INTERNET OF FOOD?

Applying IoT to agriculture: how far can we go?

Workshop on Rapid Prototyping of Internet of Things Solutions for Science
ICTP | Trieste | January, 2019

Why am I here?

1. Convince you that agriculture matters (for all of us and the planet)
2. Convince you that IoT & agriculture experts have a lot to talk about
3. Discuss about your solutions and design new ones

AGRICULTURE MATTERS!

CHAPTER #1

Why?

Poverty reduction

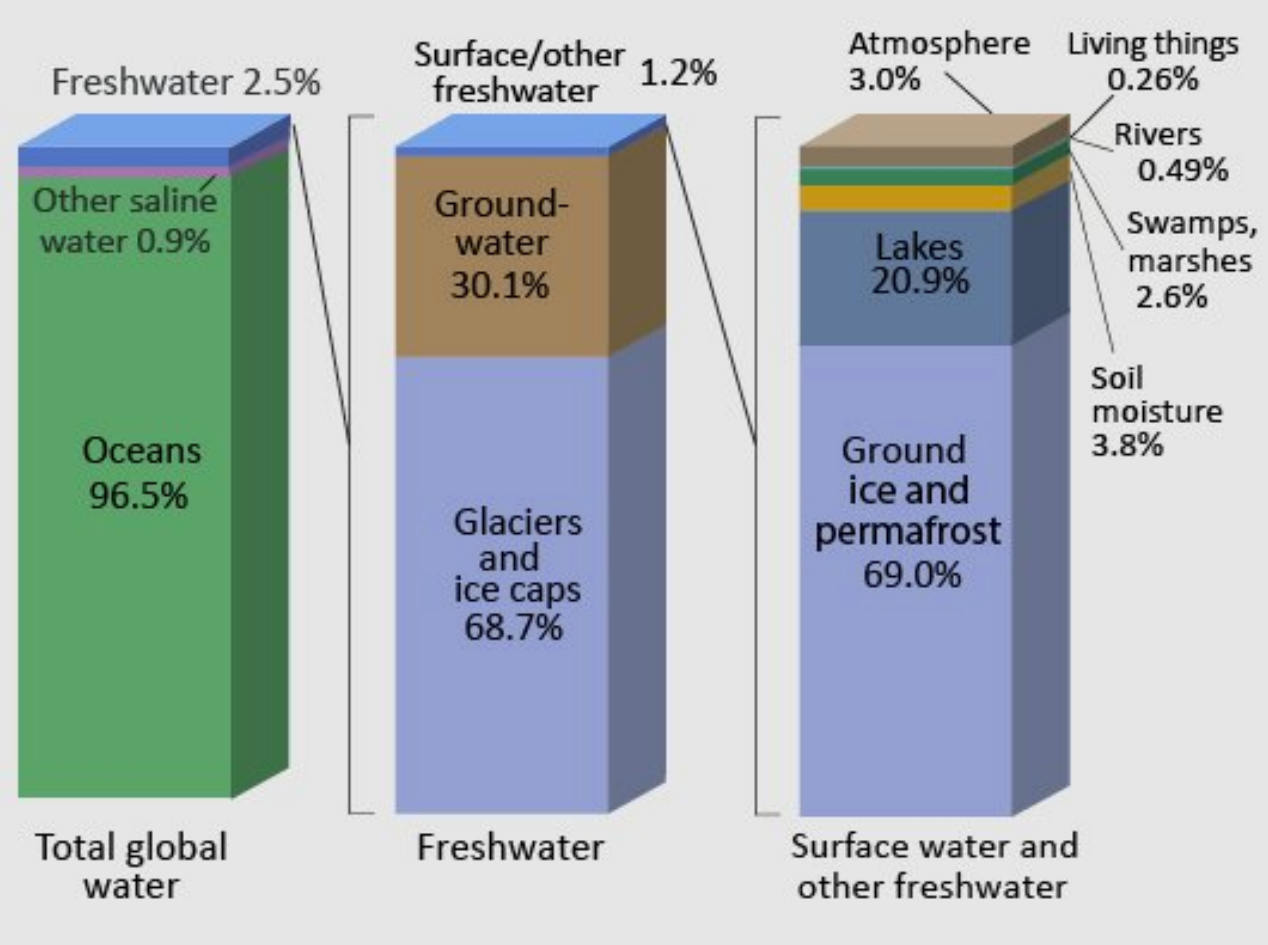
Water security

Food security

Climate change mitigation/adaptation

Gender equality

WATER

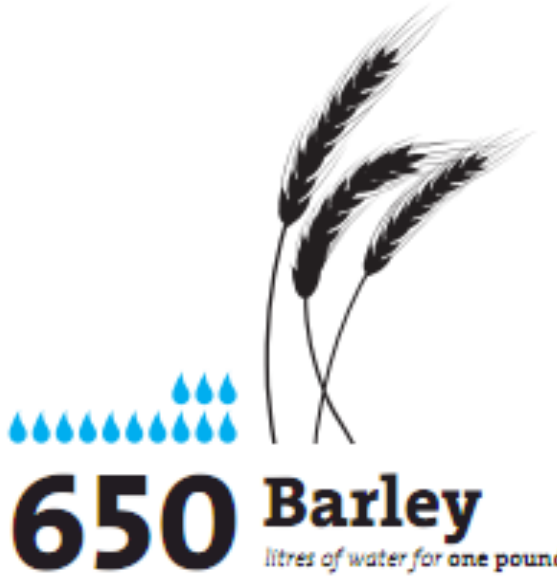

Freshwater 2.5%
Other saline water 0.9%
Oceans 96.5%
Total global water
Surface/other freshwater 1.2%
Ground-water 30.1%
Glaciers and ice caps 68.7%
Freshwater
Atmosphere 3.0%
Living things 0.26%
Rivers 0.49%
Swamps, marshes 2.6%
Lakes 20.9%
Soil moisture 3.8%
Ground ice and permafrost 69.0%
Surface water and other freshwater

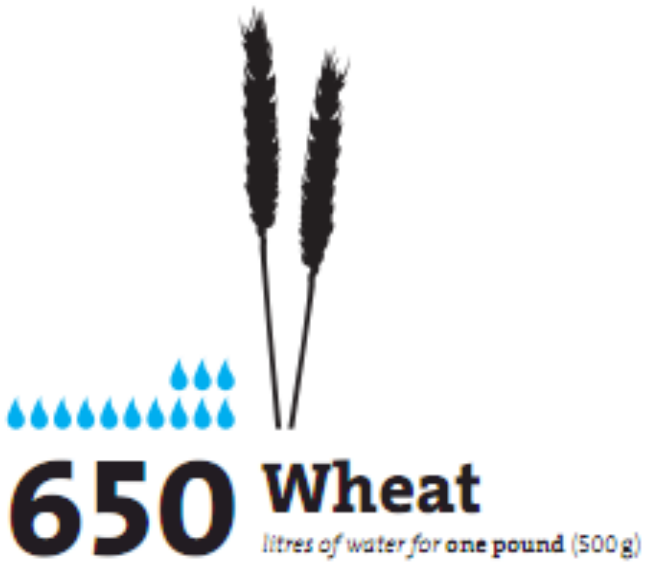
WATER

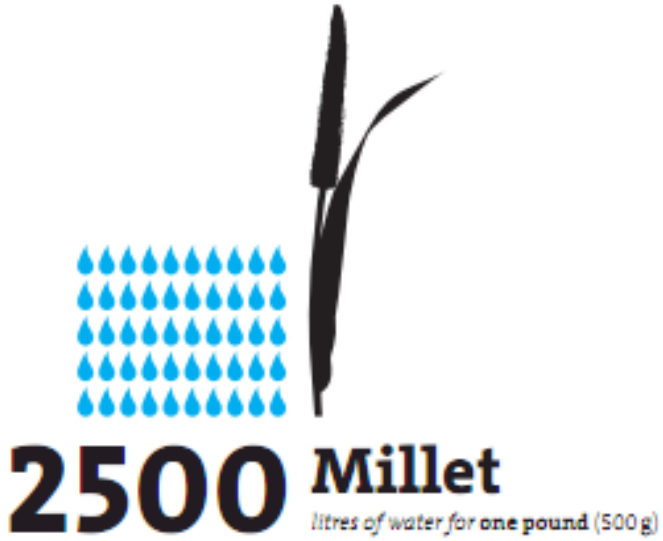
Agriculture vs Water

- Freshwater = 2.5% out of the Planet's water [USGS]
- Water use in agriculture = 70% circa [FAO]
- Agriculture-induced water pollution = biggest responsible for lakes' & rivers' pollution and second one for wetlands' pollution, among the main drivers of pollution of deltas & groundwater [US EPA]

Agriculture vs Water







1 drop
=
50 liters of water

Agriculture vs Water

650 **Toast**

litres of water for **one package** (500 g)

750 **Cane Sugar**

litres of water for **one package** (500 g)

1 drop
=
50 liters of water

90 **Tea**

litres of water for **one pot** (750 ml)

840 **Coffee**

litres of water for **one pot** (750 ml)

Agriculture vs Water

2500 Burger

litres of water for **one burger** (150 g beef)

4650 Beef

litres of water for **one steak** (300 g)

1 drop
=
50 liters of water

1000 Milk

litres of water for **one litre**

2500 Cheese

litres of water for **one big piece** (500 g)

