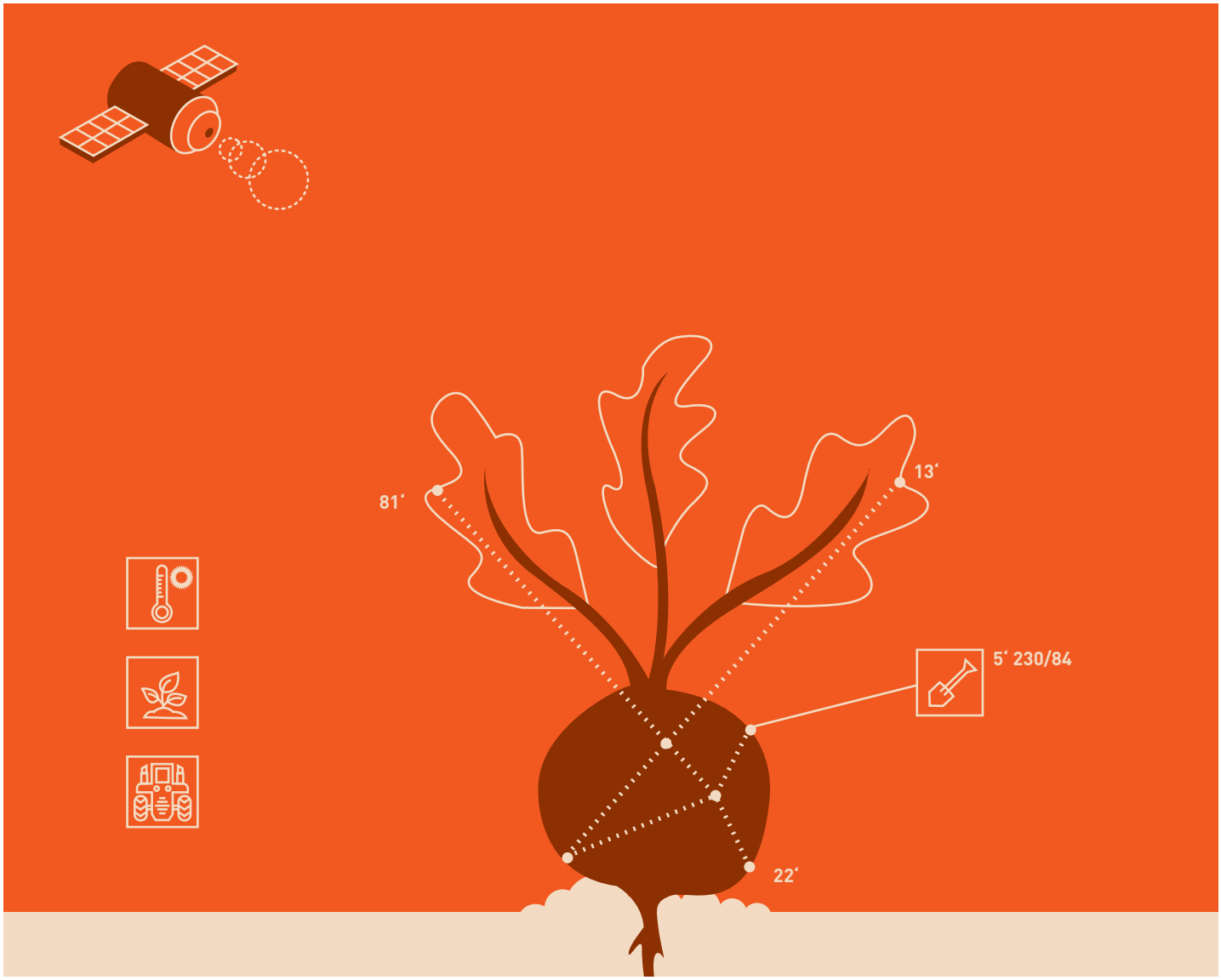


Trends To Watch

Production: How will the food supply for the world population be guaranteed in 2050?

Population growth, larger cities, increasing health awareness – agriculture is having to facing these challenges to an ever greater degree each year. By 2050, world population is expected to increase to 9.7 billion.[1] How will it then be possible to feed all these people with traditional farming practices? In addition, urban growth is encroaching on farmland, while the demand for fresh vegetables and fruit resulting from increasing health awareness continues to rise. In 30 years' time more food will have to be produced on a dwindling production area. How can we overcome this challenge? Scientists are under extreme pressure to develop efficient new cultivation methods which require less space and preserve natural resources while at the same time helping to remedy the major issue of food waste.

