- These food technologies are ripe for innovation
  (Source: Forbes, 6 Mar 2019)
  "About half of the global population—3.5 billion people—are impacted by malnutrition around the world. This is just one of the harsh realities in today’s food systems. At the same time, there is enormous untapped potential for tech-enabled companies to address such challenges. Investments in this area have lagged significantly behind sectors such as health, but innovation is beginning to flourish and business accelerators are multiplying, signalling a new era for ag and food tech"

- To combat thieves, farmers are spraying their goods with an invisible, data-encrypted liquid
  (Source: Medium, 29 Nov 2018)
  "SmartWater CSI is a colourless, odourless liquid that turns a yellowish hue when placed underneath a UV black light. Marketed as the ultimate theft deterrent, it comes in a nail polish–sized vial with a swab applicator. According to its manufacturer, 10 minutes after application, SmartWater will dry and remain on any nonskin surface for at least five years. But traces of SmartWater also rub off on anyone who touches it, staining skin and clothing. Theoretically, anyone trying to grab something would get SmartWater all over their hands, leaving stains traceable by law enforcement"

- Top 5 things to know about farm tech
  (Source: Tech Republic, 12 Feb 2019)
  "Agriculture gets a bad rap sometimes. Farmers are too often portrayed as either simple folks on a bouncy old tractor, or as a huge, heartless, agribusiness spewing pesticides. There may be some truth behind both stereotypes, but today’s farmer is also incredibly tech savvy. Here are five things to know about farm tech"

- Virtual fences, robot workers, stacked crops: Farming in 2040
  (Source: The Guardian, 17 Feb 2019)
  "It is 2040 and Britain’s green and pleasant countryside is populated by robots. We have vertical farms of leafy salads, fruit and vegetables, and livestock is protected by virtual fencing. Changing diets have seen a decline in meat consumption while new biotech production techniques not only help preserve crops but also make them more nutritious"

17. Fish farming

- 3D printing to improve water quality in fish farms
  (Source: 3D Print, 25 Jun 2018)
  "While fish farming may not have the romance that comes with nostalgic views of 19th century cow herding, it is proving to be an important method of creating the supply of food fish demanded by today’s public. Around the world, carp, tilapia, salmon, and catfish, among others, are raised in commercial fisheries composed of tanks and enclosures and requiring a great deal of human intervention in order to produce fish that are safe and satisfactory for human consumption"

- Hydropower in Cambodia could threaten food security of region
  (Source: Science Daily, 31 May 2018)
  "Farmers and anglers in Cambodia depend on the Mekong River’s predictable seasonal patterns,
but new dams for hydroelectricity are altering the hydrology of the river. These changes have the potential to threaten fish migration, livelihoods, and regional food security"

- **How lasers and robo-feeders are transforming fish farming**  
  (Source: BBC, 20 Feb 2018)  
  "Fish farming is big business - the industry now produces about 100 million tonnes a year - and with salmon prices soaring, producers are turning to lasers, automation and artificial intelligence to boost production and cut costs. How do you know if farmed salmon have had enough to eat? Well, according to Lingalaks fish farms in Norway, which produce nearly three million salmon each year, the fish make less noise once the feeding frenzy is over"

- **Controlling fish farms water quality with smart sensors in Iran**  
  (Source: Libelium, 21 Feb 2018)  
  "The fish farming industry in Iran has rapidly grown within recent years, doubling employment rates and multiplying its production. This activity began with the enhancement of the quality of fish species selected from the Caspian Sea and then continued through the development of intensive aquaculture utilizing different foreign species. Investing in the development of earth ponds, reservoirs and sea cages has become crucial for the local government, which supports the private sector by providing low rate interest loans and suitable land at competitive prices"

- **Off shore fish farms**  
  (Source: Red Ferret, 14 Jan 2019)  
  "We eat a lot of seafood. We, as humans of the Earth. It’s one of the world’s major sources of proteins and people seem to love it"

- **10 foods that (basically) never expire**  
  (Source: Top Tenz, 18 Feb 2019)  
  "Before you go through your kitchen pantry and throw away food based on the expiration date, you should know that for certain foods, that is merely a suggestion. Some edible items never expire... or, at least, they can last for years before it’s time to dispose of them"

- **Animal-sourced foods vital to combating malnutrition and stunting in the developing world**  
  (Source: Telegraph, 14 Nov 2018)  
  "When poorly nourished children in developing countries fall behind in their physical growth and become stunted relative to their healthier peers, they tend to fall behind in a lot of other things too: their health, cognitive development, schooling, and eventually, their productivity and income as adults. The high social and economic costs mean that there are high returns to preventing stunting, provided these actions happen early"

- **Apple Watch Series 3 tracks food nutrition using RFID tags in new patent**  
  (Source: IB Times, 2 May 2017)  
  "The US Patent and Trademark Office granted the Cupertino giant with Patent No. 9,640,088, which is for electronic tags that provide nutritional information about food items. Although the newly awarded patent to Apple focuses on radio frequency identification (RFID) tags"

- **Food choices today, impact health of both ‘people and planet’ tomorrow**  
  (Source: Un, 6 Feb 2019)  
  "The food we eat has huge potential to improve both human health and environmental sustainability, but too often today it is posing a threat to both people and planet, according to a new report by the EAT-Lancet Commission, launched at United Nations Headquarters in New York"

- **Plans underway for new nutrient management tool for farmers to comply with EU rules**  
  (Source: Independent, 4 Mar 2019)  
  "A new tool is being developed to help farmers manage the use of nutrients on their farm and comply with new rules under the Common Agricultural Policy (CAP) proposals for 2021-2027. The European Commission has said proposed Farm Sustainability Tool for Nutrients (FaST) will facilitate
a sustainable use of fertilisers for all farmers in the EU while boosting the digitisation of the agricultural sector

- **Technology to keep food products fresher for longer**
  (Source: Foodbev, 4 Mar 2019)
  "Kemin Food Technologies Asia has launched Powerpacked Molecule, a new technology which is said to enhance the chemical blending process and keep food and beverage products safer and fresher for longer. Using the technology, Kemin has developed naturally derived antioxidants within similar levels of food protection as conventional natural antioxidants, but at reduced dosage amounts"

- **The hottest food trend right now isn’t ‘vegan’ - it’s ‘plant-based’**
  (Source: South China Morning Post, 19 Feb 2019)
  "The number of new US food and drink products that mentioned “plant-based” grew 268% between 2012 and 2018. The term evokes healthfulness but spares meat and dairy eaters — often the target audience — the connotation of shunning all forms of animal products"

- **Watch for these 7 sustainable food trends in 2019**
  (Source: Environmental Leader, 9 Jan 2019)
  "The sustainable food industry has evolved rapidly in recent years. Growth in the global organic products market, for example, continued in 2018, with consumer demand for organic foods strengthening and sales of organic foods reaching more than 5% of retail food sales in the US. This year is expected to be no different for sustainable foods"

**19. Food security, safety and waste**

- **A toxic fungal threat is encroaching on global food supply chains**
  (Source: Brink News, 2 Oct 2018)
  "Pests and fungal diseases are on the march. Milder conditions from climate change provide a more sympathetic environment for all kinds of fungi to grow on food crops, including the moulds that produce mycotoxins"

- **African consumers need more investment in food safety to tackle high human cost of foodborne illness, new GFSP report finds**
  (Source: GFSP, Feb 2019)
  "Development spending efforts should target improved food safety for African consumers, who need greater information and awareness to be able to demand higher standards, finds the Global Food Safety Partnership"