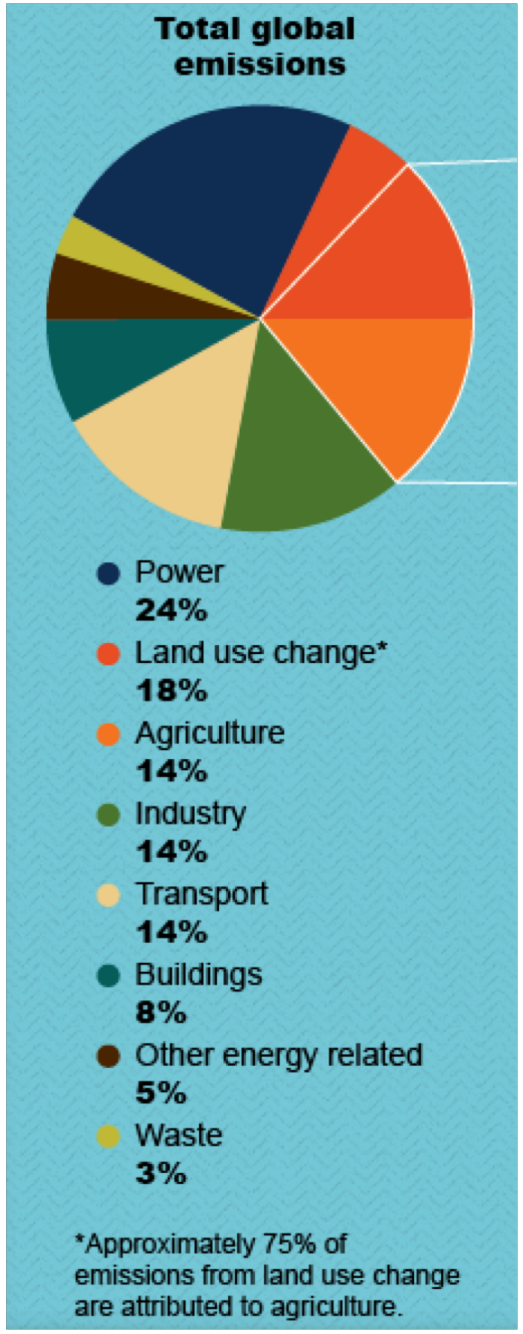
Food Security (in light of climate change)

Food Security (in light of climate change)

- Food production: decrease by up to 2% each decade for 21st century
- Global food demand: increase by as much as 14% each decade
- Extreme weather increase risks to food production

2014 IPCC report

Climate Change



Climate Change

- Agriculture = major contributor of methane and nitrous oxide
- Agriculture accounts as much as transport & industry emissions

Poverty Reduction

Poverty Reduction

- 75% of world poorest (1.4 billion people) lives in rural areas
- Agriculture = 40% global work force, up to 75-80% in some LDCs
- Growth in agriculture in developing countries is 5 times more effective in reducing extreme poverty than that of other sectors [uNu-WIDER, 2010]
- 313B US$ = estimated value of Africa's food markets (could exceed US$1 trillion by 2030) [World Bank, 2013]

Gender Equality

- Women's land ownership = ?
- Women = x% of the agricultural labor force in DCs
- Women could increase yields by y% if had access to same resources as men do.

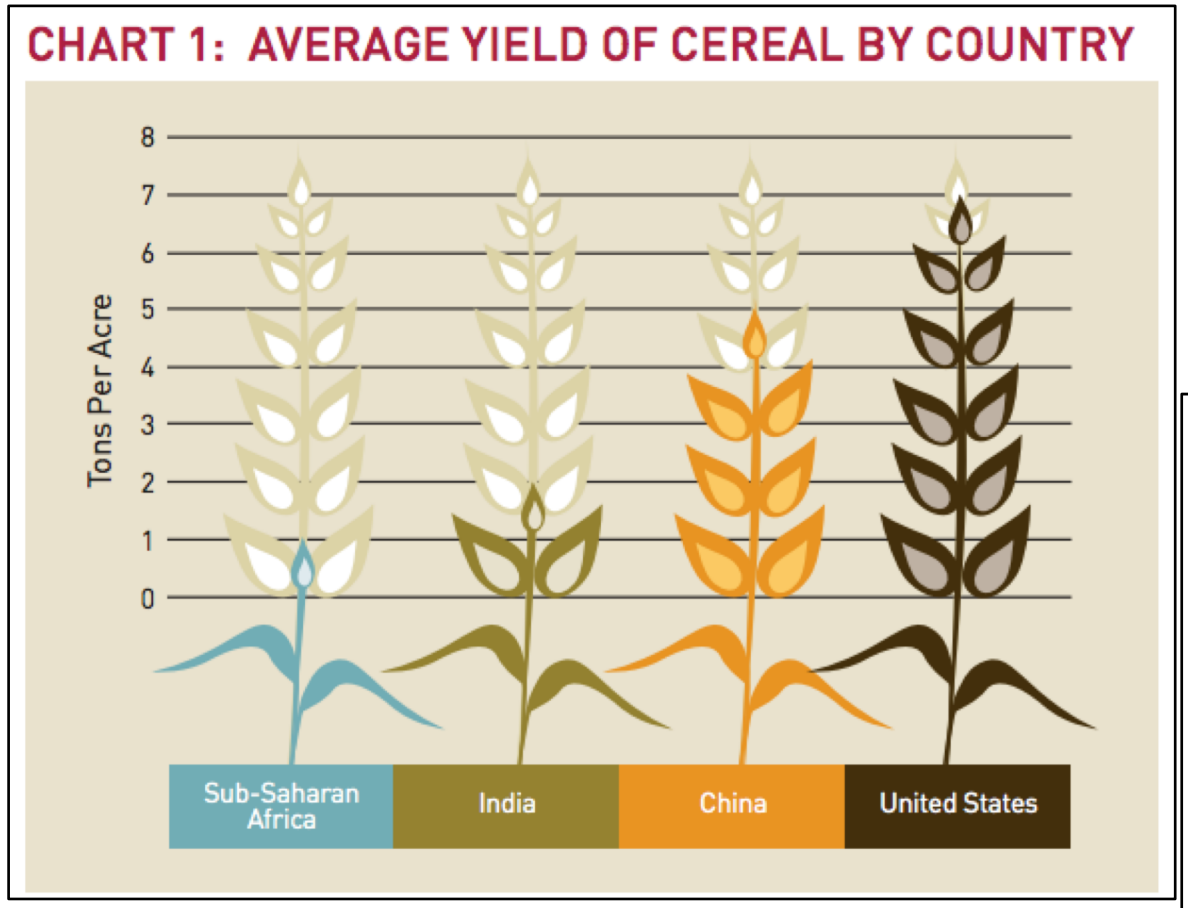
Gender Equality

- Women's land ownership = 1% [UNDP]
- Women = 43% of the agricultural labor force in DCs
- Women could increase yields by 20–30% if had access to same resources as men do.

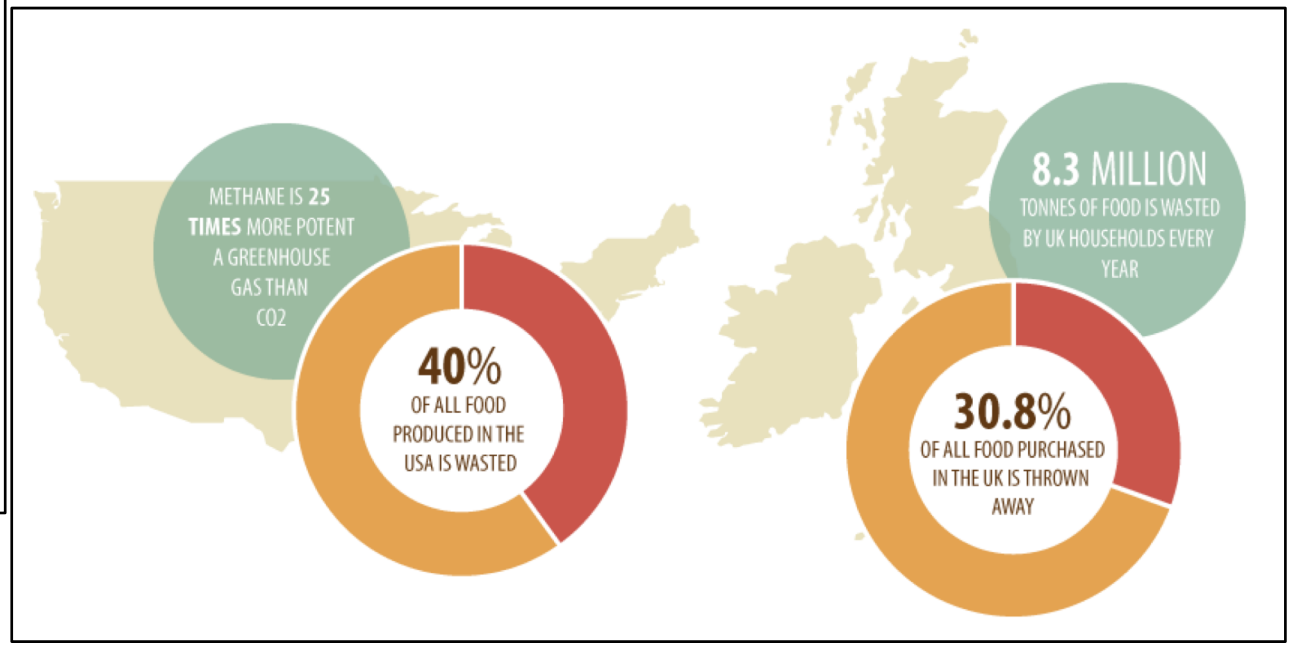
Agriculture: where are we now?

Revolution	Period	Benefits	Impacts
Green Revolution	1960-1970	Yield Enhancing Technologies	Better Nutrition Higher Per Capita Incomes Food Security
Biotechnology Revolution	1990-2000	Yield Enhancing Disease & Pest Resistance	Genetically Modified Foods Food Security/ Health Issues
ICT & Mobile Revolution	2000-2010	Access to Input & Product Markets	Market Information Systems ↓Transaction Costs

Agriculture: where are we now?



