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Центр компетенции НТИ по технологиям беспроводной связи и интернета вещей

“Smart agriculture” technologies for FOODNET

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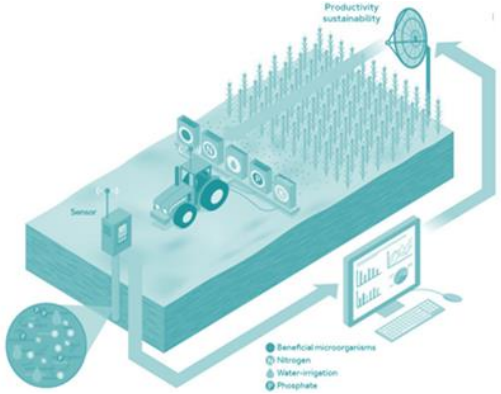
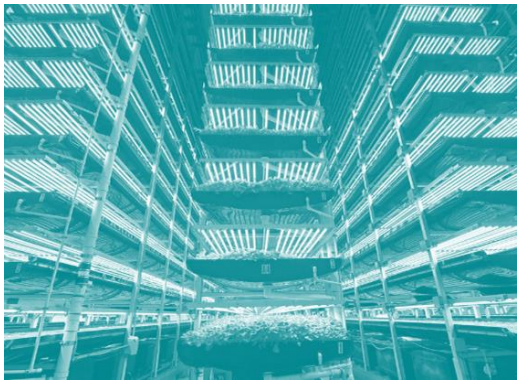
Different sectors of agriculture need Wireless, 5G and IoT

- At the animal and herd level

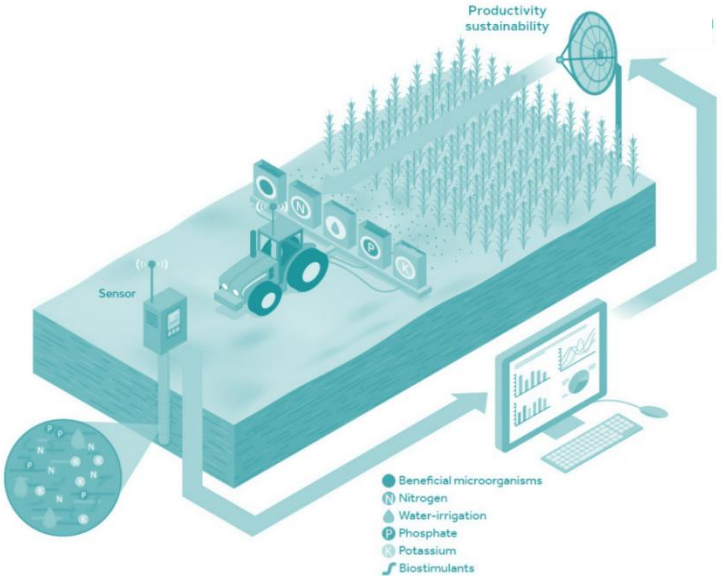


- At the plant population and field level

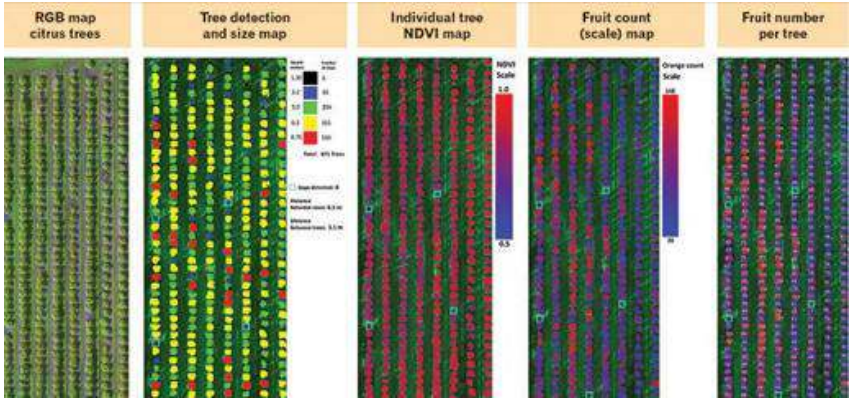


- At the plant and greenhouse level

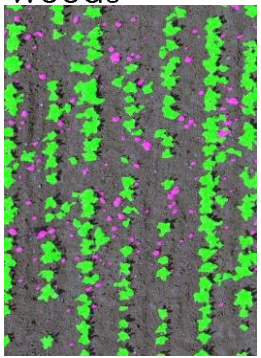
At the plant population or field level : soils, plants .... and unwanted mates