- **Agricultural mechanization, a key to food security in developing countries: Strategy formulating for Iran**
  "Mechanization is a multi-dimensional concept and widely used in agriculture. There is, however, a major difference between the application of mechanization in developed and developing countries. The developing countries tend to design their own strategies in food security given the challenges they face in all aspects of their economy including feeding a growing population, reducing poverty, protecting the environment, managing the effects of climate change and fighting malnutrition all of which may further contribute to a reduction in economic growth and political instability"

- **Agriculture sector can address global food challenges**
  (Source: Triple Pundit, 3 Jan 2019)
  "The global population is set to increase by over two billion in the next 30 years. Malnourishment is endemic, soil quality is in decline and water and other critical resources are becoming scarcer. Nevertheless, agricultural companies have a great opportunity to integrate sustainability into their core business practices in order to meet the growing global demand for high quality food, and do so sustainably"
• Agroecology key to food security in developing countries
  (Source: University of Cape Town, 31 Aug 2018)
  "Industrial agriculture – farming that involves the intensive production of livestock, poultry, fish and crops – is one of the most environmentally destructive forms of land use. It depends on mechanisation and on inputs like synthetic fertiliser and harmful pesticides and herbicides and has led to widespread contamination of soil and water. It also relies on just a few major crops like wheat, maize, soybean and rice, the seeds of which are owned by a mere handful of companies. A different approach to agriculture is sorely needed. This should, ideally, deliver household food security, ensure sustainable livelihoods and produce quality nutrition in a rapidly changing climate"

• Automated composting makes quick work of food waste
  (Source: Facility Executive, Oct 2018)
  "Many organizations face challenges in meeting local laws that regulate how they dispose of food waste. Chief among these is the cost of compliance, which includes assigning personnel to sort waste before disposal, maintaining separate areas for waste storage, paying companies to properly dispose of waste, and sometimes setting up and staffing composting operations of their own"

• Can developing countries leapfrog the West to a new food security reality?
  (Source: Science Nordic, 17 April 2018)
  "There are some mega-challenges ahead for food systems, particularly in developing countries where almost a 800 million people go hungry and where climate change poses a major threat to food production. On top of that, the global community has some very ambitious goals to eliminate hunger by 2030 according to the UN sustainable development goals, while limiting global warming to just two degrees centigrade and preferably less"

• Can we ditch intensive farming
  (Source: The Guardian, 28 Jan 2019)
  "Why do we need to grow more food? Food production around the world must rise by half in the next 30 years to sustain a global population expected to top 10 billion by 2050. Compared with 2010, an extra 7,400tn calories will be needed a year in 2050"

• Developing country-wide farming system typologies: An analysis of Ethiopian smallholders’ income and food security
  (Source: IFAD, Nov 2018)
  "This paper aims to better understand the context in which smallholder farms operate. The study has developed a new methodology to establish country-wide farm typologies that combines household and macro-level data (household survey, agricultural census and land cover data) to analyse food security and poverty, to enable an analysis that is both farm-system specific and spatially explicit"

• Fake food or fraud food in Nigeria, Kenya and other African countries
  (Source: Quartz, 10 Mar 2018)
  "In late February 2018, a 14-year-old died after eating tainted biscuits at a classmate’s birthday celebration in their school, located just outside Nigeria’s capital Abuja. Several other children in their class were hospitalized. Panic and threats from angry parents forced a temporary school closure, but to date, there have been no efforts to investigate the root causes nor track or shut down the responsible company. This tragic incidence is part of a global explosion of food fraud, when companies purposely mislead the public about products. According to the United States’ Grocery Manufacturers Association, food fraud affects approximately 10 percent of all commercially sold food products and costs the global food industry between $10 billion and $15 billion annually"

• Fighting food waste and fraud
  (Source: Pymnts, 21 Jan 2019)
  “A great business idea is only half the battle in an always-on, digitally connected world — the other half involves convincing consumers to try it out. In the case of new mobile order-ahead services,
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- **Food safety is top of the menu at world conference**
  (Source: South China Morning Post, 12 Feb 2019)
  "The two-day forum is bringing together government officials and health experts from 125 countries to combat the peril of unsafe food, which kills more than 400,000 people each year, according to UN estimates"

- **From seed to shelf: How IBM innovations will transform every stage of the food supply chain within the next five years**
  (Source: IBM, Feb 2019)
  "Within the next five years, the Earth’s population will cross the eight billion mark for the first time. Our complex food chain—already stressed by climate change and a finite water supply—will only be tested further. To meet the demands of this crowded future, we will need new technologies and devices, scientific breakthroughs, and entirely new ways of thinking about food safety and security. IBM researchers around the world are already working on solutions at every stage of the food chain. They are helping farmers maximize crop yields and developing ways to curb the epidemic of waste that destroys 45% of our food supply. Our scientists are working to create a safety net to catch pathogens and contaminants before they make people sick. And they’re inventing ways to keep plastic out of our landfills and oceans"

- **Global legislation and sustainability will shape the food safety discussion in 2019**
  (Source: Webwire, 19 Feb 2019)
  "Packaging safety is an important topic for all players along the value chain in the food industry. It is also a complex field that is constantly evolving, continuously influenced by technological innovation, market developments, and new legislation"

- **Innovation platforms for food security in Eastern and Southern Africa**
  (Source: 3BL Media, 2 Mar 2018)
  "A project in Uganda is empowering smallholder dairy and honey farmers to control their own community development by gaining access to high-value markets. The project, funded by ACIAR and run by the World Agroforestry Centre, has been operating since 2015 and aims to bring farmers together through innovation platforms, enabling farming communities to take a collective approach to common problems. The biggest challenge facing smallholder communities around the world is accessing high-value markets and receiving the best possible return for their produce—a monetary difference impacting livelihoods and food security"

- **Kenya urged to adopt climate-smart seeds to boost food security**
  (Source: Enviro News Nigeria, 11 Feb 2019)
  "Kenyan farmers should adopt seed varieties that are resilient to climatic shocks in order to achieve food security and expand revenue streams, a UN Food and Agricultural Organisation (FAO) official said"

- **Making food safer in developing countries**
  (Source: Food Security Portal, 7 Nov 2018)
  "Unsafe food poses a significant threat to human health and well-being and can hamper agricultural transformation, market integration, and economic development. Populations in low- and middle-income countries are often hardest hit by the effects of unsafe food, with countries in South Asia, Southeast Asia, and Africa south of the Sahara accounting for 53% of all foodborne illnesses and 75% of related deaths. According to the World Health Organization, the illness, disability, and premature deaths resulting from unsafe foods led to productivity losses of about USD 95 billion in 2016 in low- and middle-income countries"

- **New graphene-based sensor design could improve food safety**
  (Source: Science Magazine, Dec 2018)
  "Approach offers high sensitivity for detecting gases, chemicals and pathogens. In the U.S., more
than 100 food recalls were issued in 2017 because of contamination from harmful bacteria such as Listeria, Salmonella or E. coli"

• **Pocket-size food scanner**
  (Source: Phys, 3 Jan 2019)
  "According to a study by the environmental organization WWF Germany, ten million metric tons of food are thrown in the garbage every year in Germany despite still being edible. A mobile food scanner will allow consumers and supermarket operators in the future to test whether food items have gone bad"

• **Rebooting food: Finding new ways to feed the future**
  (Source: Reuters, 24 May 2018)
  "Welcome to the brave new world of food, where scientists are battling a global time-bomb of climate change, water scarcity, population growth and soaring obesity rates to find new ways to feed the future. With one in nine people already short of enough food to lead a healthy, active life, supporters pushing for a Second Green Revolution argue without major changes hunger will become one of the biggest threats to national security and human health"