Our goal: feed 9 billion people by 2050, increasing our food production of 70/100% while reducing the impact of agriculture on our natural resources and the climate system



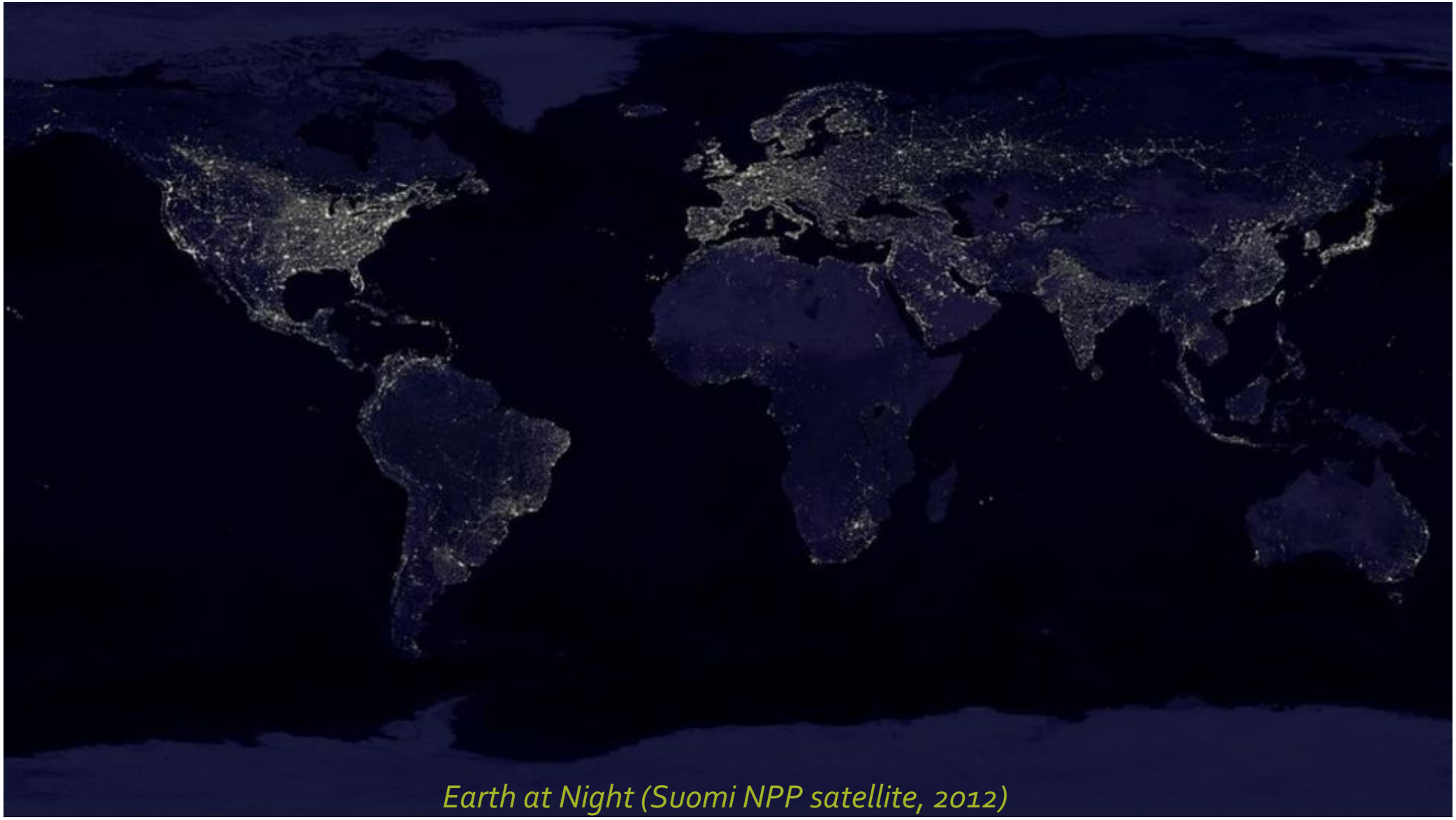
Additional challenges to take into account

- Making agriculture attractive to the **youth**
  - "For Africa* to be able to feed itself, agriculture needs to become a more attractive option for youth" [CGIAR, 2014]
- Make bottom-up pressure at the public/private level for a greener agriculture

→ Digital technologies can help on both sides

** 200M between 15-24 years old; figure to double by 2045*

Additional challenges to take into account



Earth at Night (Suomi NPP satellite, 2012)

Additional challenges

- WEF nexus
- Climate variability & change
- Land/Water Grabbing, large-scale land acquisition
- Global shift in food preferences

IOT & AGRICULTURE

A fertile field!

Monsanto Acquires The Climate Corporation

Year after year, farmers gain valuable insights from their crops and fields. The information helps farmers grow their crops more efficiently, and allows them to make smarter choices as they work to produce more food using fewer resources.

Last year Monsanto paid $250 million for Precision Planting , a company that enables farmers to plant seeds in various depths and spaces, almost by the square meter, so different parts of a farm can get different treatment. Mr. Preete said Monsanto saw this as a first step in developing two-way farm machinery systems that took up and receive data, giving farmers better sense of what to plant and how much water and fertilizer to use.

(2013)

IOT & AGRICULTURE IN THE NEWS…

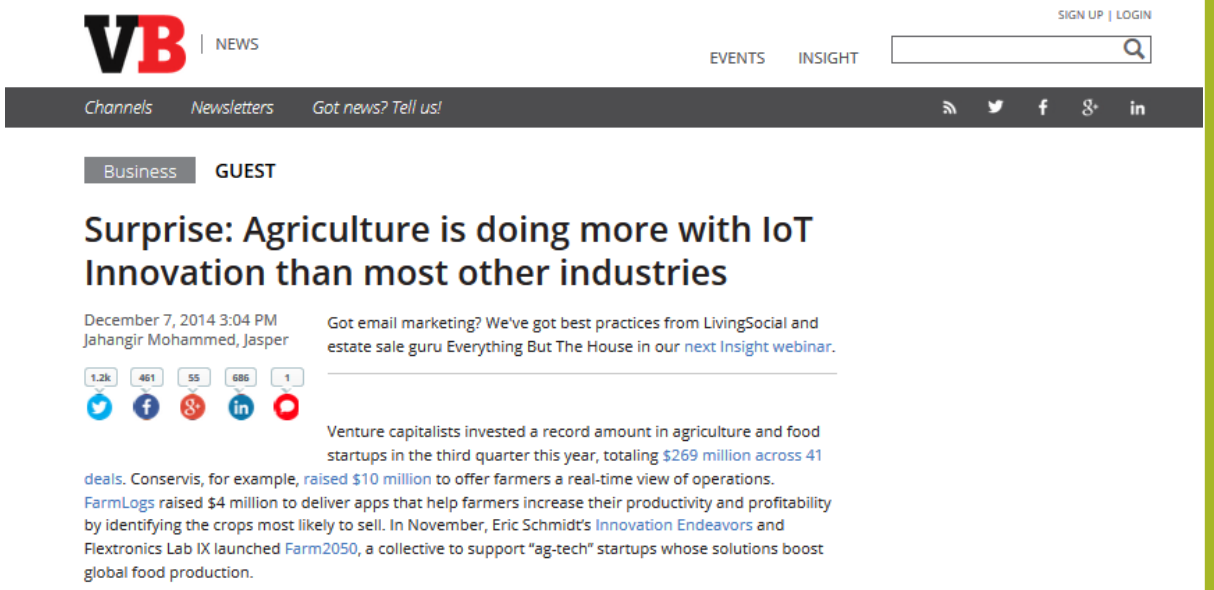
ComputerWeekly.com | IT Management | Industry Sectors | Technology Topics | Search the TechTarget Network

IoT could be key to farming, says Beecham Research

Warwick Ashford
Security Editor
04 Feb 2015 16:55

The internet of things could be key to the farming industry meeting the challenge of increasing food production by 70% by 2050, says report

The internet of things (IoT) could be key to the farming industry, increasing food production by 70% to feed the...



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Business GUEST

Surprise: Agriculture is doing more with IoT Innovation than most other industries

December 7, 2014 3:04 PM
Jahangir Mohammed, Jasper

Got email marketing? We've got best practices from LivingSocial and estate sale guru Everything But The House in our next Insight webinar.

1.2k 461 55 686 1

Venture capitalists invested a record amount in agriculture and food startups in the third quarter this year, totaling $269 million across 41 deals. Conservis, for example, raised $10 million to offer farmers a real-time view of operations. FarmLogs raised $4 million to deliver apps that help farmers increase their productivity and profitability by identifying the crops most likely to sell. In November, Eric Schmidt's Innovation Endeavors and Flextronics Lab IX launched Farm2050, a collective to support "ag-tech" startups whose solutions boost global food production.

(2014/2015)

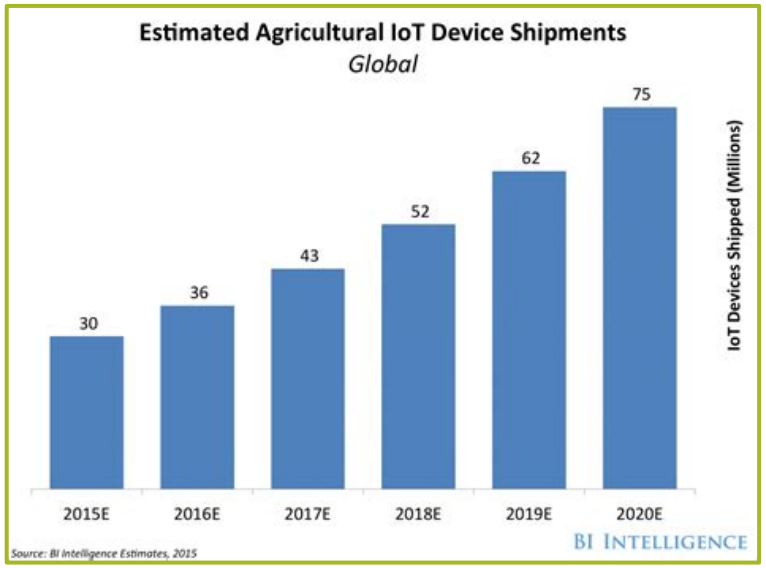
IOT & AGRICULTURE IN THE NEWS…

THE WALL STREET JOURNAL.

TECH

Agriculture Giants Boost Cybersecurity to Shield Farm Data

Companies like Monsanto and Deere invest more as business becomes more datacentric



Dell: Security key for IoT in agriculture

Exec says agriculture already embracing IoT, but obstacles remain

By Scharon Harding | Public Sector | 19 May 2015

(2015)

IOT & AGRICULTURE IN THE NEWS…

BUSINESS INSIDER

TECH | FINANCE | POLITICS | STRATEGY | LIFE | ALL

PRIME | INTELLIGENCE

Here's how IoT is transforming 6 different industries

Cadie Thompson Oct. 25, 2016, 1:47 PM

Agriculture is embracing IoT in a big way.

