Instituto Nacional de Investigación Agropecuaria
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Sistemas Ciber Físico y acceso remoto a la información: una aproximación desde el agro

Cyber physical systems and remote access to information: an approach from the agricultural sector

Guadalupe Tiscornia - Alejandro La Manna

AgriTech – factors that promote its use in agriculture

a) **Advances** in communications (**connectivity**) and mobile terminals that allow information systems to be taken to production centers.

b) **Reduction in the price** of equipment, sensors and computer supplies in general.

c) Maturity and growing **offer of advanced business** management **applications** (customer management, supplies, production control, information on areas of interest, etc.).

AgriTech – factors that promote its use in agriculture

d) **Generational shift** (farmers and technicians).

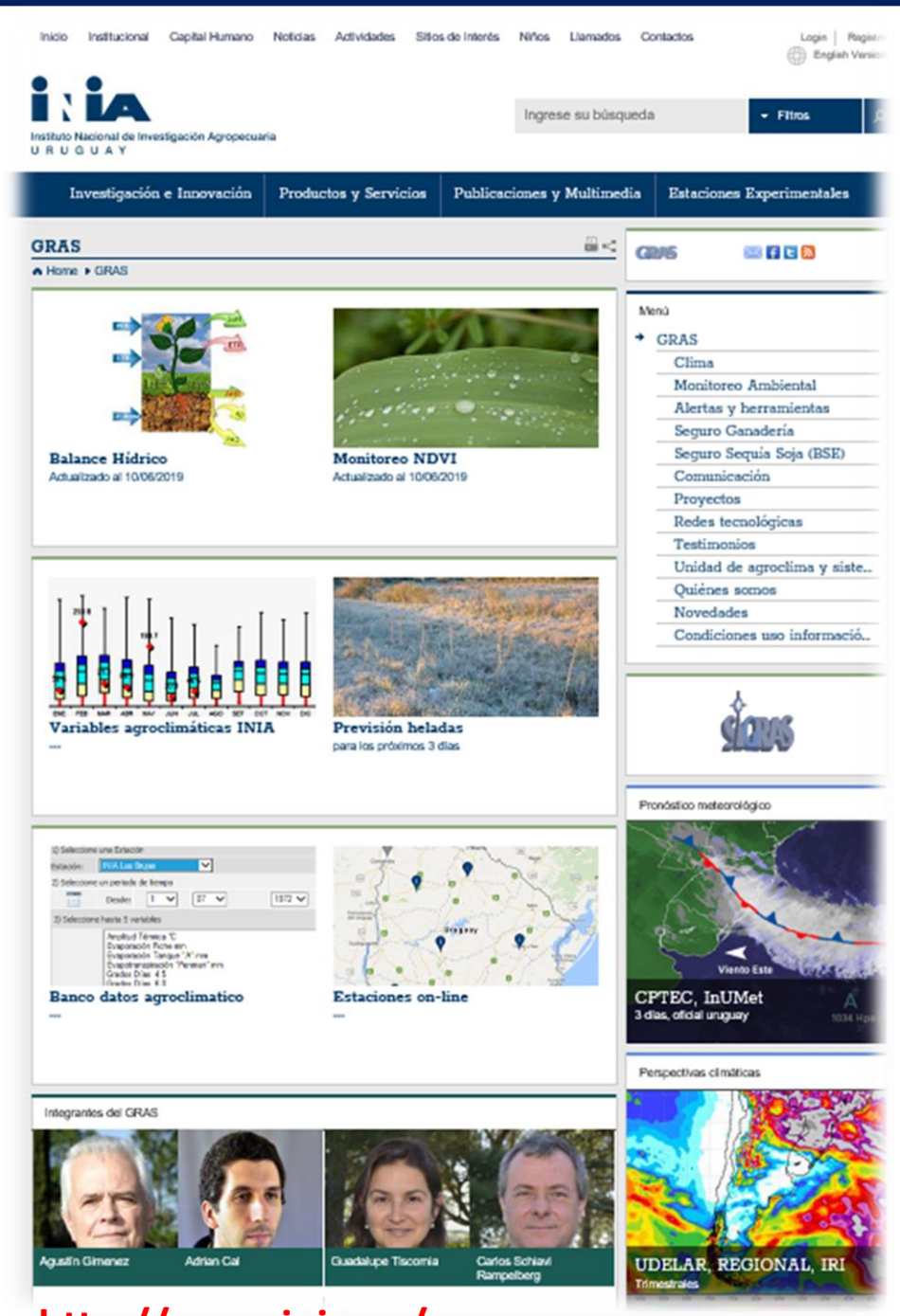
e) **Labor shortage** for specific tasks.