• **Reshaping Africa’s rural food systems and cutting food losses**
  (Source: Ensia, 15 Jan 2019)
  "Nearly a third of the food farmers grow in sub-Saharan Africa is lost due to lack of refrigeration, poor market access and other related factors. Annual food losses for fruits and vegetables are an estimated 40% to 50%. These losses have devastating ripples through rural communities. In addition to causing low farmer incomes, it is a major reason why hunger, malnourishment and broader economic poverty are endemic in rural Africa. Sub-Saharan Africa has the largest concentration of poor people in the world, most of them agriculture-dependent populations living in rural areas. According to the UN Food and Agriculture Organization, 95% of agricultural research investments in sub-Saharan Africa over the last 30 years have been directed to increasing productivity, with only 5% aimed at reducing food losses"

• **Sourcing food products from developing countries to integrate underserved communities in the global supply chain**
  (Source: Business Call to Action, 18 Dec 2018)
  "Ethical food sourcing company Coconut Merchant has signed on as Business Call to Action (BctA)’s newest member, with a commitment to focus on sourcing food products from underserved communities and farmers in developing countries to provide sustainable income, and new routes for their products to international markets"

• **Tens of thousands dying each year as ‘unsafe produce’ impacts food system in sub-Saharan Africa**
  (Source: Telegraph, 6 Feb 2019)
  "International donors and domestic governments must do more to tackle high levels of illness and death caused by unsafe food in sub-Saharan Africa. A new report by the Global Food Safety Partnership, part of the World Bank, says that “relatively little” is being done to reduce the number of food-borne illnesses among people in sub-Saharan Africa, despite the fact more than 100,000 people are killed eating unsafe food every year"

• **The high cost of food monopolies in Africa**
  (Source: Project Syndicate, 7 Aug 2018)
  "Many consumers in Africa spend a disproportionate percentage of their household income on food. One of the biggest reasons is the failure of regional governments to ensure competition in the food sector, which has led to higher prices and made local agriculture less competitive. In May 2018, global food prices increased 1.2%, reaching their highest level since October 2017. This upward trajectory is having a disproportionate impact in Africa, where the share of household income spent on food is also rising. To ensure food security, governments must work quickly to reverse these trends, and one place to start is by policing the producers who are feeding the frenzy"
• There is no food security without food safety
(Source: Agri Links, 12 Feb 2019)
"At the First International Food Safety Conference in Addis Ababa, being held February 12-13, food
safety and security experts agreed that food safety is everyone’s issue: there can be no food
security without food safety. More than 700 delegates are attending the conference, organized by
the African Union, the Food and Agriculture Organization, the World Health Organization and the
World Trade Organization. The main goal of this conference is to bring together high-level actors
from government (including ministers of agriculture, health and trade) and non-governmental
organizations (including scientific experts, consumer representatives, food producers, civil society
and the private sector) from both developed and developing countries to address current and
future challenges to global food safety and strengthen commitment and international collaboration
to improve global food safety, especially in developing countries"

• Unsafe food is killing thousands in sub-Saharan Africa every year
(Source: Global Citizen, 8 Feb 2019)
"More than 100,000 people die from unsafe food and lack of investment in food safety in Sub-
Saharan Africa every year, according to a report published by Global Food Safety Partnership. It
found that improvements to the food system in Africa are essential in ensuring the country’s long-
term well-being, but that currently little effort is being made to limit cases of foodborne illness"

• Why is Africa importing $35bn in food annually?
(Source: Africa News, 17 April 2017)
"The President of the African Development Bank (AfDB) says his outfit has achieved major
milestones in this year alone but a lot more needed to be done to improve the continent’s
economic fortunes. Top of the AfDB’s proposals on how to ‘fast-track’ Africa’s economic potential is
to improve the power sector and to turn to agriculture. The AfDB believes that the continent must
break the food import chain and aim for self-sufficiency in food production within the shortest
possible time"

• Why is one-third of the world’s food being lost or wasted?
(Source: Boston Consulting Group, 14 Sep 2018)
"This infographic is based on Tackling the 1.6-Billion-Ton Food Loss and Waste Crisis, BCG article,
August 2018. The original data comes from the Food and Agriculture Organization of the United
Nations and the BCG FLOW model"

20. Fruit and vegetable farming

• 45 crazy uses for lemons that will blow your socks off
(Source: Real Farmacy, Feb 2019)
"Most people are familiar with the traditional uses for lemons to soothe sore throats and add some
citrus flavour to our foods. However, the diversity of applications for lemons far exceeds general
knowledge and once you read the following list, you’ll likely want to stock at least a few lemons in
your kitchen 24/7"

• Agricool raises another $28 million to grow fruits in containers
(Source: TechCrunch, 3 Dec 2018)
"French start-up Agricool is raising another $28 million round of funding (€25 million). The company
is working on containers to grow fruits and vegetables in urban areas, starting with strawberries"

• Fruit juices may have harmful levels of lead, arsenic, study finds
(Source: USA Today, 30 Jan 2019)
"Another knock against fruit juices: Many contain potentially harmful levels of arsenic, cadmium
and lead, according to Consumer Reports. The non-profit consumer research and advocacy group
tested 45 fruit juices (apple, grape, pear and fruit blends) sold across the U.S. and found elevated
levels of those heavy metals in nearly half of them. Particularly concerning to the researchers was
that many of the juices were marketed to children"
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- **Irrigating vegetables with wastewater in African cities may spread disease**
  
  (Source: Science Daily, 12 Oct 2018)
  
  "Urban farmers growing vegetables to feed millions of people in Africa's ever-growing cities could unwittingly be helping to spread disease by irrigating crops with wastewater, a new study reveals"

- **Bioelectronic 'nose' can easily sniff foul smells in rotting food**
  
  (Source: News Medical, 6 Dec 2017)
  
  "Strong odours are an indicator that food has gone bad, but there could soon be a new way to sniff foul smells earlier on. Researchers have developed a bioelectronic "nose" that can specifically detect a key decay compound at low levels, enabling people to potentially take action before the stink spreads. It can detect rotting food, as well as be used to help find victims of natural disasters or crimes"

- **Foodtech start-up creates portable scanner that detects chemical contamination**
  
  (Source: Food Navigator, 13 Mar 2019)
  
  "FoodTech start-up Inspecto has developed a portable scanner that detects chemical contamination in food in real-time, expected to be commercially available in 2020"

- **How farmers use the internet of things to stop disease**
  
  (Source: Bosch, 8 May 2018)
  
  "Agriculture is a difficult industry. It’s not just early starts and physical labour; it’s also the unpredictability. One bad frost or outbreak of disease, and the profits are gone. So, while we might harbour images of rustic farmhouses and rural landscapes, farmers eagerly embrace any technology that gives them more control"

- **How IoT is being used for Australian agriculture in 2019**
  
  (Source: Tech Republic, 28 Feb 2019)
  
  "The development of IoT for agriculture is still in its early stages, but it looks promising as more farmers are putting these technologies to work. Australian agriculture has historically been defined by long droughts and irregular rainfall. For farmers, these harsh conditions leave small margins for error, meaning that gruelling work on the paddock does not necessarily translate to healthy stock or strong crop harvests. One way that farmers have adapted to these conditions is the use of Internet of Things (IoT) devices and sensors. But in comparison to other sectors, farmers have been slow to adopt these technologies due to concerns surrounding the cost of implementation and ongoing service—particularly when there is no immediate value received for certain IoT technologies, which can sometimes take several years of accumulating data before it shows its value"

- **IoT is helping farmers run their farms from a smartphone**
  
  (Source: Business Insider, Sep 2018)
  