[1] news.nationalgeographic.com/2015/07/world-population-expected-to-reach-9-7-billion-by-2050/

INDUSTRY 4.0: THE INTERNET OF THINGS, BIG DATA AND PRECISION FARMING

What is it all about?

As part of the 4th industrial revolution and the internet of things, agriculture is taking a big step towards full automation. Machines, plants and computers communicate and cooperate directly with each other. Since computers are continuously becoming smaller and better embedded, people hardly notice their presence these days. And as a result of the constant interaction between the different computers, enormous volumes of data are being produced. The retail trade and food service sectors have already been using big data for some time to understand customer actions and attitudes. This mass data should equally help to support agriculture. In this case it is not about collecting customer information, but rather generating information about factors which might influence the effectiveness of agricultural production. Precision farming is a term that is often used in relation to big data in agriculture. Precision farming – or precision agriculture – involves taking account of ground or microclimate variations within a particular cultivation area in order to optimise yields. Subsection-specific cultivation allows for measures such as adjusting the amount of seed or fertiliser used to specific ground conditions, thus helping to reduce the application of chemicals.

Assessment of opportunities and risks

Big data and precision farming allow a significantly more efficient cultivation of land, resulting in more sustainable agriculture with lower crop protection use and less irrigation.

Opportunities: While precision farming is usually based on big data, big data does not automa-

tically equate to precision farming. Big data analytics can also utilise data from weather stations and satellites, and other sensors used primarily for scientific purposes. This allows, for instance, the prediction of crop disease epidemics.

Risks: Big data usually means that insights are based on historical data. Unforeseen circumstances are not necessarily considered. The effort and financial resources necessary in implementing precision farming on smaller areas of land would have to be quantified in advance.

Examples:
www.precisionag.com
Variable-Rate Application (VRA) means that the seeds and fertiliser are distributed in variable quantities based on land mapping and alignment with the specific ground conditions.

Flint River Partnership
The Flint River Partnership strives to optimise field irrigation in Georgia. By means of an analysis service run on an IBM super-computer, data from thousands of local weather stations, satellites and commercial weather networks is analysed to provide highly localised weather forecasts for the next 72 hours in 10-minute intervals.

VERTICAL FARMING: THE HIGH-RISE GREEN REVOLUTION

What is it all about?
Vertical farming could be become the future of agriculture. Scarcity of resources, population growth and urban sprawl necessitate a rethink in terms of food production. In the past, fields and plots have been laid out at ground level. To facilitate the better utilisation of available land, the vertical farms of the future grow plants on several different levels. The roofs of these 'farm scrapers' could be fitted with solar panels, wind turbines and rain water collectors. Underneath, vegetables, fruit and fish are cultivated by means of aeroponics, hydroculture, aquaponics and aquaculture. These can then be marketed directly in shops and restaurants located on lower floors.

Assessment of opportunities and risks
Vertical farms increase the yield per square metre of ground area, while also significantly reducing resource consumption through closed-loop operation under greenhouse conditions. Due to the controlled environment, fruit and vegetables can be produced all-year round. And since the plants in the greenhouse towers are not at the mercy of the elements, the risk of crop failures caused by severe droughts or floods is eliminated.

Opportunities: Since farm scrapers are primarily operated in urban areas, distribution mileage to distributors and consumers is reduced, resulting in further resource savings.

Risks: Critics note that the additional input required for artificial lighting, irrigation and other operational tasks could cancel out any savings based on the geographical proximity to the buyers.

Examples:
www.skygreens.com
Sky Greens in Singapore is the first commercial vertical farm in the world. Soil cultures and hydrocultures are arranged in A-shaped rotating towers which ensure optimal distribution of sunlight and nutrition through their rotation.

farmedhere.com
FarmedHere in Chicago is the largest organic indoor vertical farm in the USA. FarmedHere employs an aquaponics system which combines fish farming in aquaculture and plant breeding in hydroculture.

infarm.de
InFarm (Indoor Urban Farming) designs and constructs vertical farms in various sizes which are used both by private households, and by restaurants, hotels and supermarkets.

www.nemosgarden.com
Nemo's Garden focuses on depth, rather than height. Plants are propagated in air-filled plastic chambers below sea level. Sea water condensation is used for irrigation, while consistent temperatures, large amounts of sunlight, and the absence of pests create an optimal climate.

FARMTECH & OPEN SOURCE: AUTOMATION OF AGRICULTURE

What is it all about?
Not even agriculture can escape digitalisation. New technologies are changing the way in which food is produced today and in the future. From specialised harvest robots, through high-precision agricultural machinery, to soil and plant monitoring with sensors in the soil – agriculture has undergone fundamental changes over the past few decades, as has society as a whole.