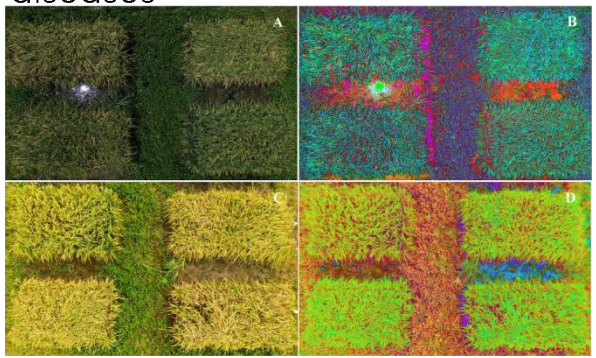
Soil : chemistry, microbiome
fertilizers, physical measurements



weeds



diseases



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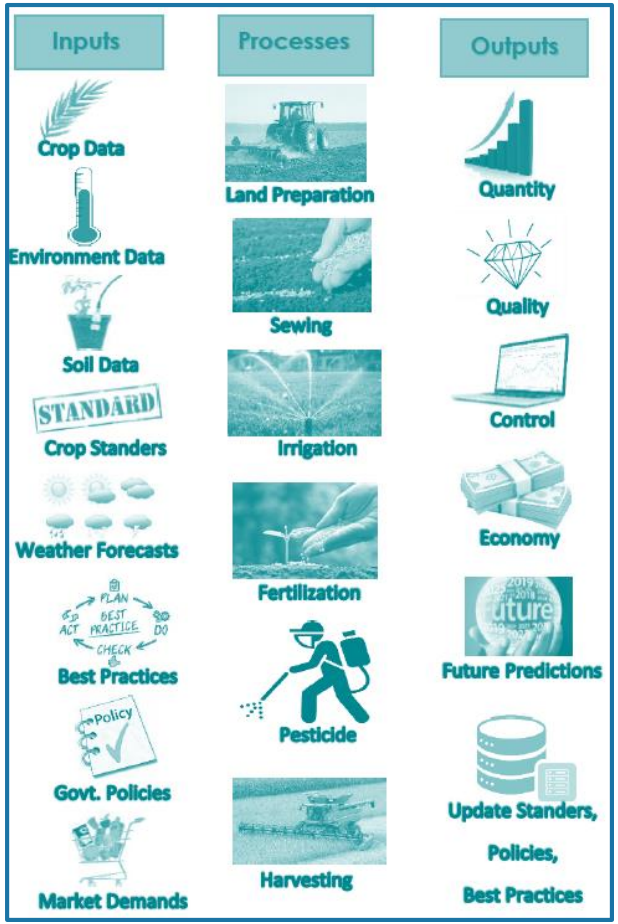
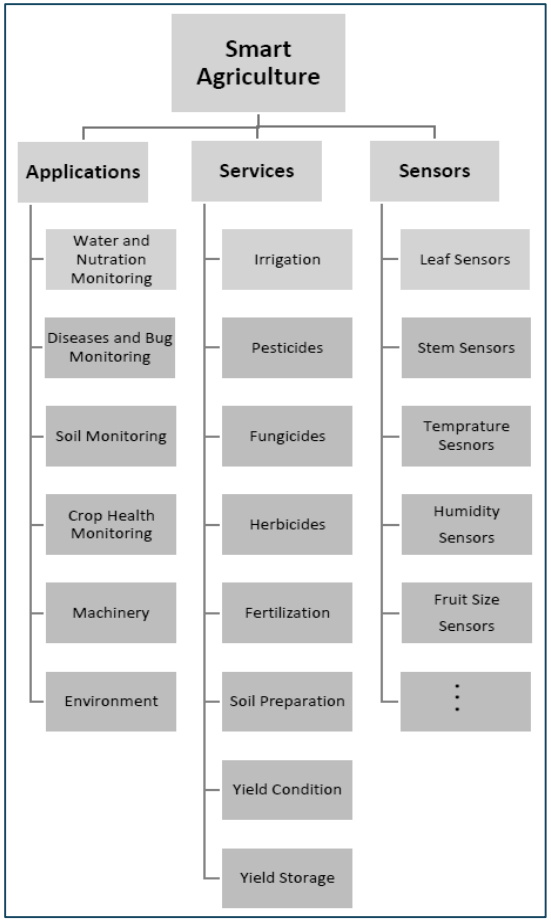
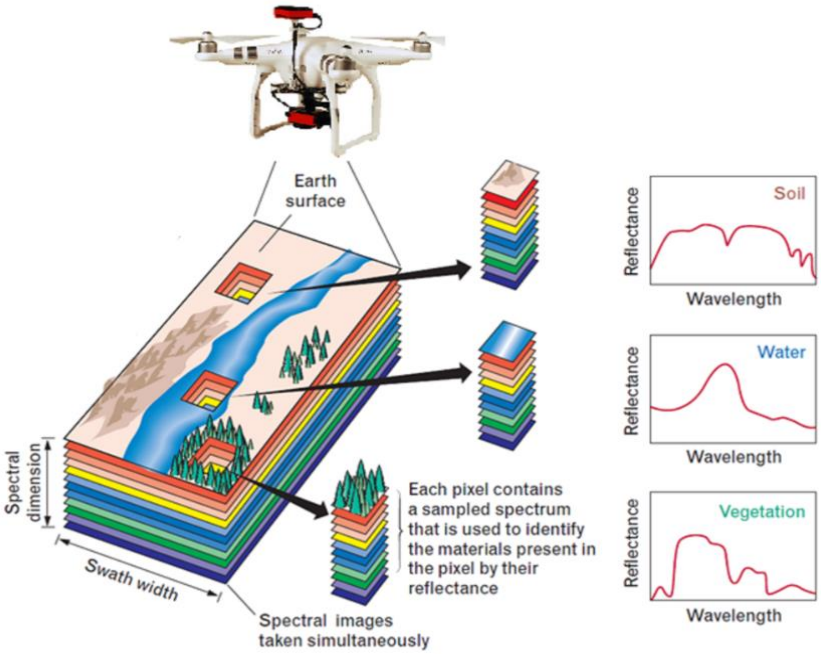
Smart agro for outdoor plant production