  "Farmers are now using the Internet of Things (IoT) to work remotely from a laptop, tablet or smartphone. It’s helping to create more sustainable farming methods, control farming strategy, and even give some time back to the farmers. Through automated monitoring of trends in weather, local water levels and soil moisture, it offers farmers visibility into the real-time performance of their irrigation to improve strategy"

- **Sensor monitors health of plants**
  
  (Source: R&D Magazine, 6 Nov 2018)
  
  "A Purdue University professor has built an innovative handheld sensor that gives plant scientists and farmers a more precise way of measuring the health of crops while gathering up-to-the-minute data that state and federal officials and others will find valuable"

- **The industrial internet of things is revolutionizing these 4 areas of food manufacturing**
  
  (Source: Manufacturing, 10 Jan 2019)
  
  "By now, we’ve all realized the reality of today’s internet-connected world: Smart devices aren’t..."
just in our pockets and in our homes. The Industrial Internet of Things (IIoT) is revolutionizing the food and beverage industry"

- **The ultimate ‘smell test’: Device sends rotten food warning to smartphones**  
  (Source: Science Daily, 27 June 2018)  
  "When it comes to the 'smell test,' the nose isn't always the best judge of food quality. Now scientists report that they have developed a wireless tagging device that can send signals to smartphones warning consumers and food distributors when meat and other perishables have spoiled. They say this new sensor could improve the detection of rotten food so it is tossed before consumers eat it"

**22. Investment, financing, insurance and business incubation**

- **5 agritech start-ups join Senegal start-up accelerator**  
  (Source: Disrupt Africa, 7 Jan 2019)  
  "Five agritech start-ups have been selected to join the Senegal start-up Accelerator run by Kosmos Innovation Centre and Reach for Change; receiving six months’ incubation and US$2,000 seed funding. The Senegal start-up Accelerator aims to support young Senegalese entrepreneurs with innovative ideas tackling the challenges facing the agriculture sector using technology"

- **A tech hub on the banks of the Sea of Galilee announces agritech venture fund**  
  (Source: Algemeiner, 8 Mar 2019)  
  "The Jordan Valley-based Kinneret Innovation centre (KIC) announced a new venture capital fund dedicated to agritech investments. KIC intends to raise $50 million for the fund, which is set to invest in start-ups local to the Jordan Valley. The fund will be backed by agricultural communities and kibbutzim in the area, and by international investors, KIC said. KIC is an agriculture and food technology hub and research lab located on the banks of the Sea of Galilee in northern Israel. The hub was founded by the Kinneret Academic College in collaboration with Zemach Regional Industries, a cooperative owned by 27 agricultural communities in the Jordan Valley"

- **Alfalfa risk management tools**  
  (Source: Brownfield Ag News, 8 Mar 2019)  
  "The president of the National Alfalfa and Forage Alliance says there’s a risk management tool many farmers aren’t aware of: The Alfalfa Seeding Year Insurance product. “It insures against that establishment year, which is one of the critical years in alfalfa production.”"

- **Basic farm tech tools won’t provide VCs the exit returns they need, so why are VCs still investing in them?**  
  (Source: Ag Funder News, 13 Mar 2019)  
  "Agtech point solutions focused on improving the efficiency of current farming practices are great but they are not going to provide venture capital firms with the exit returns they need to justify their business model"

- **Cutting edge agriculture: how artificial intelligence, satellites and big data are transforming farmers’ access to finance**  
  (Source: Next Billion, 8 Jun 2018)  
  "It is often said that there is more “tech” than “fin” in fintech innovation. But when it comes to the oldest sector in the world, agriculture, this dichotomy isn’t sustainable: Both a financial and a technological revolution are necessary to meet the burgeoning demand. The latest World Bank estimates suggest the demand for food is expected to rise 70 percent by 2050 to feed an estimated 9 billion people. Agricultural finance, therefore, is not just an enabler of farmers’ success — it has become an imperative for everyone’s existence. Bridging the $450 billion gap in financing, of which roughly 3% is met, is a gigantic task. It will require a new synergy between financial and technological tools – and fortunately, this transformation is underway"
• Elemental Excelerator provides up-to $1m to start-ups tackling our biggest agriculture challenges
(Source: Ag Funder News, 27 Feb 2019)
"Elemental Excelerator, a non-profit funder of agriculture, water, energy, mobility, and circular economy start-ups, is accepting applications for its 8th cohort. The growth-stage accelerator fills a capital gap for start-ups that exists between pilot and commercialization"

• Fintech for farming
(Source: Newsbytes, 11 Feb 2019)
"Where farming is concerned, the Philippines is a picture of irony. The country has a land area of 30 million hectares, 47% of which are agricultural lands planted to rice, corn, coconut, bananas, pineapple, sugarcane, mangoes, and other crops. It is even one of the world’s major rice importers"

• Foodtech connect Arabella advisors on transformative food system investment opportunities
(Source: FoodTech Connect, 14 Feb 2019)
"An advisory that helps its clients develop food system, conservation and climate change related philanthropic and policy strategies. They also lead Good Food Ventures, an investment club that sources and diligences transformative market-based solutions"

• For agritech, digital health start-ups, enormous opportunities in Africa and India
(Source: Forbes, 20 Sep 2018)
"According to a McKinsey report, Africa’s agri-food manufacturing sector presents tremendous market potential for companies across the value chain – from agritech and food production, to food processing and packaging. The UN says Africa’s food production industry is poised to be worth US$1 trillion by 2030 as the continent seeks to substitute imports with high-value domestically-manufactured food. As Africa’s population doubles over the next 30 years, the business opportunities in Africa’s agribusiness space should be enormous"

• How start-ups are accelerating the future of food
(Source: Food Dive, 11 Feb 2019)
"It wasn’t long ago that consumer packaged goods (CPG) titans drove a majority of the food industry’s R&D programs in-house, but times are changing—and fast. As many of the legacy programs become obsolete, more and more CPGs are transitioning to an approach that has them nurturing and mentoring cutting-edge start-ups through emerging business incubators or accelerators"

• Making African agriculture more attractive for investors
(Source: African Business Magazine, 20 Sep 2018)
"While global population growth slows, Africa’s population is set to double over the next three decades, reaching around 2.2bn people by 2050. This surge in numbers will have significant ramifications for the continent’s food security, which is already under pressure mainly due to climate change. The good news is that Africa’s agriculture sector has been growing at a steady pace and the continent boasts at least 65% of the world’s uncultivated arable land. If this is fully utilised, then African farmers could meet the food needs of the entire world"

• Steak and chips: How IoT and machine learning will disrupt risk in animal insurance
(Source: TechRadar, 1 Oct 2018)
"On the face of it, the connection between the internet of things (IoT) and animals is not an obvious one. However, a number of trials and larger-scale implementations of IoT use with household pets and on farms are showing that connecting Fido and Daisy to sensors could provide real benefits"

• Sum-Africa project offers unique insurance service to farmers in Uganda
(Source: Property Casualty 360, 12 Feb 2019)
"In Uganda, farmers face increasing exposure to risks associated with changing weather patterns, suffering from severe drought and the effects of climate change. As a result, farmers’ crops are often destroyed in these poor conditions with no insurance to help recover the cost, sending many African farmers into a vicious cycle of poverty while also creating a devastating food shortage. To
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help protect farmers and increase sustainable food production, the SUM-Africa project, supported by the Geodata for Agriculture and Water (G4AW) program of the Netherlands Space Office (NSO), provides satellite-based drought index insurance to protect these smallholders, offering a cheaper insurance product where there are very few other options

• The agtech industry may be growing up
  (Source: Forbes, 8 Mar 2019)
  "The AgTech industry is continuing to mature, at least according to AgFunder’s latest AgriFood Tech Investing Report. This “record breaking year” for the industry included $16.9 billion in funding spread across 1,450 investments"