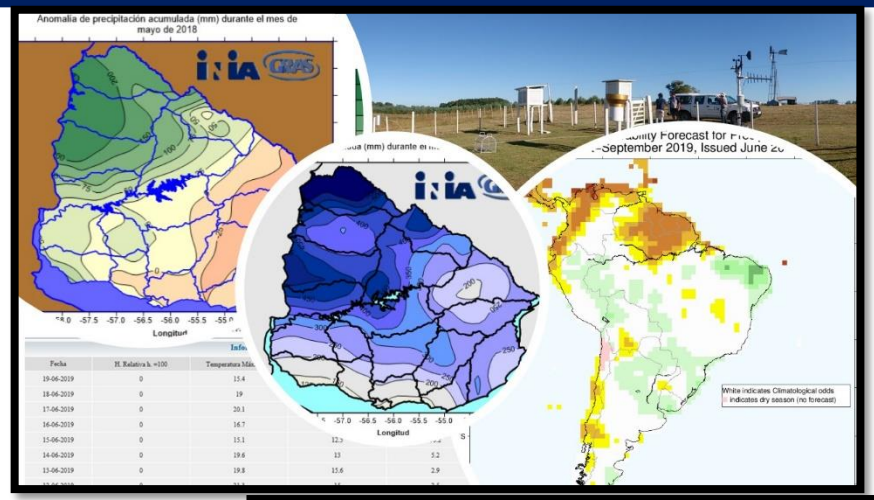
f) Demand / need / regulations for less adverse, healthier, more attractive **working conditions.**