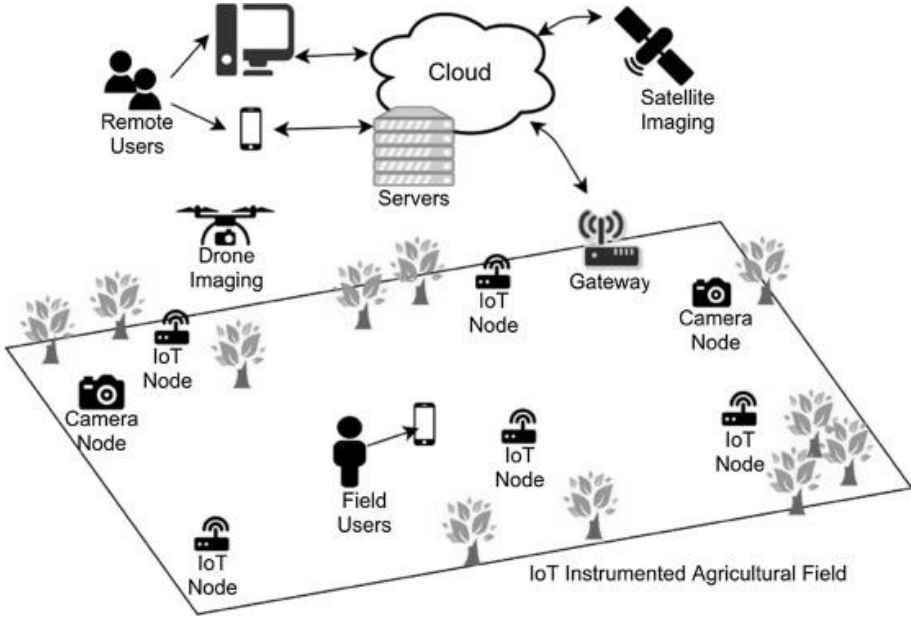




(Ayaz et al., 2019. IEEE Xplore)