According to BI Intelligence, Business Insider's premium research service, IoT device installations in the agriculture industry are estimated to grow from 30 million in 2015 to 75 million in 2020.

Farmers are collecting data about their crops and livestock in a variety of ways. For example, John Deere has started using sensors in its tractors to connect them to the internet so that farmers can easily access data about their crop yields. By combining those sensors with advanced data analysis, farmers can get a sense for the best times to plant crops and how to optimize their yields.

(2016/2017)

Information Age

Diversity Events Ne

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Sectors

Agriculture

Nick Ismail

12 July 2017

7 industries that will be radically changed by the IoT

What will the transformative impact of the IoT be on a number of sectors in the coming years, and in what areas will this impact be felt?

1. Farming

Technological innovation in farming is nothing new, but farmers and agricultural organisations are now turning to the internet of things for greater production capabilities and meet the demands of the world's ever growing population.

Smart agriculture is already taking off among farmers, with the desire to drive additional efficiencies increasingly making high tech farming the standard across the industry. This is facilitated through devices such as agricultural drones and sensors. The ability to monitor every animal and plant individually and assign each a personalized feeding and medical regime may soon become the norm.

>See also: **How the Internet of Things is impacting enterprise networks**

IOT & AGRICULTURE IN THE NEWS…

IoT in Agriculture Market Worth $48.71 Billion by 2025 at 14.7% CAGR: Allied Market Research

NEWS PROVIDED BY
Allied Market Research →
Dec 06, 2018, 09:15 ET

SHARE THIS ARTICLE

PORTLAND, Oregon, December 6, 2018 /PRNewswire/ --

Increase in demand for food with rise in global population, adoption of new technologies for improving yield, and implementation of IoT-based technologies to cope up with changing climatic conditions drive the growth in the global IoT in agriculture industry

Forbes

2,738 views | Jan 23, 2019, 4:00 pm

Smart Farming Through The Internet Of Things

Lorin Fries Contributor

Food & Drink

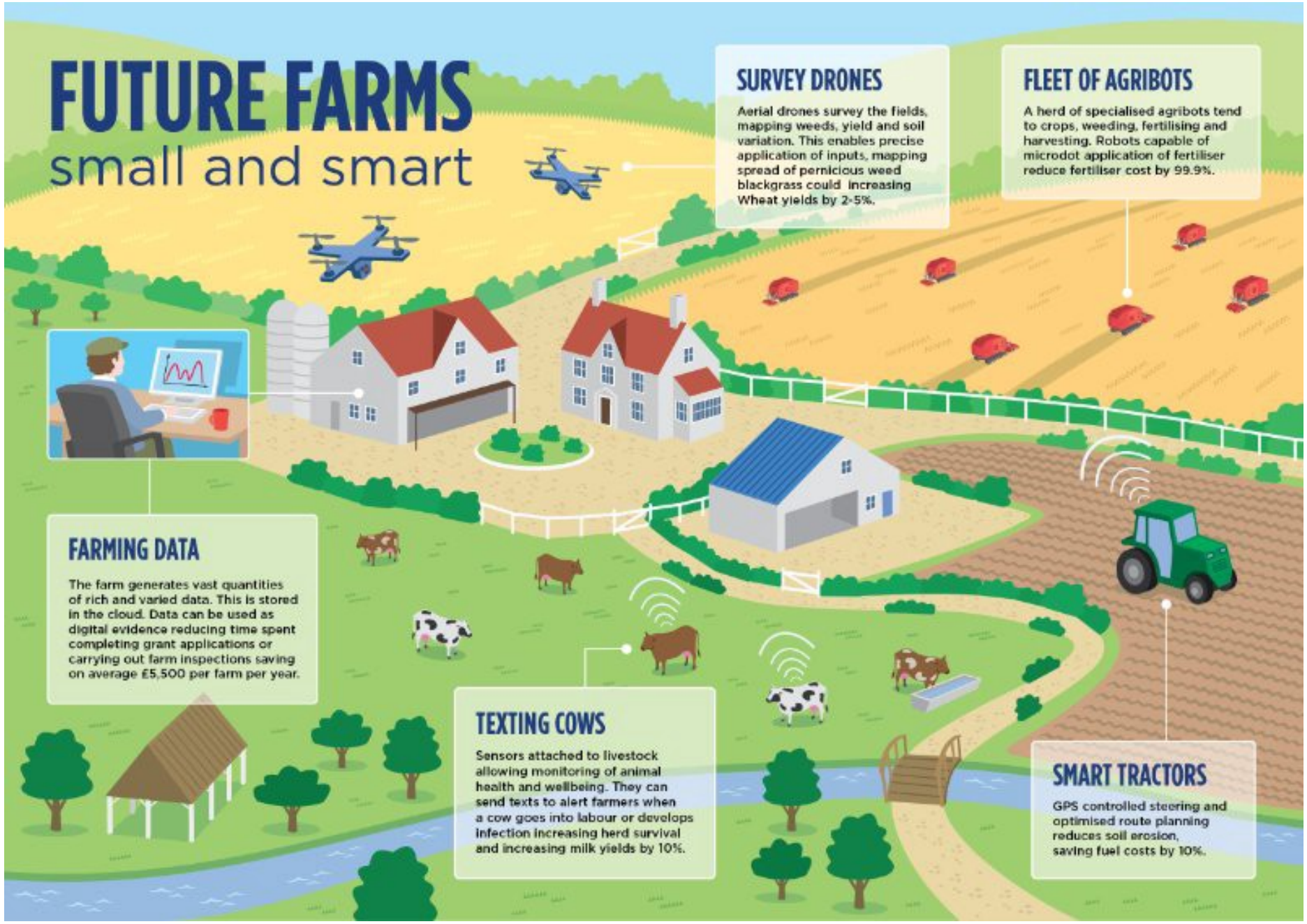
How technology is transforming food and ecological systems

The so-called "smart agriculture" market is projected to reach $13.5 billion by 2023. As technologies like the Internet of Things transform business and farming operations from the U.S. to East Africa and India, there is enormous opportunity to improve the quality and sustainability of our food – not just the volume of yield. I spoke with Tony Franklin, General Manager for the Internet of Things at Intel Corporation, about the trends and examples he sees in this space.

(2018/2019)

IOT & AGRICULTURE IN THE NEWS…

SO WHY AREN'T WE ALL RICH ALREADY?

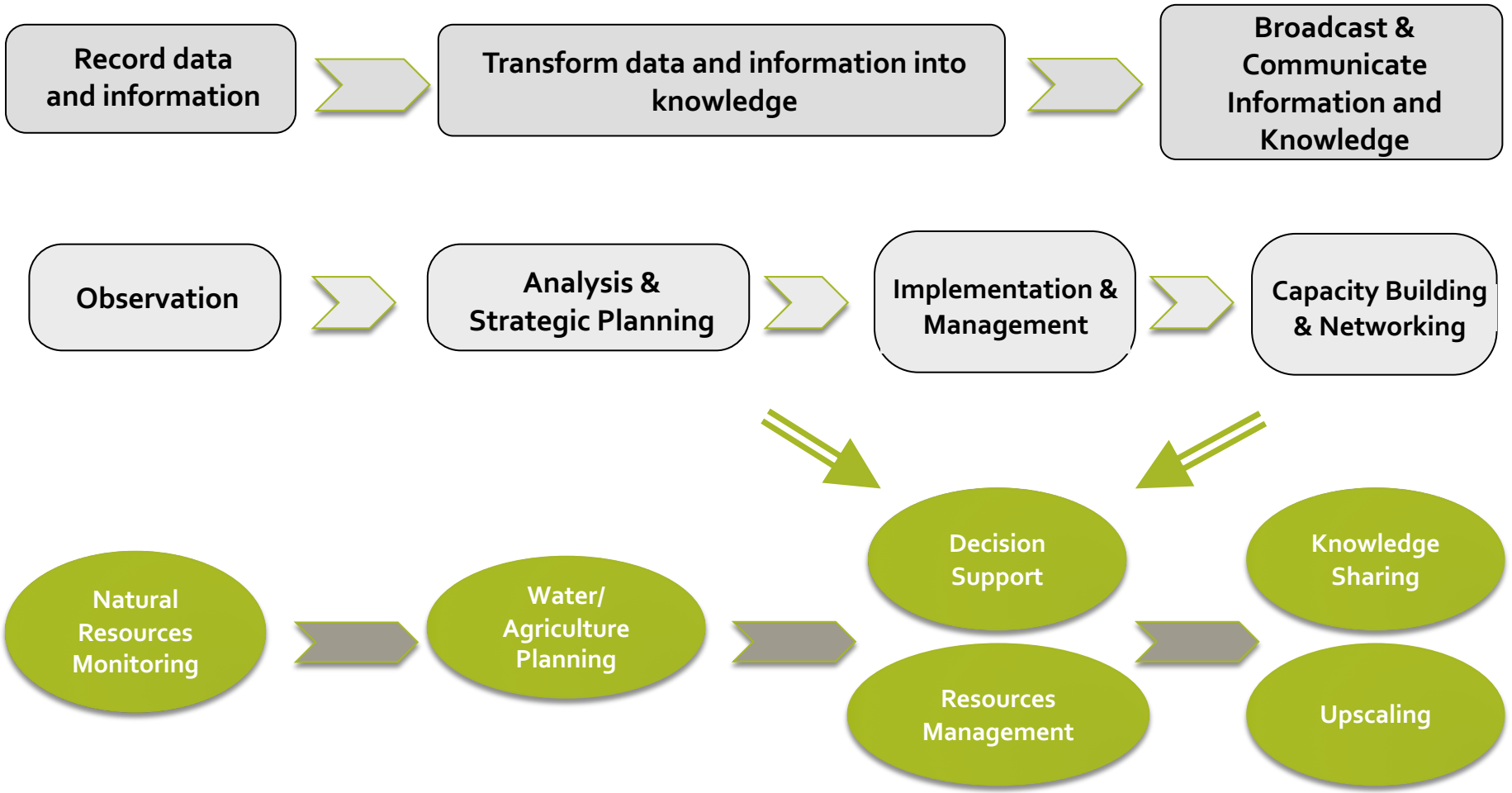

FUTURE FARMS
small and smart
SURVEY DRONES
Aerial drones survey the fields, mapping weeds, yield and soil variation. This enables precise application of inputs, mapping spread of pernicious weed blackgrass could increasing Wheat yields by 2-5%.
FLEET OF AGRIBOTS
A herd of specialised agribots tend to crops, weeding, fertilising and harvesting. Robots capable of microdot application of fertiliser reduce fertiliser cost by 99.9%.
FARMING DATA
The farm generates vast quantities of rich and varied data. This is stored in the cloud. Data can be used as digital evidence reducing time spent completing grant applications or carrying out farm inspections saving on average £5,500 per farm per year.
TEXTING COWS
Sensors attached to livestock allowing monitoring of animal health and wellbeing. They can send texts to alert farmers when a cow goes into labour or develops infection increasing herd survival and increasing milk yields by 10%.
SMART TRACTORS
GPS controlled steering and optimised route planning reduces soil erosion, saving fuel costs by 10%.