• This agritech start-up is digitizing operations for Nigerian farmers in Port Harcourt
  (Source: TechMoran, 30 July 2018)
  "Structurally, CAD Digital Consulting is a three-pronged system consisting of software as a service (SaaS), the consulting division and a business incubator. These systems interplay in advancing the concept of a digital farm. “There’s a dynamic to farming. For every agricultural production, there are standard business processes to follow. But the digital farm model, is what makes production optimal. In poultry farming, for example, the poultry management system — which automates egg production — is a use case for digital farming"

• Why Maersk is investing in agrifood tech start-ups
  (Source: Ag Funder News, 14 May 2018)
  "Maersk, the end-to-end transport and logistics company and the biggest food transporter in the world, is currently accepting applications from agrifood tech start-ups to take part in an equity-free start-up support program called FoodTrack. The program, a partnership with the multi-vertical start-up accelerator, Rockstart, will focus on combating food loss across the supply chain"

23. Mobile technologies and telecommunications

• App promises to save tea farmers billions of shillings
  (Source: Business Daily, 10 Oct 2018)
  "He has developed a mobile phone application dubbed Ukulima Halisi that he says can save tea farmers at least Sh33 million monthly and enable children to focus on their studies without having to waste time waiting for lorries to collect the tea. The app, which can be downloaded from the Google Store, alerts farmers on the date and time when tea will be collected and delivered to the factory"

• Farm Dog, John Deere and Adama unveil mobile-to-sprayer integration solution
  (Source: Precision Agriculture, 26 Feb 2019)
  "Farm Dog, John Deere, and ADAMA recently previewed their mobile-to-sprayer integrated solution to 750 agriculture professionals at the 2019 Develop with Deere Conference in Chicago from January 23-24"

• Farmers say poor rural connectivity is leaving them behind
  (Source: TechRadar, 16 Jan 2019)
  "The National Farmers Union (NFU) says it plans to hold the government to its pledge to improve rural connectivity after a new report highlighted the persistence of poor mobile and broadband coverage in remote areas"

• How 5G will impact the future of farming and John Deere's digital transformation
  (Source: ZD Net, 22 Oct 2018)
  "At 180 years old, John Deere has become a household name that conjures images of farmland, tractors and rural America. But what’s less known about the iconic company is that it’s become a leading tech innovator in the precision agriculture space, and in many ways, serves as an example of how every business is digital"
• **Microbes, drones and artificial intelligence may be keys to farms of the future**  
  (Source: Clean Technica, 16 March 2018)  
  "Fertilizers, pesticides, and genetically modified seeds are doing a dance of death that is making it harder for farmers to grow crops without using more fertilizers, pesticides, and genetically modified seeds. All that “better living through chemistry” is turning farms into barren places unable to support the growth of fruits and vegetables”

• **Mobilising mobile in agriculture**  
  (Source: Disruption Hub, 10 Dec 2018)  
  "Farmers are calling on mobile technology to streamline the agricultural industry. Back in 2011, Accenture’s Connected Agriculture report concluded that mobile technology had the potential to increase global agricultural revenues by $138bn. The report also suggested that mobile solutions could reduce the industry’s CO₂ equivalent emissions by almost five mega tonnes. The fact that mobile could bring about huge developments in AgTech is now common knowledge. But how much progress has been made, and what needs to happen to make the mobile agricultural revolution a reality?"

• **New app helps farmers track profitability in real-time**  
  (Source: Ag Web, 13 Feb 2019)  
  "As farmers look to develop marketing plans for the coming growing season, there’s a new app that can help them track profitability in real time. The Bennett Consulting Profitability App was designed to keep producers informed on profitability per acre on a daily basis"

• **Smartphone system more quickly detects foodborne pathogens**  
  (Source: Mobihealth News, 16 May 2018)  
  "Researchers at Purdue University have developed a new system that enables normal smartphones when paired with a phone cradle to detect foodborne pathogens in produce"

• **The global connected agriculture market is expected to grow from $1.8 billion in 2018 to $4.3 billion by 2023, at a compound annual growth rate (CAGR) of 19.3%**  
  (Source: PR Newswire, 11 Feb 2019)  
  "Growing need to increase farm yield and reduce labour cost, and rising government initiatives for modernizing the agriculture industry are expected to drive the overall growth of the connected agriculture market"

• **The Khula app is revolutionizing small-scale farming in South Africa**  
  (Source: Ventures Africa, 8 Nov 2018)  
  "South Africa’s agricultural sector is unique in such a way that it favours industrial farming, unlike in many countries on the continent. However, the recent debate over expropriation of land in South Africa, most of which is used for farming, have sparked discussions about the increase of small-scale farming in the country"

• **This Ghanaian start-up enables remote farming**  
  (Source: Ventures Africa, 23 Aug 2018)  
  "Founded in June 2017 by a team of agricultural scientists, entrepreneurs and engineers, CompleteFarmer is a “crowd farming” platform that gives users the opportunity to own and manage farms on their devices from the comfort of wherever they are. What this means is that expert farmers and farm managers do the actual farm work in the communities where CompleteFarmer operates, while farm owners and sponsors monitor farm progress on their mobile devices from wherever they are. After harvest, the produce is sold at a profit to ensure the farm sponsors get returns"
24. Organic and vegan food and farming

• Big food and non-profits are promoting organic conversion, so why aren’t there more organic-focused technologies?
  (Source: Ag Funder News, 21 Feb 2019)
"Organic grain production in the US is not growing fast enough, according to a new report from the US Organic Grain Collaboration in partnership with the Organic Trade Association. The amount of US farmland devoted to the production of organic corn, soybeans, wheat, oats, and barley grew by over 20% from 626,000 acres to 765,000 between 2008 and 2016. During roughly the same timeframe, however, the US organic livestock products industry nearly tripled in size from $1.2 billion in sales to $3.3 billion. As the demand for organic products and ingredients continues to grow, increasing numbers of US farmers are interested in converting all or portions of their acres to organic production. Between 2015 and 2016, organic food sales increased by 23% to $7.6 billion in 2016, while the number of organic farms increased by just 11%. The US is making up for the shortfall with imports from overseas countries including Turkey, the UK, India, Turkey, and Argentina"

• Can vegan pet food be good for the planet and your pet?
  (Source: Inhabitat, 20 Dec 2018)
"Does your pup hover at your feet when the smell of bacon or steak wafts in his direction? It’s no surprise, considering the ingredients dogs are used to receiving and the evolution of the species. Every bag of food at the pet store promotes meat as its main ingredient. From chicken to lamb to bison, meat reigns supreme in the pet food world. Now it is coming to light that maybe it would benefit the planet and our pets if we moved to vegan food to fulfil their dietary needs. But is a plant-based diet both good for your pup and our Earth?"