Currently most popular applications : UAV to combine 5G and IoT

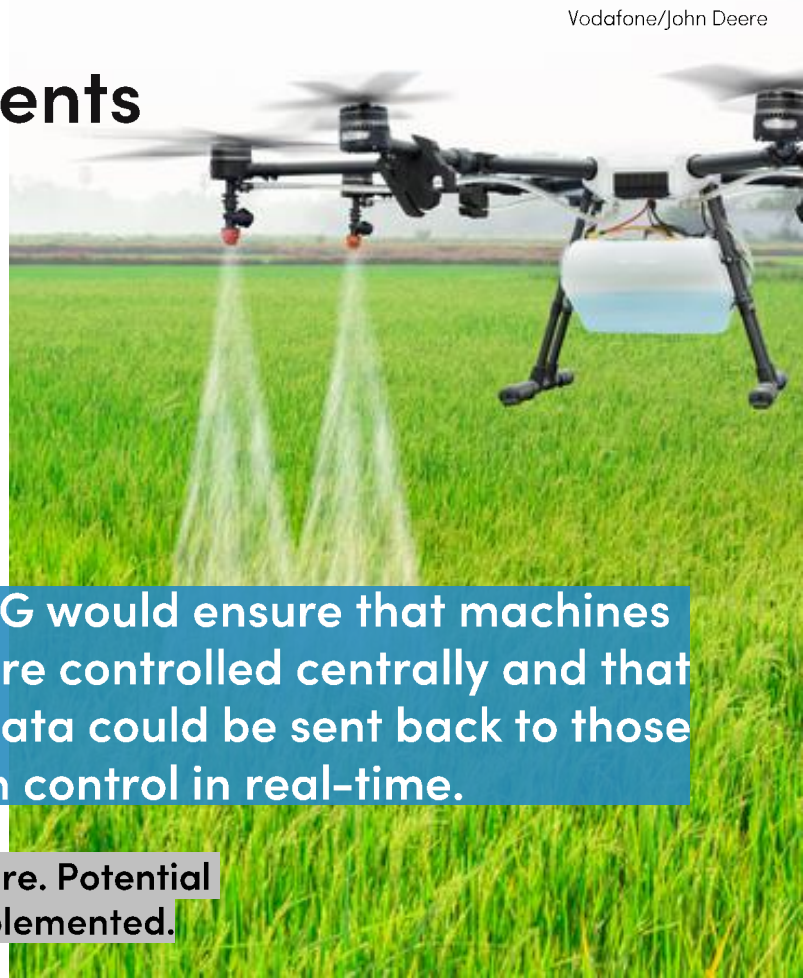




UVA : unmanned aerial vehicles

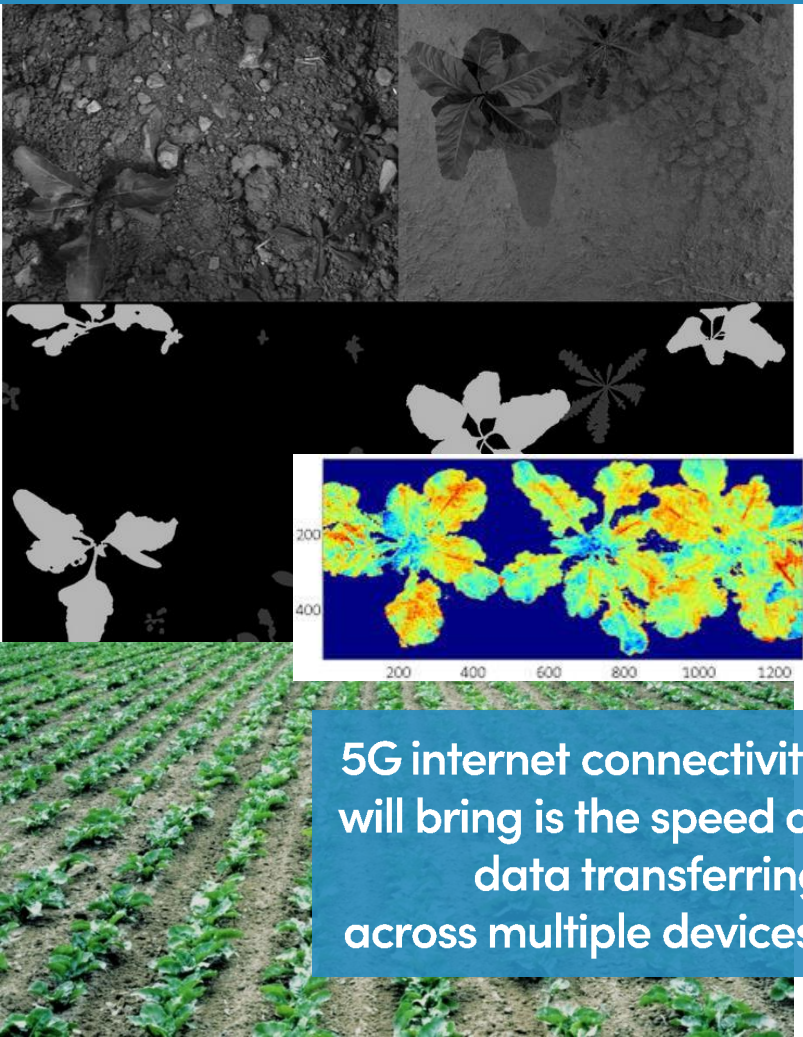
Precision agriculture example: optimize treatments

- The robots are fitted with cameras that capture images of the plants in the ground, which is then sent over a 5G connection to a computing server.
- If the server concludes that the image is of the unwanted plant, the robot receives this information and then activates its precision herbicide sprayers.
- This process takes approximately 250 milliseconds,
- 20-25 milliseconds: vehicle to the central computer and back again
- 200-230 milliseconds: for the cloud application to process and analyze the images



5G would ensure that machines are controlled centrally and that data could be sent back to those in control in real-time.

Spraying is one of the most costly inputs in agriculture. Potential save up to 90% on costs if such technologies are implemented.



5G internet connectivity will bring is the speed of data transferring across multiple devices.

Precision agriculture : monitor and forecast

Case from Deleplanque/Strube Cie – Sugar beet

- 1: Study the dynamics of soil cover evolution for different varieties in different sites over several years in relation to sugar yield.
- 2: Study the predictive value of soil cover on yields by integrating information such as temperatures, rainfall, susceptibility to disease or stress.
- 3: Construct and validate an automatic scoring method on beet yellows (BYV or BMYV) virus
- 4: Validate the use of a multispectral sensor in the acquisition of data in culture.