Nesta
2015

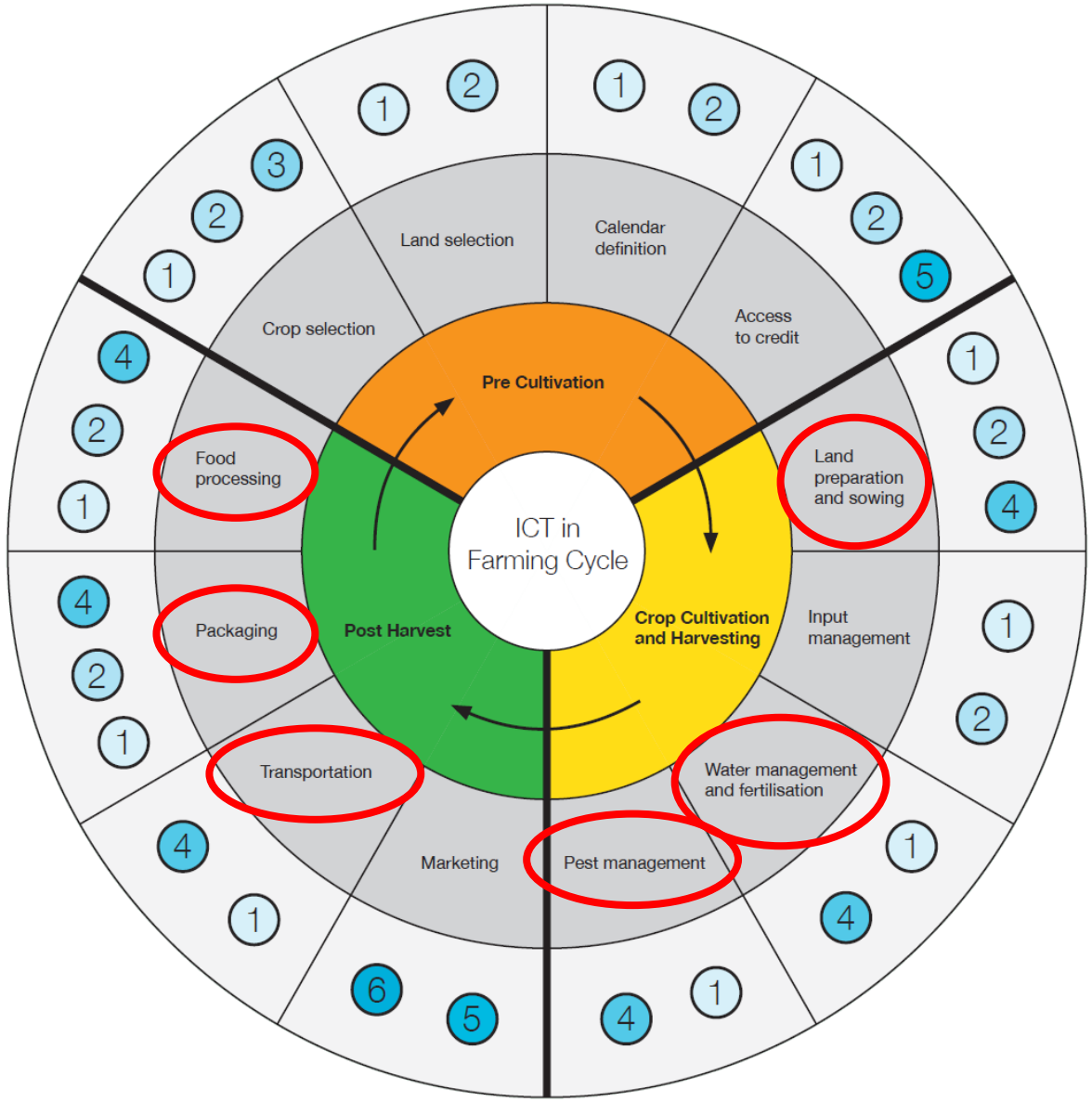
CBInsights
2017

CBInsights
2017

Data/Information/Knowledge flow



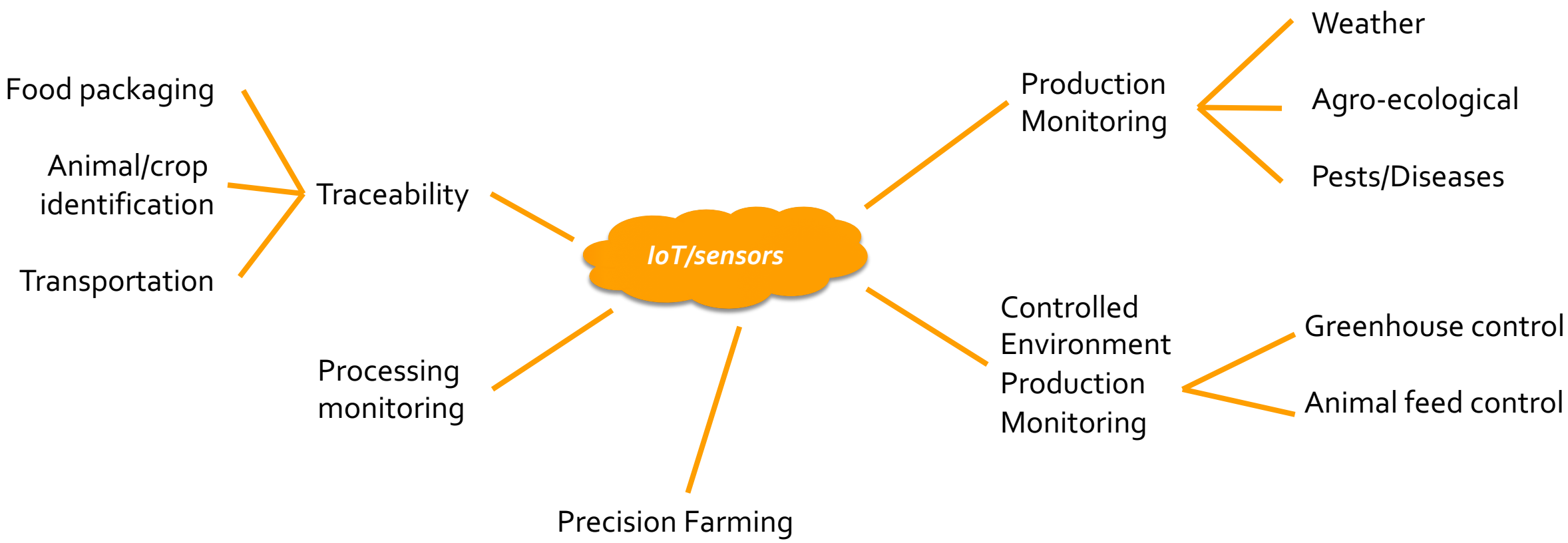
IoT and agricultural seasonal cycle



1. Information systems including DSS/MISS/GIS etc
2. ICT-enabled learning and knowledge exchange
3. Modelling solutions
4. Sensory and proximity devices
5. ICT-enabled networking solutions
6. Online commerce tools (eCommerce/mCommerce)

Deloitte, 2012

IoT: many potential applications in agriculture



EXAMPLES OF APPLICATIONS

IoT + agrifood = ?