• Kyrgyzstan announces 10-year plan to switch to 100% organic agriculture
  (Source: Natural News, 2 Mar 2019)
"The tiny country of Bhutan in southeast Asia was the first country in the world to implement a 100% organic, GMO-free national agricultural plan. Then, in 2014, another small country, Kyrgyzstan, banned the cultivation and importation of genetically modified crops. And, taking it a step further, late last year the country’s parliament announced a 10-year plan to slowly phase out non-organic farming and make the switch to 100% organic agriculture"

25. Poultry farming

• Can chickens work as tiny pharmaceutical factories?
  (Source: Modern Farmer, 20 Feb 2019)
"When you hear “chickens are being bred to lay cancer-fighting eggs,” it would be pretty understandable if you were sceptical. A team of researchers from Scotland made news with that very product, but the truth of what they’ve done, or could do, is much more complex, interesting, and, potentially, real"

• Machine-learning identifies source of salmonella
  (Source: New Food Magazine, 12 Feb 2019)
"A team of scientists led by researchers at the University of Georgia centre for Food Safety in Griffin has developed a machine-learning approach that could lead to quicker identification of the animal source of certain Salmonella outbreaks"

• New salmonella controls put to the test: Folium Science undertakes poultry trials for "guided biotics"
  (Source: The Poultry Site, 23 Feb 2019)
"Folium Science continues to prove the efficacy of its unique and patented Guided Biotic™ technology to counter productivity losses associated with the burden of bacterial pathogens in farmed animals"
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- **Poultry farmers undergo bio-security training at Wamfie**
  
  (Source: Modern Ghana, 2 Oct 2018)

  "Poultry farmers in the Dormaa East District, have began training on how to ensure bio-security on their farms. Bio-security however, is ensuring good management practices to prevent diseases from coming to the farm and to also stop diseases from living the farm to other farms or homes. The training is part of a five year Ghana Poultry Project (GPP) sponsored by the United States Department of Agriculture to increase competitiveness of the domestic poultry and improve profitability of egg production"

- **Spotting salmonella could be twice as quick**
  
  (Source: The Poultry Site, 11 Feb 2019)

  "New research using viruses that infect salmonella bacteria could halve the time it takes to detect the foodborne pathogen"

- **The man who dreams of bringing intensive chicken farming to Africa**
  
  (Source: The Guardian, 27 Dec 2018)

  "The three partners aim to revolutionise food production in central Africa and “save” people from hunger by growing chickens on an American scale. The little chicks and hens are the expeditionary force of an army of Cobb 500s to follow. There are probably far more Cobb 500s alive than there are humans Irvine’s $20m (£15m) parent stock laying eggs on the high plains below Mount Kilimanjaro is just the start. In a year’s time they expect to be sending 500,000 fertilised eggs a week to a sister hatchery on the Tanzanian coast, where millions of one-day-old chicks will be sold to local farmers. In a few years they could be rearing and exporting 40m or even 50m broilers a year to neighbouring Kenya, Rwanda, the Democratic Republic of the Congo and other African countries"

- **Robotics and automation**

  (Source: RTOZ, 12 Feb 2019)

  "This robot can see the fruits and understand whether they are ripe and ready to pick, even in highly cluttered and complicated growing enrolments. Robot grippers can reach deep into tangled vines and pluck a single dried fruit without leaving a mark. It moves around inside of your plant records more than just a gentle touch. The sensors of the robot see the world in full 3d and can use this information to plan just the right path to the target"

- **5 robots that are changing agriculture forever**
  
  (Source: Wonderful Engineering, 14 Dec 2018)

  "By the year 2050, the world population is expected to rise to an extreme 9 billion. With this increase, there will be a devastating increase in the agricultural needs and demands. To cover up these needs fast, farmers are turning their attention toward robots"

- **9 robots that are invading the agriculture industry**
  
  (Source: Interesting Engineering, 13 Nov 2018)

  "The world population is expected to hit a whopping number of 9 billion by 2050. What is expected to follow is a dramatic rise in agricultural production, doubling to meet the coming demand. This need has caused farmers to turn to robotics as a solution for the coming future"

- **Agri robots to be put through their paces on farm trial**
  
  (Source: Agriland, 26 Dec 2018)

  "A three-year trial to test farmbots – farm robots – has been announced between the John Lewis Partnership and the Small Robot Company in the UK. The arrangement will see the partnership test out these farm robots at its farm in Leckford, Hampshire"

- **Building the robo-farm**
  
  (Source: Disruption Hub, 14 Nov 2018)

  "The agricultural industry adopts new technology in the face of chan. It’s no secret that the global jobs market is saturated – but not, it would seem, if you want to be a farmer. In 2016, UK farm
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labour saw a 17% shortfall. The following year, this number had increased to 29%. In 2018, the situation was expected to deteriorate. In the US, the agricultural sector appears to face the same problem. Without enough workers, farmers are forced to leave crops unharvested, cutting output and therefore income"

- **How an asparagus farmer’s death spurred robotic innovation**
  (Source: BBC, 20 April 2018)
  "White asparagus needs to be picked at a particular moment while it is still under the ground, otherwise it turns green. It is often difficult to detect and can be damaged easily. So in 2000, fed up with his situation, the farmer challenged his inventor brother to make a robot to replace human workers"

- **How robots could save strawberries, green agriculture and feed a growing population**
  (Source: Nvidia, 24 Oct 2018)
  "Like strawberries? Changes in the labour market mean harvesting fresh strawberries by hand may soon be economically unsustainable. The solution: a wild new breed of robots developed by Harvest CROO Robotics — a start-up backed by strawberry growers — that can identify ripe fruit and gently snap it at the stem"

- **How small robots may kill the tractor and make farming efficient**
  (Source: Wired, 11 Nov 2018)
  "Agriculture has a reputation of being stuck in the past. In reality, for farmers, their workplaces are a fertile testbed for innovative technology – they were among the first to embrace commercial drone use, and autonomous vehicles that could work effectively (and safely) in confined areas of farmland"

- **Mamut agritech robot captures crop data autonomously**
  (Source: The Engineer, 12 Mar 2019)
  "Cambridge Consultants has developed an autonomous four-wheeled robot called Mamut that captures data on individual crop health and overall yield. The robot’s sensor suite includes stereo cameras, LIDAR, an inertial measurement unit (IMU), a compass, wheel odometers and an onboard AI system that collates all of the input data"

- **Research and Development in agricultural robotics**
  (Source: Drone Below, 30 Aug 2018)
  "Farming is often thought as an ancient practice with conventional means, a practice in stark contrast with modernized urban practices and technologies like robotics, smart solutions, deep learning, uses of UAV’s and optimization of processes"

- **Robotic indoor farms can grow food anywhere, anytime**
  (Source: ZD Net, 19 Oct 2018)
  "This device is unable to play the requested video. Robots could turn a basic concept of farming on its head. What if, instead of growing crops in rows spread across many acres of land, food could be grown in vertical columns?"

- **Robots and AI combine for precision future farming platform**
  (Source: The Engineer, 2 Nov 2018)
  "A UK agritech start-up is developing a complete arable farming system that combines AI and robotics for more precise planting, better yields, and reduced pollution and waste. The concept comes from Small Robot Company, a collective of farmers, engineers and scientists hoping to transform the face of agriculture"

- **Robots may run farms in the future, according to researchers**
  (Source: Precision Agriculture, 14 Feb 2019)
  "Agriculture, one of the world’s oldest vocations, is also one that continues to reinvent itself with new technology, according to an article on AgDaily.com. From the introduction of the steel plow to automated tractors to modern fertilizer applications, technology has improved effectiveness and increased efficiency"
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• Robots might end coffee as we know it
  (Source: Business Insider, 10 Dec 2018)
  "$2 trillion in annual US wages could be affected by automation, RBC says in a new report. RBC analysts argue that the loss of "grunt work" means that people will no longer need caffeine in 2025 in the same way they do in 2018. Instead of sipping coffee, people will turn to CBD to ease the anxiety of 2025’s tech overload, RBC analysts theorize"

• The robotic farm of the future isn’t what you’d expect
  (Source: The Verge, 9 Oct 2018)
  "When we think about automation, we often imagine robots just doing the work of humans. Our mental image is of an android in overalls, clocking in with a lunchbox full of oil and bolts, and grabbing a hammer. But that’s not what happens. The reality is much messier, and the process of automation is one of compromise and incremental progress. Agritech start-up Iron Ox is the perfect example of this. After launching in 2015 with the aim of automating the hard work of growing produce, the company unveiled its first “autonomous” production farm last week. In 8,000 square feet of indoor space (roughly 0.2 acres), its engineers use proprietary robot systems to grow roughly 26,000 heads of lettuce, leafy greens, and herbs each year in hydroponic vats"