Assessment of opportunities and risks
Scientific advances and technological progress in food production open up new possibilities for farmers and producers all over the world. Networked digital farms reduce the workload and help to make agriculture both more efficient and more sustainable.

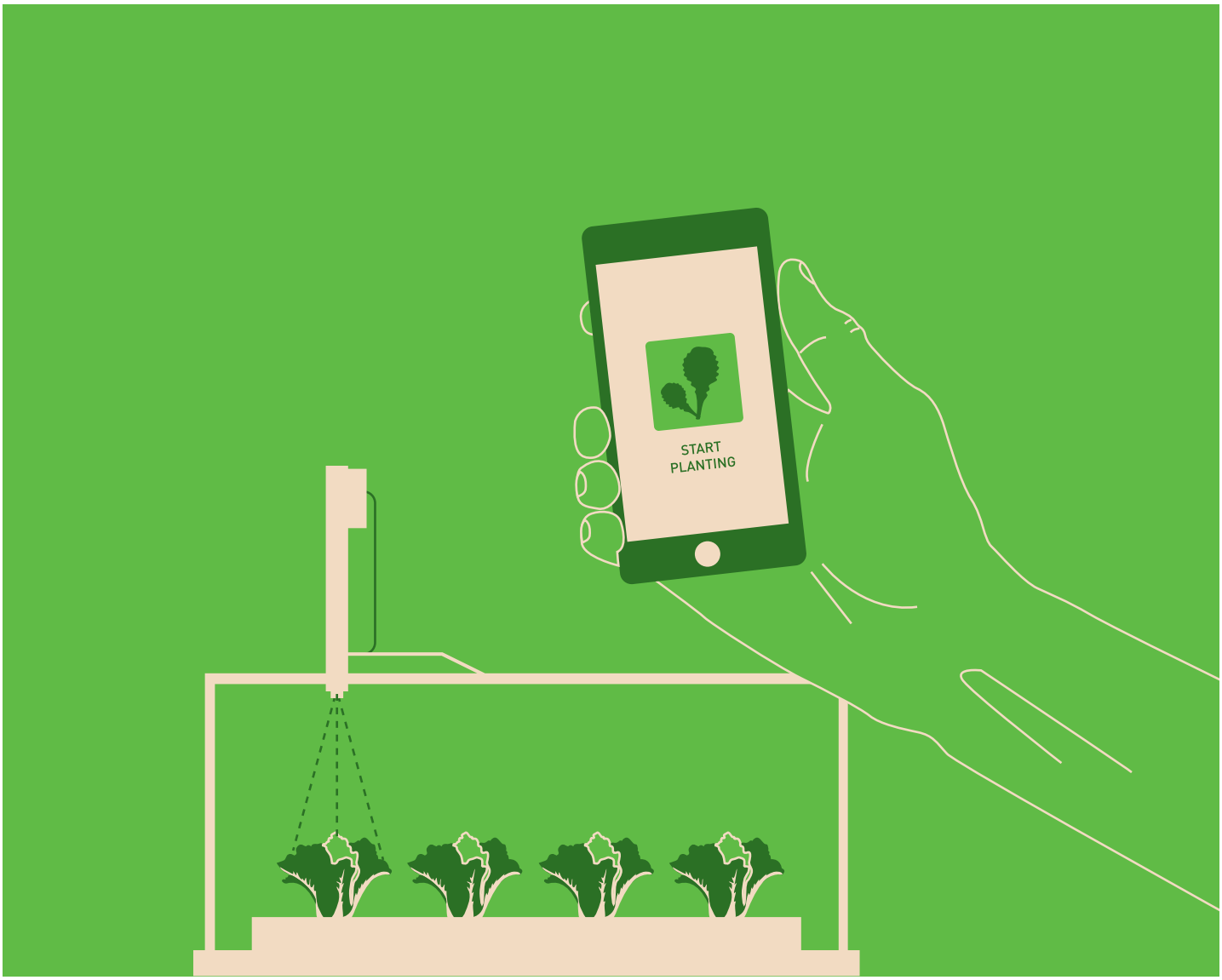
Opportunities: Big data analysis helps to estimate the required quantities of specific types of produce, facilitating optimised production, and therefore reduced food waste.

Risks: If the natural origin of fruit is emphasised, and the expertise of fruit-growing specialists highlighted, the positive image of agriculture based on technology may be difficult to align with consumers' emotional expectations.