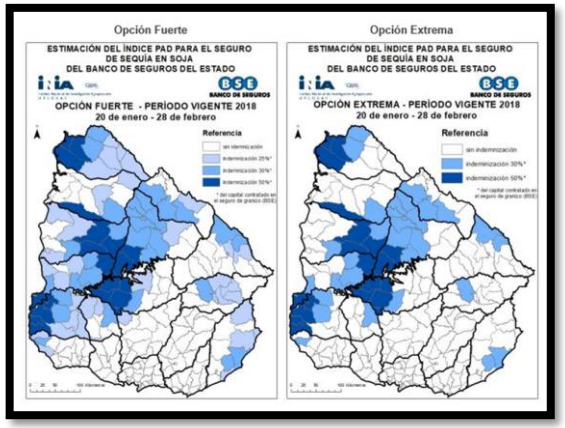
Our close future

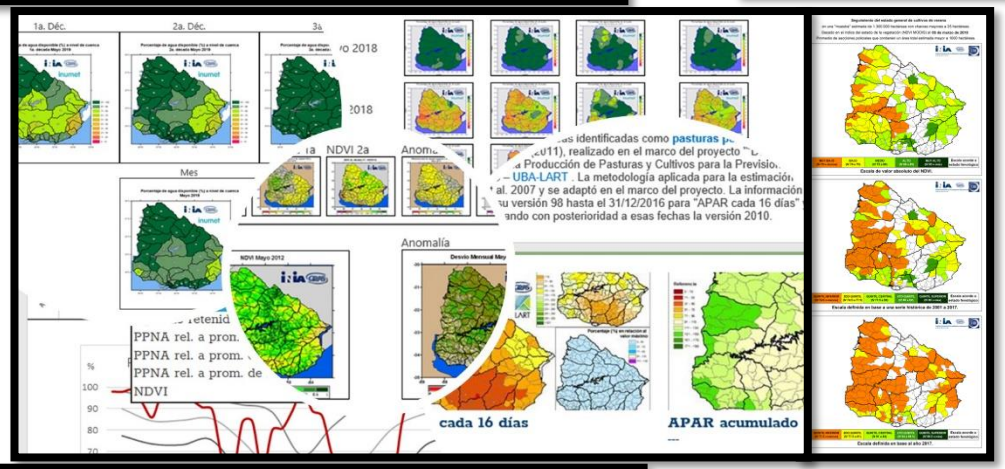
- **Strengthen** the study, evaluation and development of **ICT in agriculture** (process automation and remote management, expert systems, modern platforms for access to information, surveillance systems, etc.) and **Big Data** (data mining, machine learning, deep learning, artificial intelligence, PLN).

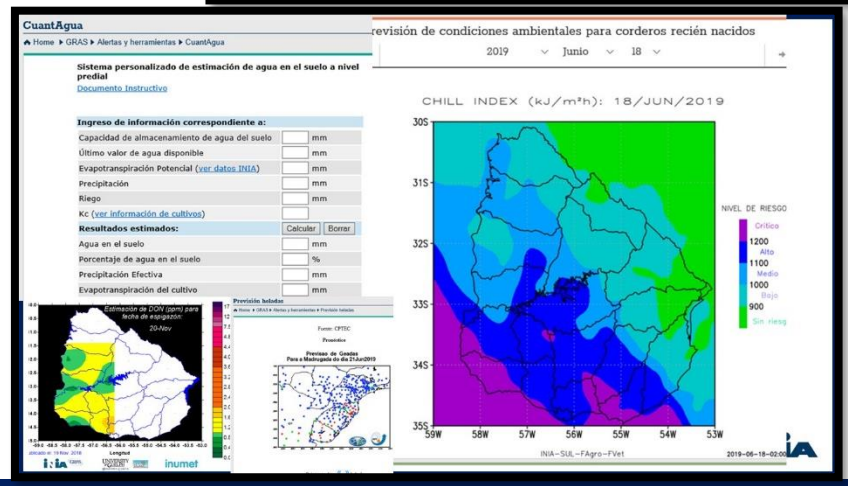
Information systems based on Big Data and remote access to information