IoT for ~~citizen~~ farmer science in agriculture

1. A broad set of varieties (10-50) is evaluated

2. Each farmer gets a different combination of varieties

4. Farmers test and report back by mobile phone

5. Farmers receive tailored variety recommendations and can order seed

6. Data are used to detect demand for new varieties and traits

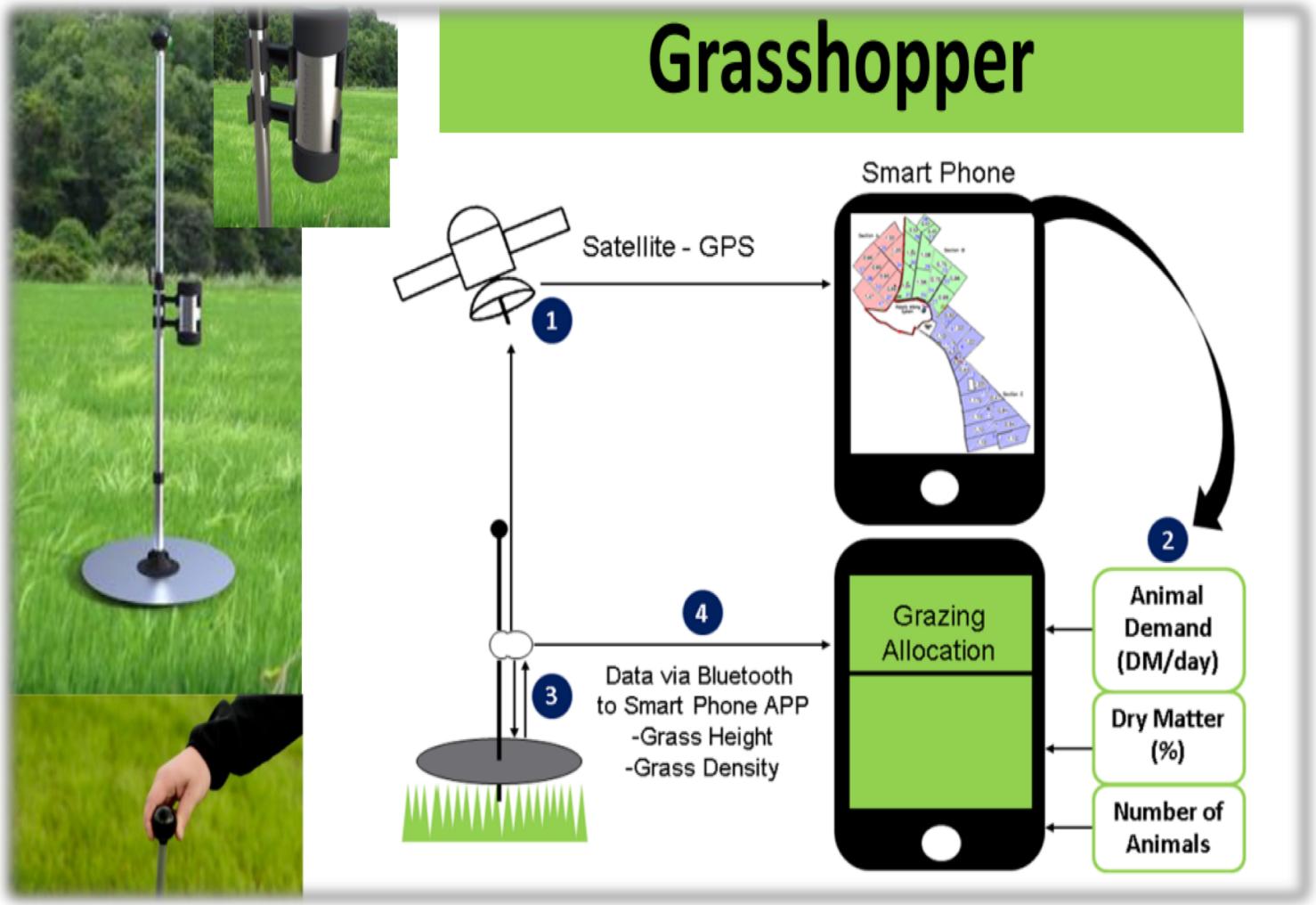
3. Environmental data (GPS, sensors) to assess adaptation

Bioversity's ClimMob: https://climmob.net/blog/

Video: https://www.youtube.com/watch?v=gbhJGA5ddqI

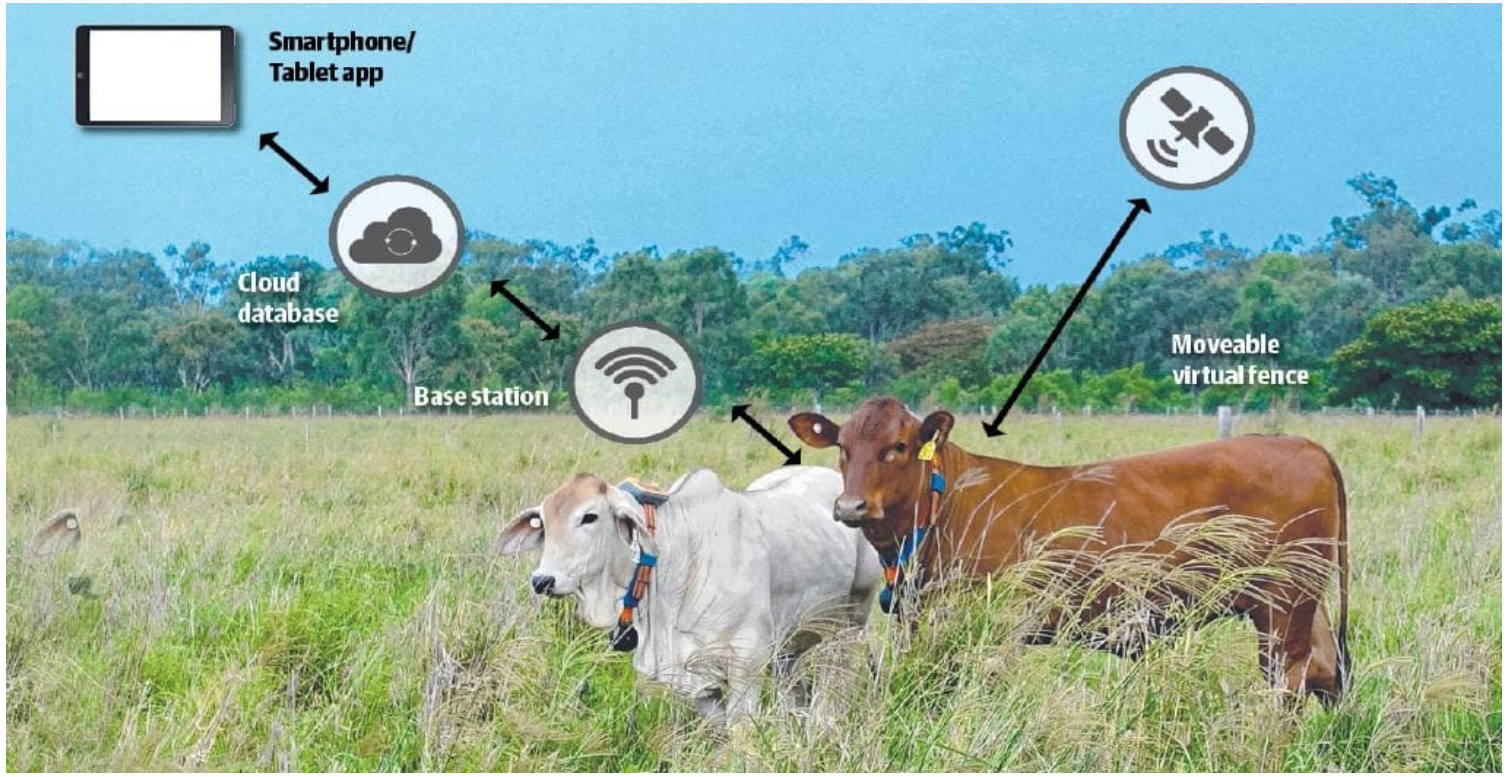
Moocall: calv birth

LIVESTOCK



Grasshopper: grazing capacity

LIVESTOCK



LIVESTOCK

Virtual fencing (by CSIRO)