Examples:
openag.media.mit.edu/hardware
The food computer is a technology platform for controlled plant growth chambers. Robot systems are employed in specialised chambers to monitor climate, energy and plant growth.

farmbot.io
Farmbot Genesis is a fully-automated farming robot capable of both planting and irrigating. Its software is 100% open source, allowing anyone to benefit and contribute.

www.phytlsigns.com
Phytl Signs is a wearable for plants claiming to facilitate communication between people and plants. In contrast to other systems which monitor the soil and solar radiation, Phytl Signs processes plant signals directly and informs the user about the plants' level of relaxation or stress, or of any diseases.



NEW PLAYERS: GOOGLE & CO. WANT TO BE INVOLVED

What is it all about?
The consolidation of agriculture and digitalisation ultimately enables traditional agricultural enterprises to use technological developments for their benefit, and brand new players to enter the market. Large technology firms with no previous agricultural experience are at the forefront of this movement, contributing extensive technological know-how. Once they have a foothold in the food-tech sector, these companies will be able to diversify their offer, utilise vacant space, and set an example in terms of sustainability with a resultant positive impact on their image.

Assessment of opportunities and risks
Tech giants entering the food sector have raised the knowledge level in the industry exponentially. The research departments of these companies are not restricted to theoretical questions, but can test and verify their theories immediately in their own indoor farms.

Opportunities: Technological development is accelerated, and new opportunities arise – and that applies to the competition as well. Moreover, the entire sector becomes more efficient as a result of increased competition from new market entrants.

Risks: Problems could arise if companies such as Google try to keep their newly developed technologies for themselves, and protect these from imitators through patents. This could lead to traditional agri-firms being squeezed out of the market.

Examples:
goo.gl/SbyWZp
Google produces fresh vegetables in former shipping containers using the Leafy Green Machine by Freight Farms.

goo.gl/I3JU47
In its GrowWise Center on the High Tech Campus in Eindhoven, Philips is researching optimal lighting and suitable climates for indoor farming to optimise production.

PACKAGING – SMARTER, PERSONALISED AND MORE SUSTAINABLE

What is it all about?
Consumer demands for convenience, together with the industry's requirement for efficient logistics in terms of the improved freshness of fresh products, have both resulted in an increase in plastic packaging in recent years. Although the example of Germany shows that the recycling of plastics has seen an enormous increase – from 11.6 % in 1991 to a staggering 99.5 % in 2014[2], consumer perception of this issue is usually quite different. They are often confronted with images of polluted oceans and animals trapped in plastic packaging. As a result, consumer acceptance of

[2] www.bmub.bund.de/fileadmin/Daten_BMU/Bilder_Infografiken/verpackungen_gesamt_bf.pdf

such packaging is continuously declining. Nevertheless wish and reality are often miles apart, and consumer behaviour is hybrid. Convenience often wins out because the consumer wants healthy food fast in suitably portioned sizes. In reality the volume of plastic waste almost doubled between 1991 and 1994[3]. Retailers such as "Original Unverpackt" who avoid any form of packaging certainly have their finger on the pulse of the time. Conventional plastic packaging is no longer en vogue, and natural, bio-degradable packaging materials that can extend freshness are already being intensively researched. Furthermore, smart technology can allow packaging to respond to its specific content, thus for example adapting the best-buy date and the freshness of the product. Packaging is also developing in other ways. Voges Packaging, for instance, has developed "Gropak" which allows mushrooms to continue to grow during transport and storage.

Assessment of opportunities and risks
Consumer acceptance of unnecessary packaging is continuing to decline, even though this trend is in conflict with the desire for convenience. Surveys in Europe show that the majority of consumers would approve a ban on plastic bags . REWE has already stopped selling plastic bags from its outlets at checkout in Germany. Aldi will also ban this type packaging from its stores in 2017. The subject of packaging is thus expected to become increasingly important for consumers and lawmakers alike.

Opportunities: New technologies facilitate bio-degradable and ever smarter packaging. Packaging-free retailing is gaining popularity.

Risks: Novel packaging concepts are significantly more expensive than traditional ones, and put increasing pressure on a low-margin sector in the area of convenience. Legal framework conditions still thwart the development of novel packaging materials in Germany. German packaging regulations dictate that TÜV-certified bio-degradable plastics may not be disposed of in industrial composting facilities.

Examples:
www.voges-packaging.com
Gropak is a packaging concept that allows fresh products to continue to grow both during transport and in the store.

original-unverpackt.de
Original Unverpackt is a supermarket concept that avoids using one-way packaging.

www.designbysol.co.uk/bumpmark
Bump Mark is a bio-reactive freshness label. The sticker's texture changes according to the freshness of the packaging material.

[3] www.bmub.bund.de/fileadmin/Daten_BMU/Bilder_Infografiken/verpackungen_gesamt_bf.pdf
[4] yougov.de/news/2016/10/09/62-prozent-fur-verbot-von-plastiktuten/