Examples of physical sensors use in smart farming

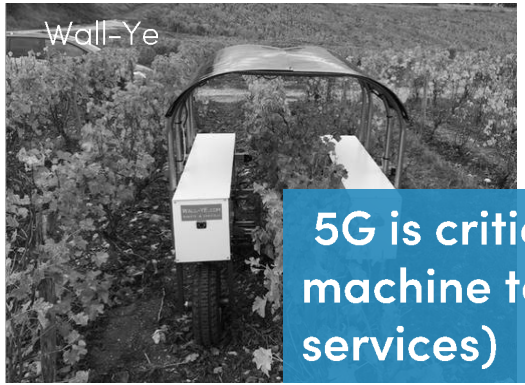
Substrate monitoring	Soil temperature, soil moisture	DS18B20 (Maxim Integrated, San Jose, CA, USA), VH400 (Vegetronix, Salt Lake City, UT, USA), HL-69, ECH2O-10HS (METER Group, Pullman, WA, USA)
	PH	E-201 (Shanghai REX Sensor Technology Co, Shanghai, China)
	Chemical elements (e.g.,: nitrate, nitrogen, etc.)	SEN0244 (DFROBOTS, Shangai, China)
Environment monitoring	Air temperature, air humidity	DHT11, DHT22 (AM2302, Aosong Electronics Co. Ltd., Guangzhou, China)
	Solar radiation	SQ-110 (Apogee Instruments, Inc., Logan, UT, USA)
	Rain	YF-S402 (Graylogix, Bangalore, Karnataka, India), YL-83 (Vaisala Corp., Helsinki, Finland) SE-WS700D (Lufft Inc., Berlin, Germany)
	Luminosity	BH1750 (Rohm Semiconductor, Kyoto, Japan), TSL2561 (Adafruit Industries, New York City, NY, USA)
	Atmospheric pressure	MPL3115A2 (NXP Semiconductors, Eindhoven, Netherlands)
	Wind speed and direction	WS-3000 (Ambient Weather, Chandler, AZ, USA), SEN08942 (SparkFun Electronics, Niwot, Colorado, USA)
	CO2 concentration	MG-811 (Zhengzhou Winsen Electronics Technology Co., Ltd., Zhengzhou, China), MQ135 (Waveshare Electronics, Shenzhen, China)
Other	Tracking	Mifare Ultralight NFC tag (NXP Semiconductors, Eindhoven, Netherlands), Blueberry RFID reader (Tertium Technology, Bangalore, Karnataka, India)
	Localization	UM220-III (Unicore Communication Inc., Beijing, China)

(Navarro et al., 2020)

Innovation opportunities: agro-robotics

Challenge : develop carnivorous robots and scaling to crops

Challenge : harvesting robots (vegetables, fruits)



Challenge : sowing drones (trees, harsh environments)

5G is critical as it supports machine to machine (M2M services)

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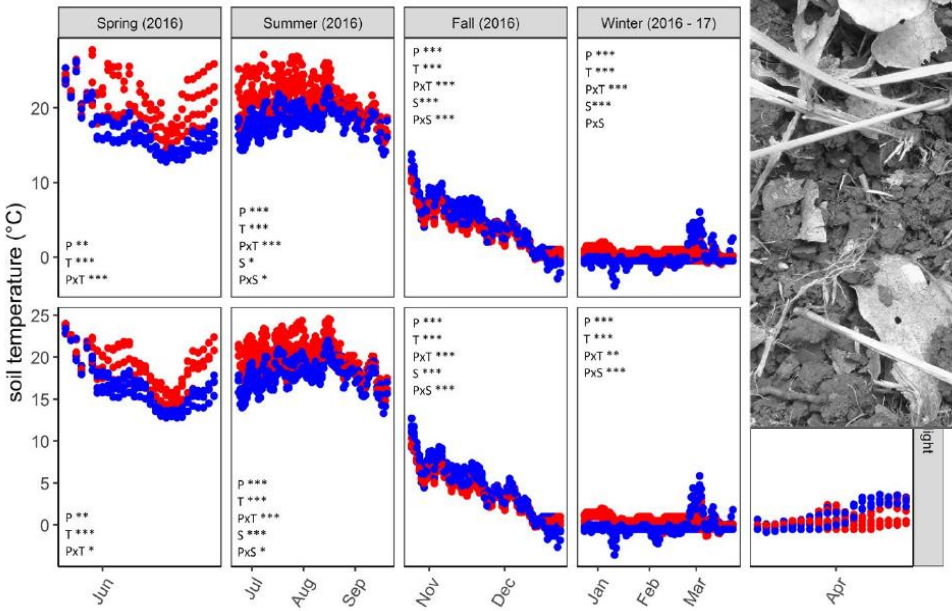
Innovation opportunities : data loggers for micro-climate monitoring and climate models improvement

(Fawcett et al., 2019)



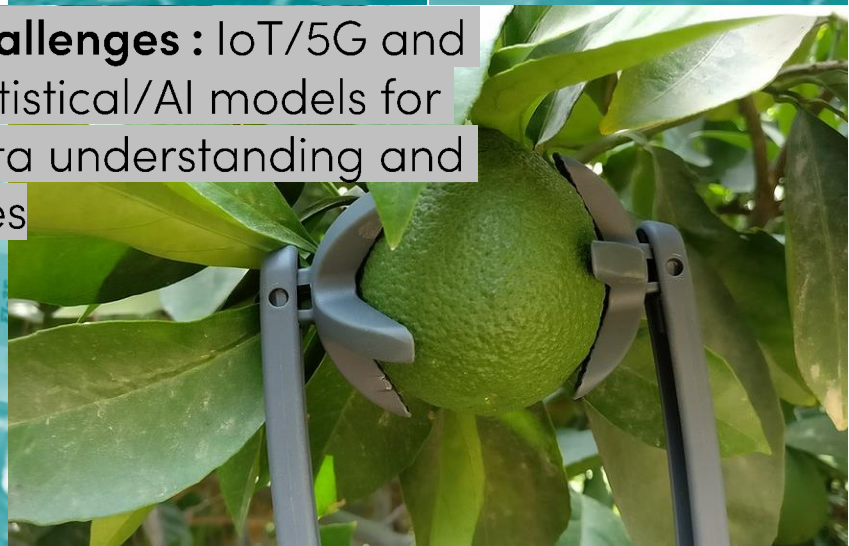
crop management devices, placed in the field → as a component of precision farming