Herd monitoring

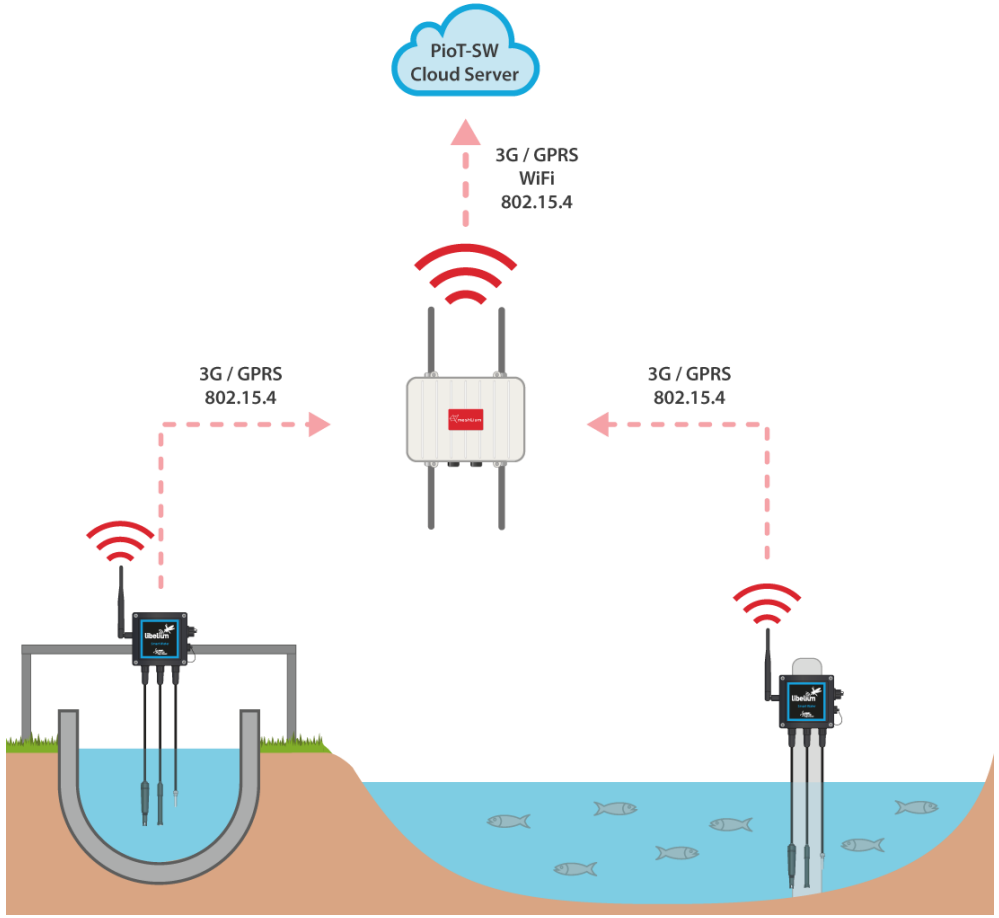
LIVESTOCK

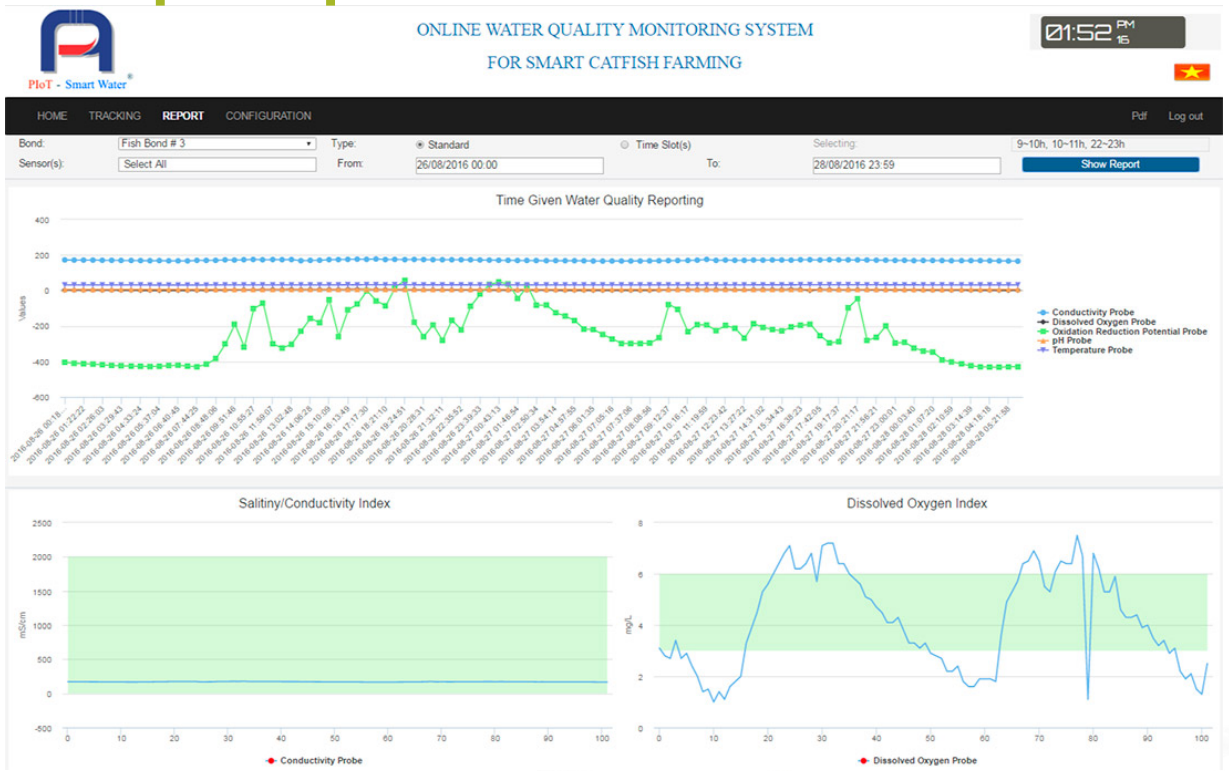
IoT-powered shrimp production

	Problem to solve	Sensor implementation	Risk warning	Result
Shrimp pools	35° / 25° → Dissolved Oxygen	Digital multisensor	Temperature increases alert	Control of consumption level
	Growth of toxic algae		PH increases alert	Control of water fertilization
Field	Shrimp food in bad condition due to humidity	Humidity Sensor	High levels of humidity	Control of water fertilization
Anti-theft control	Shrimp theft	Radio Frequency Transmitter	Opening shrimp pool gate alert	Loss control Fraud detection

AzLogica, Colombia

IoT-powered tilapia production





Libellium, Viet Nam

IoT-powered tilapia production

WAZIUP: A low-cost infrastructure for deploying IoT in developing countries

Congduc Pham[1], Abdur Rahim[2], Philippe Cousin[3]

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[2] CREATE-NET
abdur.rahim@create-net.org
[3] Easy Global Market
philippe.cousin@eglobalmark.com

Abstract. Long-range radio are promising technologies to deploy low-cost Low Power WAN for a large variety of IoT applications. There are however many issues that must be considered before deploying IoT solutions for low-income developing countries. This article will present these issues and show how they can be addressed in the context of African rural applications. We then describe the WAZIUP low-cost and long-range IoT framework. The framework takes cost of hardware and services as the main challenge to be addressed as well as offering quick appropriation and customization possibilities by third-parties.

Key words: LPWAN; Low-power IoT; Low-cost IoT; rural applications

The low cost way: **https://wazihub.com/**

Estimating Soil Moisture and Electrical Conductivity Using Wi-Fi

Jian Ding
Microsoft Research

Ranveer Chandra
Microsoft Research

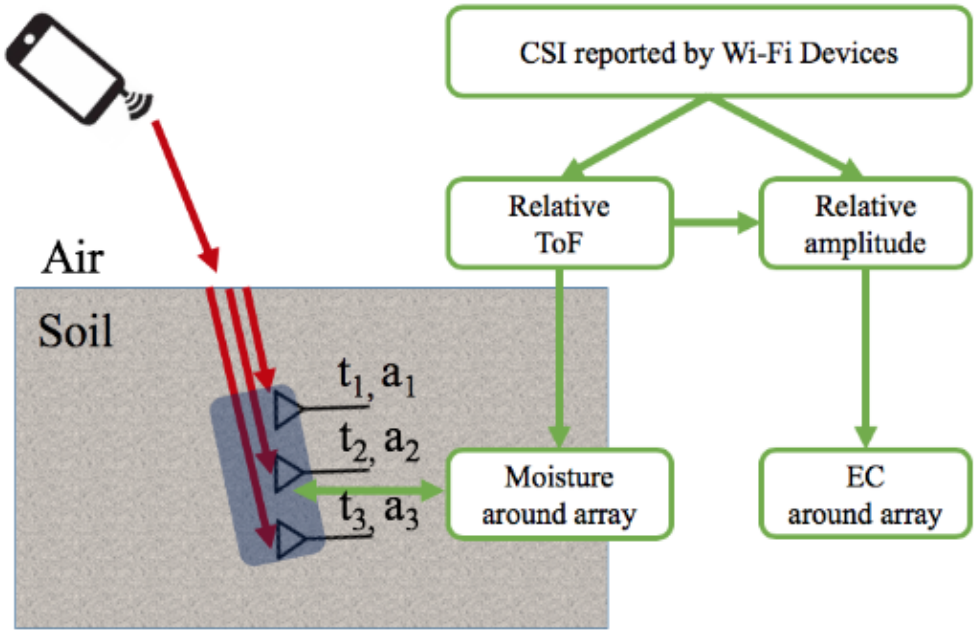
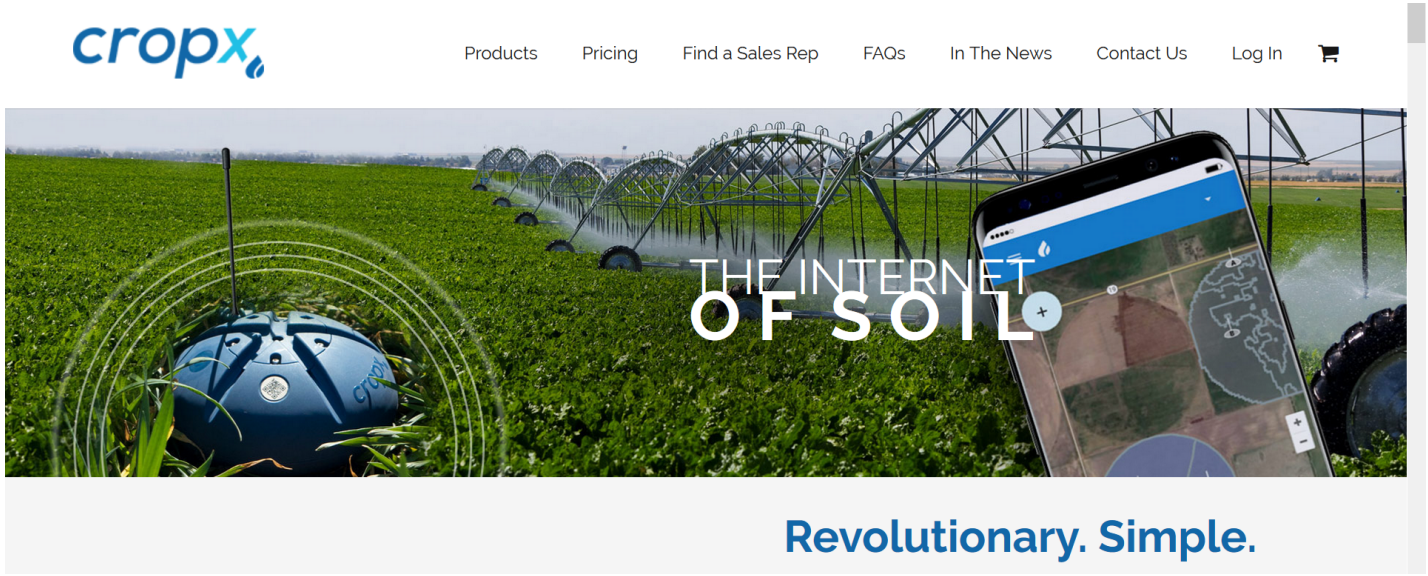


Figure 1: Overview of SMURF

IOT FOR SOIL ANALYSIS

IOT FOR SOIL MONITORING



https://www.youtube.com/watch?v=CoPyPv24Usg

agrocares
nutrient intelligence

IOT FOR SOIL ANALYSIS

Lab-in-a-Box

The most complete, fast, affordable and reliable solution to test nutrients on-site