• The world’s first autonomous farm features a 1,000-pound robot farmer named Angus
  (Source: Business Insider, 3 Oct 2018)
  While the typical farmer has to check crops multiple times a day, making sure they have the proper amounts of water, nutrients, and nitrogen, Angus speeds up the process by transferring crops from the harvesting area to the production centre"

• World’s first fully automated indoor farm is being built in Ohio
  (Source: Mental Floss, 30 Sep 2018)
  "Farming has changed drastically in the last couple decades, but the mental image of people toiling in the fields from sun-up to sundown still persists. Alas, those days are quickly changing. Farming is now a high-tech business, and many farm owners are now using robotics and artificial intelligence to get the job done"

27. Satellite observation and remote sensing

• Satellites warn African farmers of pest infestations
  (Source: BBC, 30 Nov 2018)
  "UK researchers have developed an early warning system to prevent the crops of African farmers from being devastated. The Pest Risk Information Service (Prise) combines temperature data and weather forecasts with computer models. It then sends farmers a mobile phone alert so that they can take precautions. It is hoped that the system will boost yields and increase farm incomes by up to 20%"

• Taranis unveils enhanced platform for aerial imagery insights into farming
  (Source: SUAS News, 12 Mar 2019)
  "Leading precision agriculture company Taranis today announced the launch of its updated platform. The company has also expanded its fleet to over one hundred manned aircraft and autonomous drones increasing reach for global customers worldwide"

28. Smart and precision farming

• ‘Smart farming’ plows ahead in Japan
  (Source: Precision Agriculture, 19 Feb 2019)
  "Smart farming,” which utilizes cutting-edge robotics and artificial intelligence, could hold the key to an agricultural resurgence in a nation of greying farmers and a general population reluctant to toil in the soil"
• 12 smart farming companies making farmers smarter
(Source: Precision Agriculture, 19 Feb 2019)
"While the Internet of Things (IoT) continues to transform practically every aspect of our existence, the agriculture sector is only now starting to really benefit from technologies like sensors"

• Africa: Smart agriculture in action
(Source: All Africa, 24 Jan 2019)
"UN Environment and partners are working in Africa to boost agricultural production, create jobs, and counter climate unpredictability. In Cameroon’s Sud Province, solar driers have been used since early 2018 to dry cassava and store it for longer, allowing farmers to get better prices"

• Airbus adds new service Verde to its precision farming portfolio
(Source: EI Journal, 5 Feb 2019)
"Airbus launched an innovative service called Verde that delivers detailed crop analytics from satellite imagery, perfectly clipped to the field and accurately de-clouded. Served as plug and play API to any precision agriculture portal, Verde provides reliable and quantified measures of the vegetation, consistent over time and space, whatever the satellite used"

• Cultivating the omnichannel farmer
(Source: McKinsey, Feb 2019)
"Smart agriculture suppliers are giving farmers what every consumer wants: a digital interface for speed and convenience and human interaction when they need it. Here’s how they’re doing it"

• How self-driving tractors, artificial intelligence, and precision agriculture will save us from the impending food crisis
(Source: Tech Republic, Dec 2018)
"Go inside the race to feed the 9 billion people who will inhabit planet earth in 2050. See how John Deere and others are working to change the equation before it’s too late"

• Precision agriculture industry at risk of imminent cybersecurity threats
(Source: Sensors Tech Forum, 5 Oct 2018)
"A report from the U.S. Department of Homeland Security called Threats to Precision Agriculture warns against the cybersecurity risks faced by the emerging technologies being adopted by the agricultural industry. Known as “precision agriculture,” the technologies include internet of things (IoT) devices such as remote sensors and global position systems (GPS) and the communications networks that support them. These devices generate large amounts of data which is then analysed by machine learning systems to improve crop yield and monitor the health of livestock"

• Precision farming enables cost savings in a tight economy
(Source: Engineering News, 31 Jan 2019)
"Agricultural equipment manufacturer John Deere has evolved from supplying ploughs more than two centuries ago, to farmers being able to control their whole fleet through an app"

• Progress and trends shaping higher education in precision agriculture
(Source: Precision Agriculture, 1 Mar 2019)
"As a greater number of producers adopt precision ag technologies in their operations, and a greater number of firms create and market solutions to meet this demand, we’ve seen a greater number of colleges and universities expand their precision ag offerings for students wanting to work in the industry. Because of wider trends in agriculture and technology, the importance of digital farming will undoubtedly increase in the coming years"

• Smart farming: a pathway for agricultural revolution in Nigeria?
Source: Leadership, 20 Apr 2018)
"Globally, the agricultural sector will certainly face enormous challenges to feed this ever-increasing population. According to experts, food production must increase to 70% by 2050, and this has to be achieved in spite of the limited availability of arable lands and the increasing need for fresh water by many competing issues (industries, domestics and agriculture). Agriculture consumes 70% of the world’s fresh water supply"
• Solving problems with smart agriculture and precision farming
(Source: Digital Pulse PwC, 11 Feb 2019)
"The world’s population is expected to hit 11 billion people by 2100, but land is scarce and farm yields flatlining. Farms must be more efficient, produce more and do less environmental damage. AI, robotics, drones and IoT are just some of the technologies revolutionising agriculture, often in unexpected ways"

29. Vertical farms, rooftops and containers
[Back to Quick Links]

• Cloud tech tapped for urban greenhouses: ‘this is the return of small farms’
(Source: Food Navigator, 12 Feb 2019)
"An urban farming business that develops modular, automated greenhouses for the city environment says it is looking to expand beyond Russia into EMEA markets"

• Futuristic agriculture at Scotland’s first ‘vertical’ farm
(Source: BBC, 24 Aug 2018)
"When you step into the air lock which protects Scotland’s first "vertical" farm from the uncontrolled outside world, it feels like you’re stepping into the future. Inside, bright LED lights of differing colours keep the plants illuminated while vents distribute exactly the right flow of air. The idea is to create the most precise, time-efficient and waste-free method of growing"

• How Abu Dhabi found a way to grow vegetables in 40-degree heat
"Could you grow your lunch in an old shipping container? One that’s situated in 40-degree desert heat?"

• How Singapore is securing its food supply with rooftop farms
"Visitors to Singapore’s Orchard Road, the city’s main shopping belt, will find fancy malls, trendy department stores, abundant food courts – and a small farm. Comcrop’s 600-square-metre (6,450-square-foot) farm on the roof of one of the malls uses vertical racks and hydroponics to grow leafy greens and herbs such as basil and peppermint that it sells to nearby bars, restaurants and stores"

• Modular shipping containers are being repurposed for food production
(Source: Modern Farmer, 23 Oct 2018)
"The so-called “cheese pods” that have helped the Mystic Cheese Co. grow are actually upcycled containers, now being used by food producers across the country. On a 900-acre family-run dairy farm in Lebanon, Connecticut, two shipping containers sit among the barns and fields"

• On rooftops and in tunnels, city farms lead food revolution
(Source: The Guardian, 10 Feb 2019)
"Only the Northern line tube trains rumbling through tunnels overhead provide any clue that Growing Underground is not a standard farm. The rows of fennel, purple radish and wasabi shoots could be in almost any polytunnel, but these plants are 100 feet below the street and show that urban agriculture is, in some cases at least, not a fad"