Challenge : IoT/5G and statistical/AI models for data understanding

Smart agro for at the plant level for outdoor production

- However, farmers don't want data. They don't want to become analysts. They want to know what has gone wrong, why it happened and what they should do about it – all without directly learning how to use new AgTech.

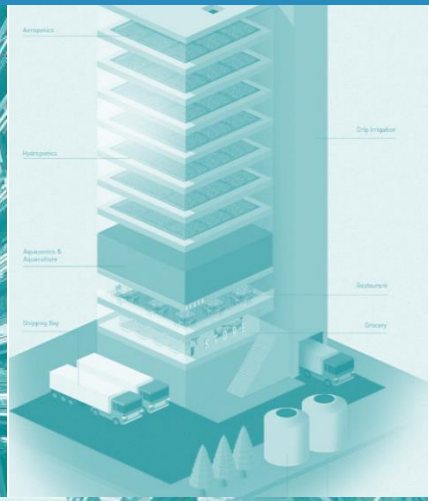
Challenges : IoT/5G and statistical/AI models for data understanding and uses

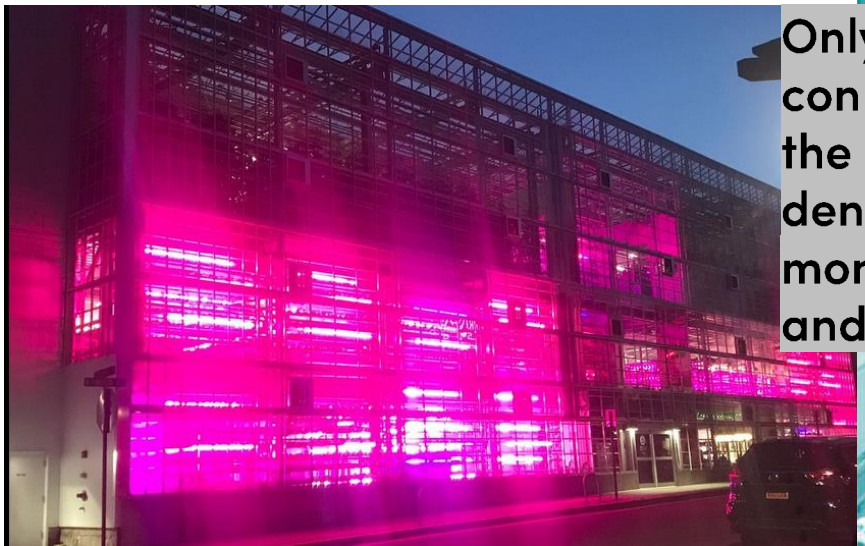


Smart agro for at the plant level for indoor production. Greenhouses and towards vertical farming

"grow food vertically & create jobs locally"

Singapore





Jackson, Wyoming, USA

Only 5G internet connectivity will bring the required sensor density per m2 to monitor environment and plant growth

Manila, Philippines

Applications of wireless/ 5G/ IoT at the animal or herd level

Collect data through different sensors: temperature, accelerometer... and send them to an IOT platform from where get results immediately and in real-time

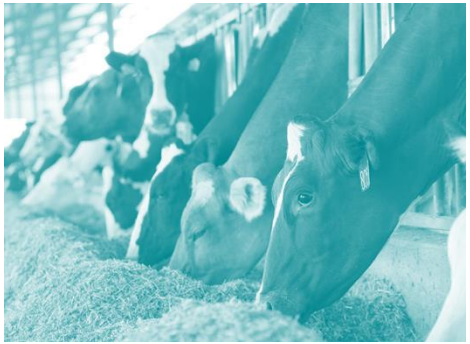
- Livestock movement
- Fertility and health
- Feed intake
- Cattle rustling

5G will enable connectivity and geolocation services, which could reduce the cost and increase the performance of livestock monitoring solutions that currently depend on proprietary radio

However, this will depend on 5G coverage being available. Early deployments are focused on urban centres.