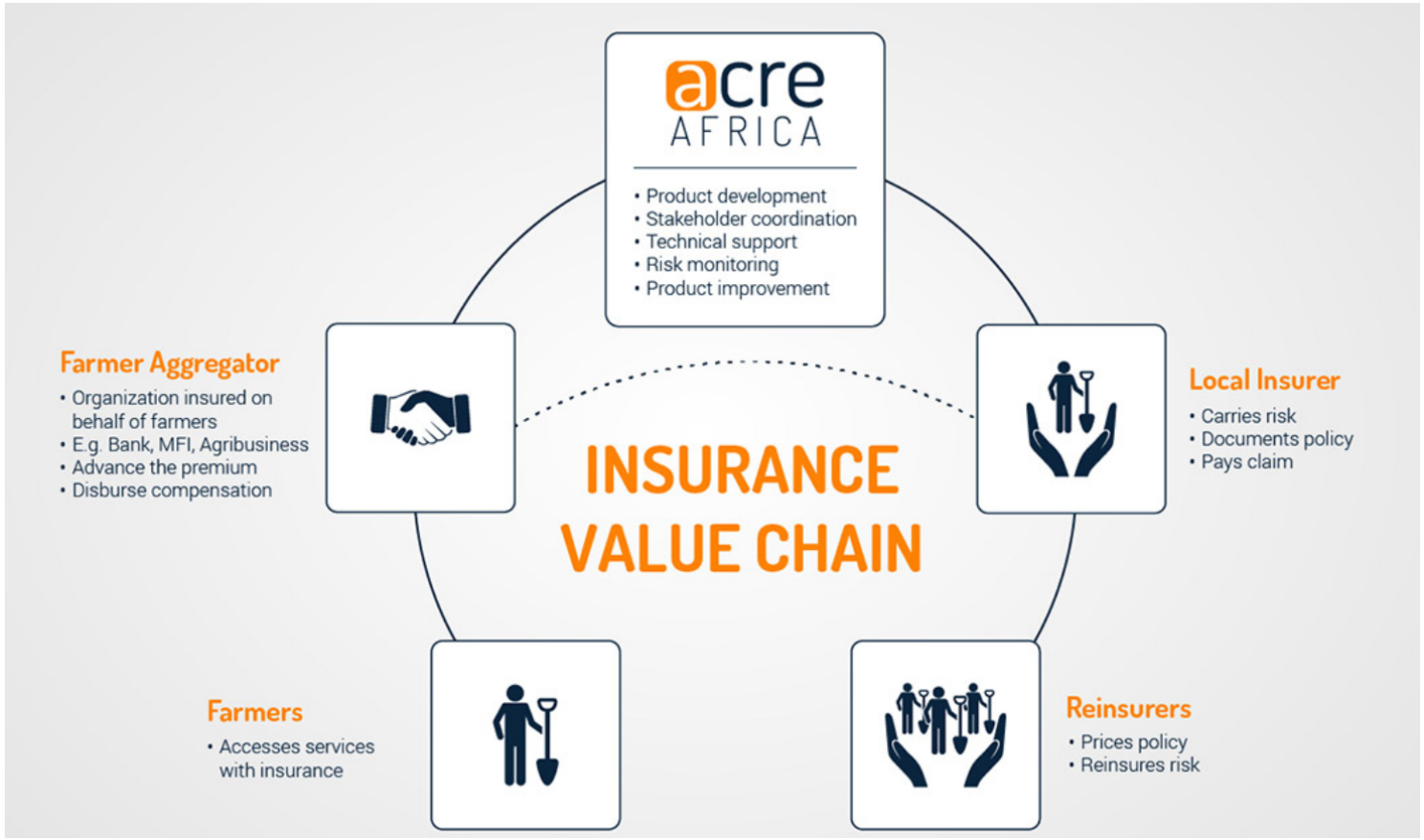
Scanner

A simple, smart and connected way to analyse your crops, raw materials and soil

Scoutbox

Beat the human eye. Digitally determine, count and locate harmful insects.

https://www.agrocares.com/en/products/scanner/



- **ACRE:** micro-insurance for farmers
- Users invest 20% more in farm operations
- Farmers' income up to 16%

IOT & FINTECH

I didn’t want to talk about sensors on drones..

Detect pests 10 days before human eye

10% increase in soil use to produce coffee in Brazil

APPLYING IOT IN AGRICULTURE

Ideation phase

Some solutions…

- Temperature control system of a chicken farm based on Lora technology
  Luis De La Cruz, Peru

- Sensor network deployed at the Aquaculture and Aquatic Biodiversity Research Unit (UR-ABAQ) at NAZI BONI University
  Zougmore Teegwende, Senegal

Hat	Role	Focus
	Logic	The facts.
	Optimism	The value and the benefits.
	Devil's advocate	The difficulties and dangers.
	Emotion	Feelings and intuitions.
	Creativity	Possibilities and new ideas
	Management	Making sure the rules of the hats are observed.

EVER PLAYED THE 6-HAT GAME?

Hat	Role	Focus
	Logic	The facts.
	Optimism	The value and the benefits.
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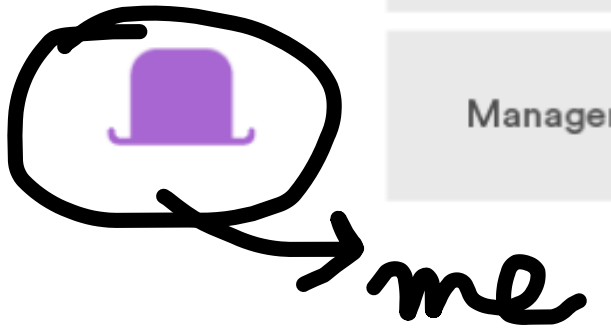


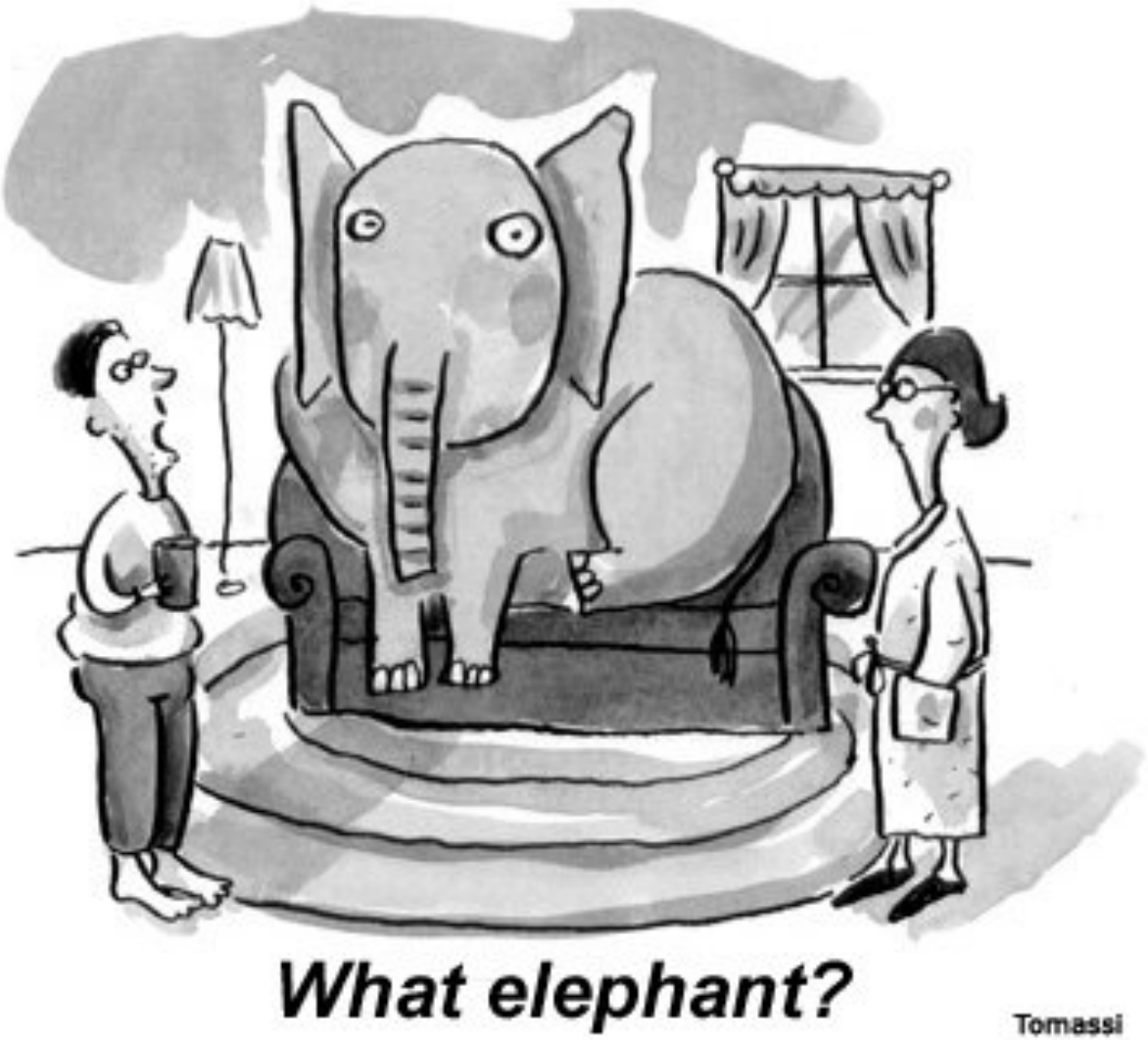
EVER PLAYED THE 5-HAT GAME?

Some problems looking for IOT-powered solutions…

1. **Availability of water**
2. **Complying with regulations**
3. **Managing pests**
4. **Increasing yields**

Some problems looking for IOT-powered solutions…

- **Water scarcity:** field sensors can be used to monitor rainfall or crop water requirements, which in turn help design irrigation strategies and reduce water consumption
- **Traceability :** helping farmers to provide data points from farm to fork and every step in between.
- **Pests:** monitor and scan the environment for infestations to pinpoint pest hotspots, allowing for more targeted applications of insecticides and other pest controls.
- **Yield gap:** quickly identify and resolve problems affecting crop and animals, improving the overall yield. Tractors can also help monitoring real-time yields as they plow, fertilize and harvest.



BEFORE YOU START...

Some problems looking for IOT-powered solutions…

Goals

- average usage (number of clients connected)
- average / peak throughput (overall / per user)
- latency and other network issues that can influence the services running on the network
- reliability (percentage of downtime)
- maintenance costs

Constraints

- local availability of equipment
- regulatory aspects (permits, fees, allowed frequencies)
- limitations of the ISP
- access to sites and infrastructures
- availability of power (and its quality/reliability)
- human resources (for deployment/maintenance)
- financial constraints (budget)

THANK YOU, IT WAS MY PLEASURE!

Simone Sala - @hereissimone – simone.sala@gmail.com