• Precht designs timber skyscrapers with modular homes and vertical farming
(Source: Arch Daily, 25 Feb 2019)
"Precht has designed a timber skyscraper concept that combines modular housing with vertical farming. The concept was created by Penda’s co-founder and his wife to reconnect people in cities with agriculture. In their proposal, the modular housing units would be built so that residents can produce their own food. Dubbed the Farmhouse, the concept aims to create more sustainable ways of living as city dwellers are increasingly losing touch with food production"
• Superfarm is an urban vertical farm that is energy self-sufficient
  (Source: Inhabitat, 19 Feb 2019)
  "French design practice Studio NAB has proposed a large-scale vertical farm as a sustainable solution to urban population growth in the face of dwindling arable land. Envisioned for urban centres, the conceptual vertical agriculture facility (the 'Superfarm') aims to produce high-yielding food with high nutrition values, including but not limited to various seaweeds, edible insects and fish raised in aquaponic systems. To minimize the Superfarm’s impact on the environment, the designers have also proposed that the futuristic indoor farming concept be powered entirely with renewable energy from wind turbines and solar panels"

• What is the future of container farming?
  (Source: Ag Funder News, 7 Feb 2019)
  "Over the past two decades, technology has allowed for drastic evolutions in many industries, such as the auto and retail industries. At first glance, the agricultural space seems to have lagged behind. Despite a clear desire for locally grown produce, today more than half of the fresh fruit and over one-third of the fresh vegetables that Americans buy is grown outside of the United States"

30. Wine and vineyards

• Counterfeit spirits and wine costs European countries €2.7 billion each year
  (Source: New Food Magazine, 6 Jun 2018)
  "Counterfeit spirits and wine cost the European economy €2.7 billion a year, a new report has revealed. In the UK alone, fraud in the sector cost €249 million (£218 million). According to the EUIPO, examples of domestic counterfeiting included criminal gangs across the EU (Belgium, Czech Republic, Spain, Italy, Poland, Portugal and the UK) repackaging of cheap wine in expensive bottles"

• Experts looking at the possibility of making wine on mars
  (Source: Mysterious Universe, Jan 2019)
  "If humans eventually get to colonize on Mars, they may still be able to drink alcohol on the Red Planet. The country of Georgia, which has been cultivating grapevines for around 8,000 years, is getting their best space and wine scientists to determine how they can grow grapes on Mars"

• From solar panels to sheep, winemakers take eco-friendly steps to grow their businesses
  (Source: Market Watch, 23 Apr 2018)
  "Photovoltaic systems, recycled glass, and Babydoll Sheep. These are just some of the eco-friendly tools that vineyards around the world are using to produce bottles of wine. Cavit Wines is an Italian winemaker in the Trentino region of northern Italy. It’s also one of the biggest U.S. imports of Pinot Grigio and Pinot Noir. To make all that wine, Cavit uses solar power. In addition, 80% of the glass and aluminium it uses is recycled, and the company has sustainable farming technologies and minimal irrigation systems in place"

• Glyphosate found in 19 of 20 beers and wines tested
  (Source: Ecowatch, 26 Feb 2019)
  "Glyphosate—the active ingredient in Monsanto’s Roundup weed killer that some studies have linked to cancer—is also a secret ingredient in nearly 20 popular beers and wines. That’s the finding of a new study from the education group U.S. PIRG, which found glyphosate in 19 of 20 wine and beer brands tested, including organic labels and brews"

• It takes status to succeed in the US wine business, says two academic researchers
  (Source: Forbes, 9 Mar 2019)
  "In a paper titled “Status Games: Market Driving through Social Influence in the U.S. Wine Industry,” the two researchers analysed the U.S. wine market with an aim to answering three questions: How do firms drive markets without technological innovation? How do firms create enduring competitive advantage with a market-driving approach? What conditions favour a market-driving approach?"
• **Magnetic treatment could help remove ‘off-flavour’ from wines**  
  (Source: Science Daily, 13 Jun 2018)  
  "From vine to wine, grapes undergo a remarkable transformation. But sometimes this makeover results in vino that doesn’t taste quite right. Scientists now report that they have found a way to use tiny magnetic particles to remove off-tasting substances in cabernet sauvignon without altering its desired bouquet. Eventually, they say this technique could help remove unwanted flavours from other wines”

• **Millennials buy more wine online and want it to be organic**  
  (Source: Beverage Daily, 27 Feb 2019)  
  "Across food and beverage, consumers are demanding transparent supply chains. They want to know what goes into products before they purchase and consume them, and have made a push for more organic and sustainable choices”

• **Overstock’s investment arm funded blockchain for wine**  
  (Source: TechCrunch, 4 Oct 2018)  
  "Of all the things to add to the blockchain, wine makes a lot of sense. Given the need for provenance for every grape and barrel, it’s clear that the ancient industry could use a way to track ingredients from farm to glass. VinX intends to create a “token-based digital wine futures platform based on the Bordeaux futures model” that lets you track wine from end to end “at a cost bearable to the industry”

• **Smart wine: Libelium’s IoT technology allows predictive control of vineyards in the Pago Pylés winery, Spain**  
  (Source: Libelium, 21 Mar 2018)  
  "The IoT technology applied to precision agriculture provides great benefits such as improved productivity, cost savings and increased predictive capacity in determining strain behaviour during the grape ripening process. The Pago Aylés winery, in collaboration with the company remOT Technologies, has invested in an IoT project with Libelium technology in order to gain efficient production and a predictive vineyard management model”

• **The internet of wine: From agtech to smart cellars**  
  (Source: IoT for All, 12 Feb 2019)  
  "IoT solutions can help winegrowers and winemakers control environmental variables and gain more insight into the production process, thereby enhancing both their bottom line and the end product. Needless to say, IoT applications in the winemaking business are still in the early stages of development”

• **This is how climate change will impact wine**  
  (Source: Inhabitat, 14 Feb 2019)  
  "Look at a wine label or chat with a wine connoisseur, and you will find that wine has always been intimately connected to location and climate. Grapes taste different from region to region, and even grapes from the same vineyard taste different from year to year, depending on the weather each season”

• **This school for wine adds an online wine sales management course**  
  (Source: Forbes, 13 Jan 2019)  
  "You can take an online course in accounting, an online course in fine arts and an online course in astrophysics, so why not take an online course in wine business management—or wine sales management?”

• **This wine fridge uses artificial intelligence to learn what you like to drink**  
  (Source: Food and Wine, 20 Feb 2019)  
  "Appliance brand Signature Kitchen Suite offers an app to track your wine collection and make recommendations based on it. Imagine a wine rack that learns what you like and recommends new wines to try when you add a new bottle"
Wine could soon come in flat bottles
(Source: Specialty Food, 1 Mar 2019)
"Wine may soon be distributed in flat plastic bottles, in an effort that could reduce carbon emissions and costs in the industry’s supply chain, reports The Guardian. The flat bottles are an alternative to the glass model that remains unchanged since the 19th century. The global wine industry is estimated to use more than 35 billion glass bottles a year and transportation involves large volumes of unused airspace"
# Innovation Insight

**No 10/19   March 2019**

Impact of emerging technologies on agriculture: Recent trends

## A selection of the emerging technologies continuously monitored by DeltaHedron®

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## Business impact and cross-cutting themes

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The impact of emerging technologies on agriculture

Recent trends

DeltaHedron® Ltd is a UK-based consulting firm with a global reach, specialising in the management of technological innovation. Our focus is on providing our clients with technology intelligence and decision support to assess and manage the strategic business impact, opportunities, risks and threats presented by emerging technologies and the dynamics of technological change.

“A company with an engineering soul, an innovation mindset and a business outlook”