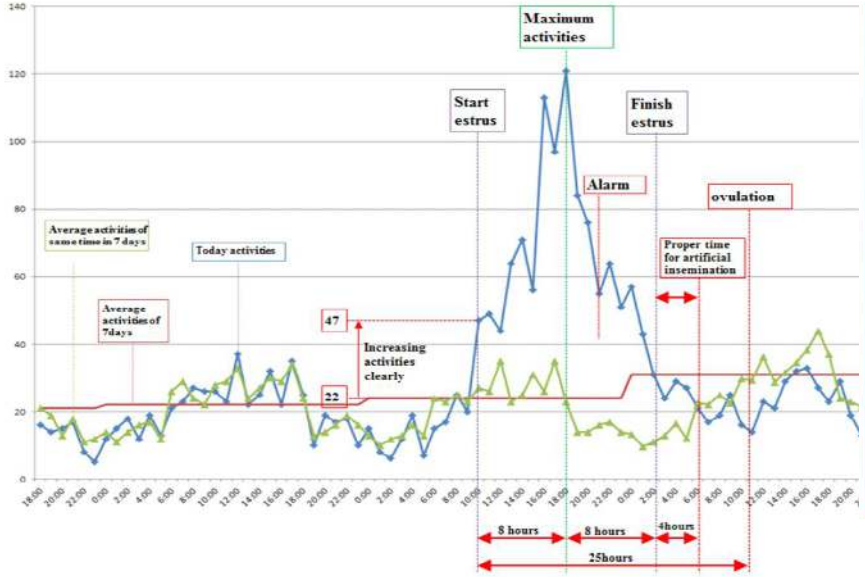
Feed intake - Fertility and health

non-invasive, tail-mounted sensor for calving detection



Using RFID ear-tags

Possibly using face recognition



IoT Livestock Oestrus Monitoring System using IoT Node Based on 3-axis Acceleration Sensors (Lee 2018)

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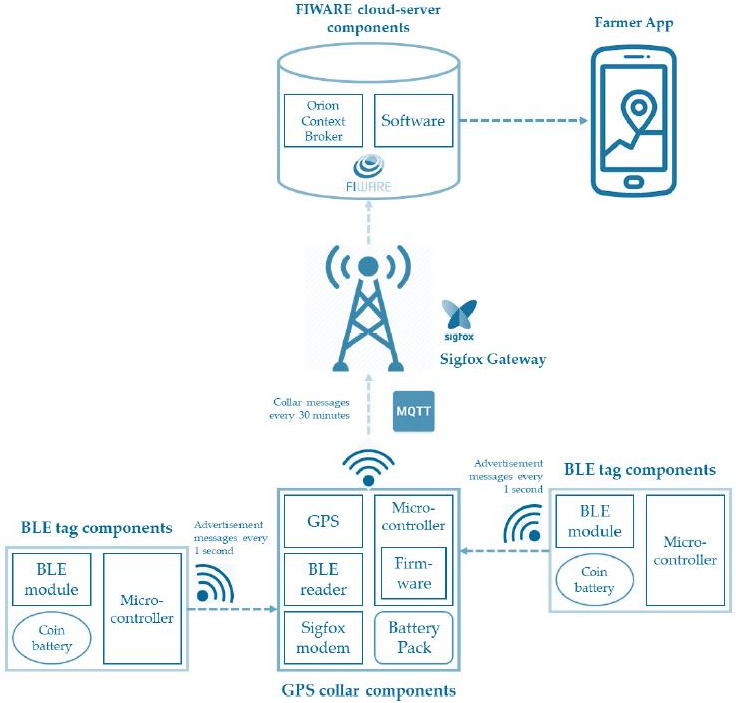
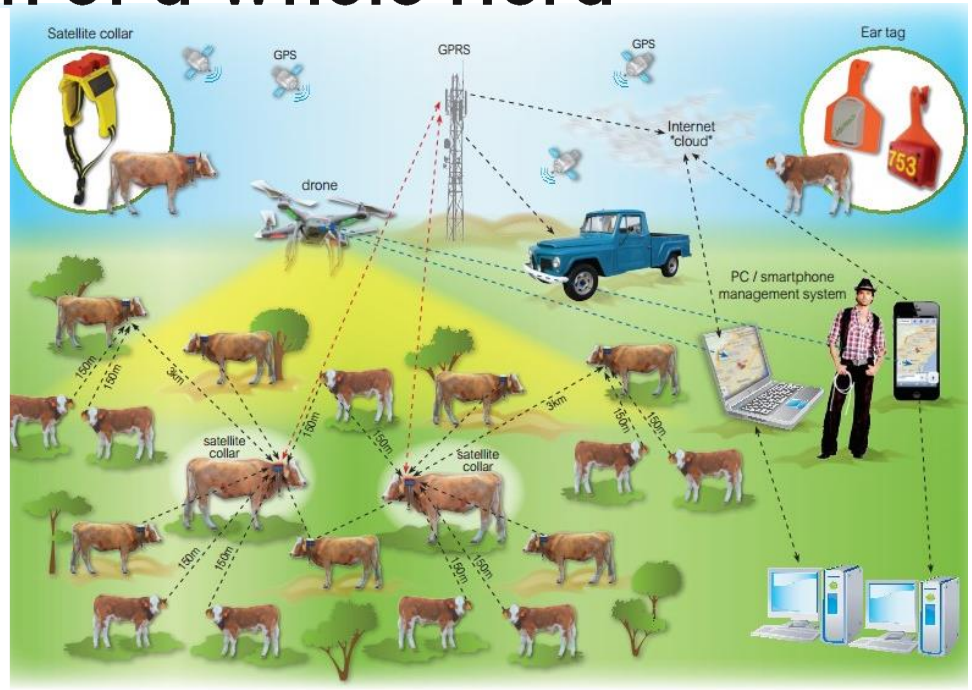
Example: Low-Cost IoT-Based System to Monitor the Location of a Whole Herd



(Maroto-Molina et al., 2019)



5G internet connectivity will bring is the speed of data transferring across multiple IoT devices.

Different sectors of agriculture need Wireless, 5G and IoT

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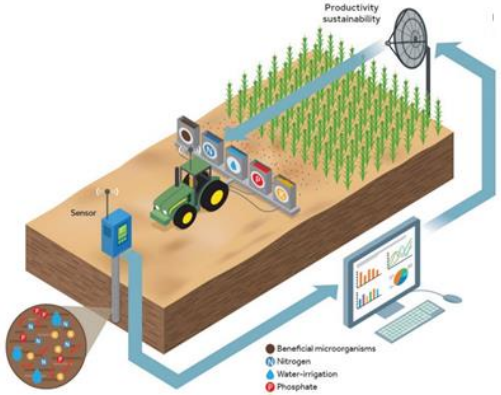
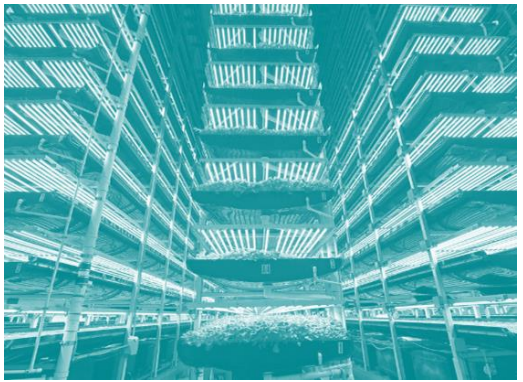
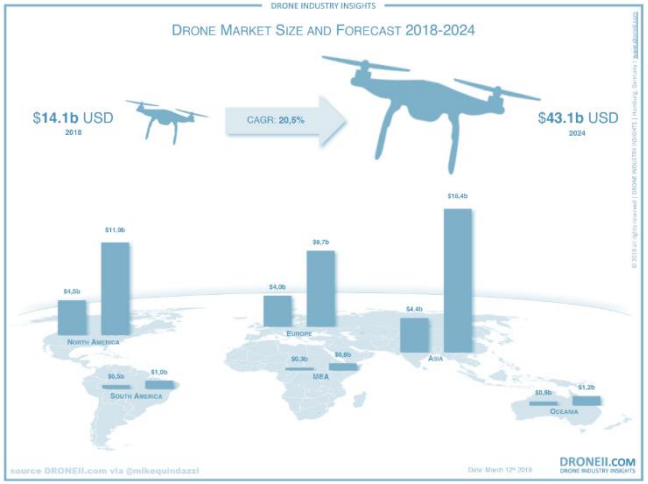


- At the plant population and field level



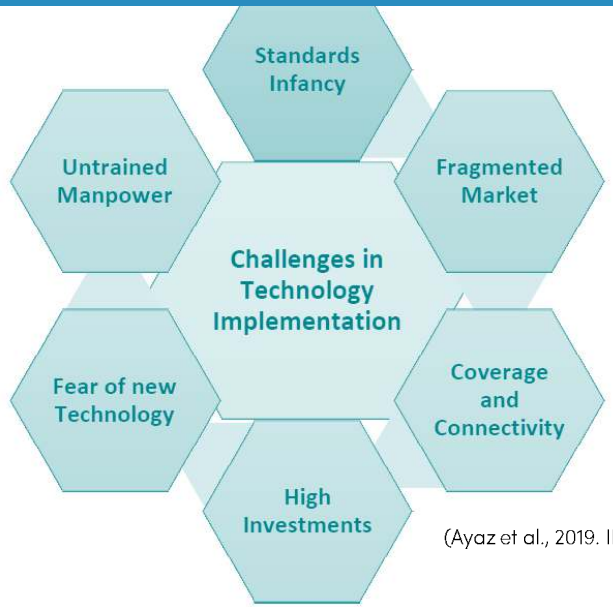
- At the plant and greenhouse level

Possible concerns and opportunities to implement technology for Smart Agriculture



Integrating the upper scale ?
- satellite imaging & remote sensing

Integrating the organismal-level ?
- Plant-by-plant
- Personalized animal data



(Ayaz et al., 2019. IEEE Xplore)

Global companies are already changing their business model:

From sales of chemicals to sales of precision farming apps and services

-> Needs to move forward quickly
-> integrating all segments of the value chain

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Thanks!

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