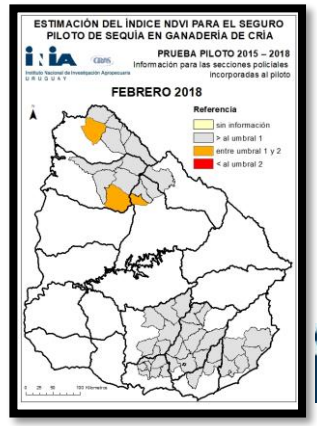






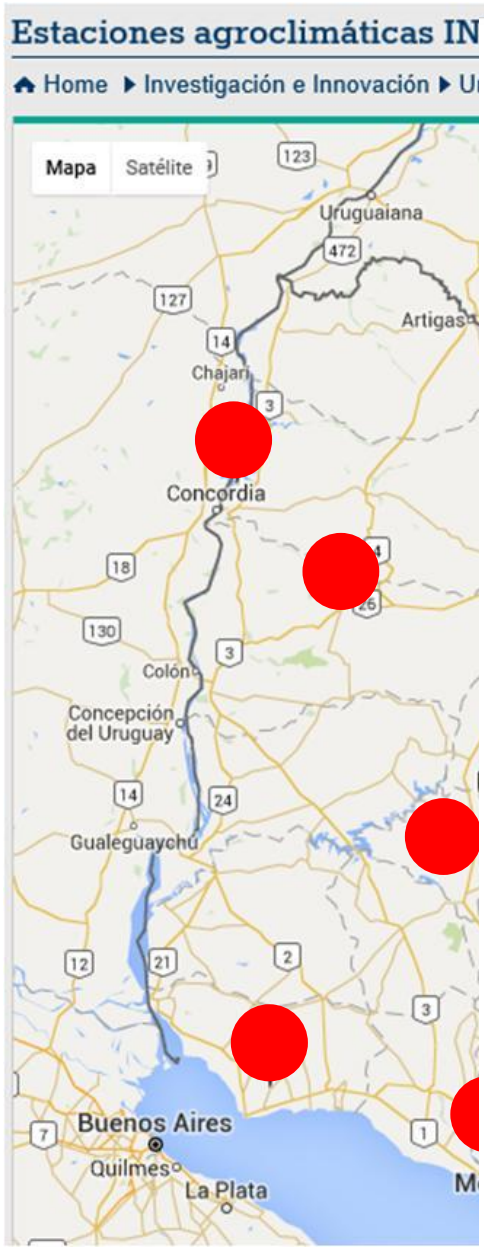


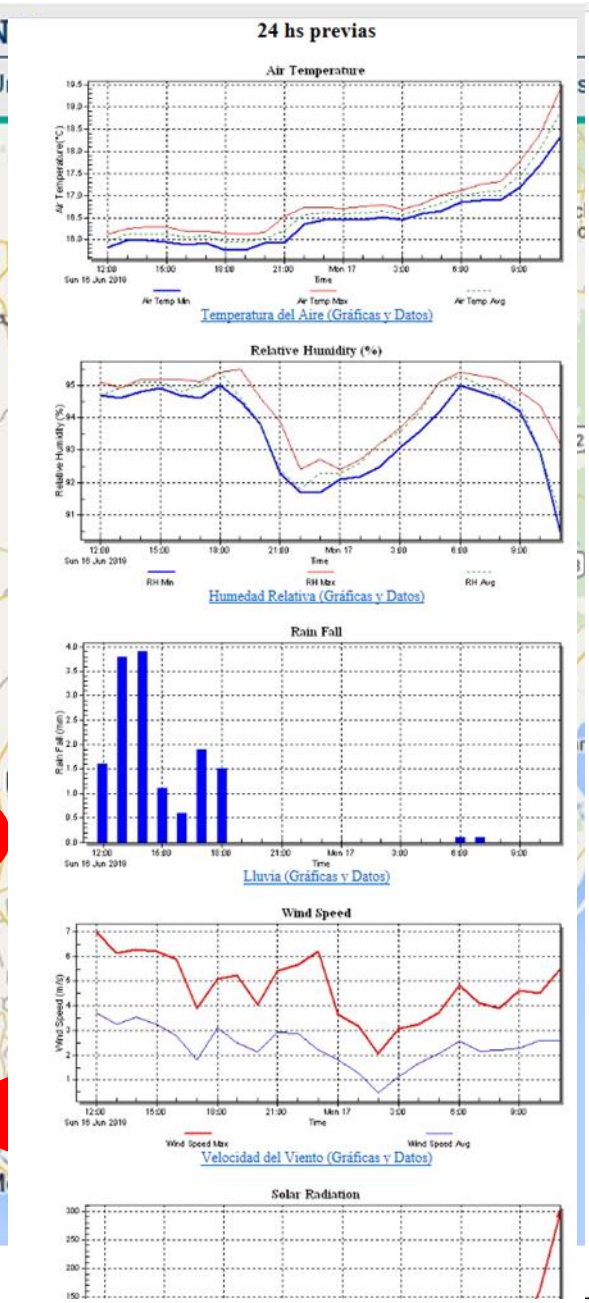


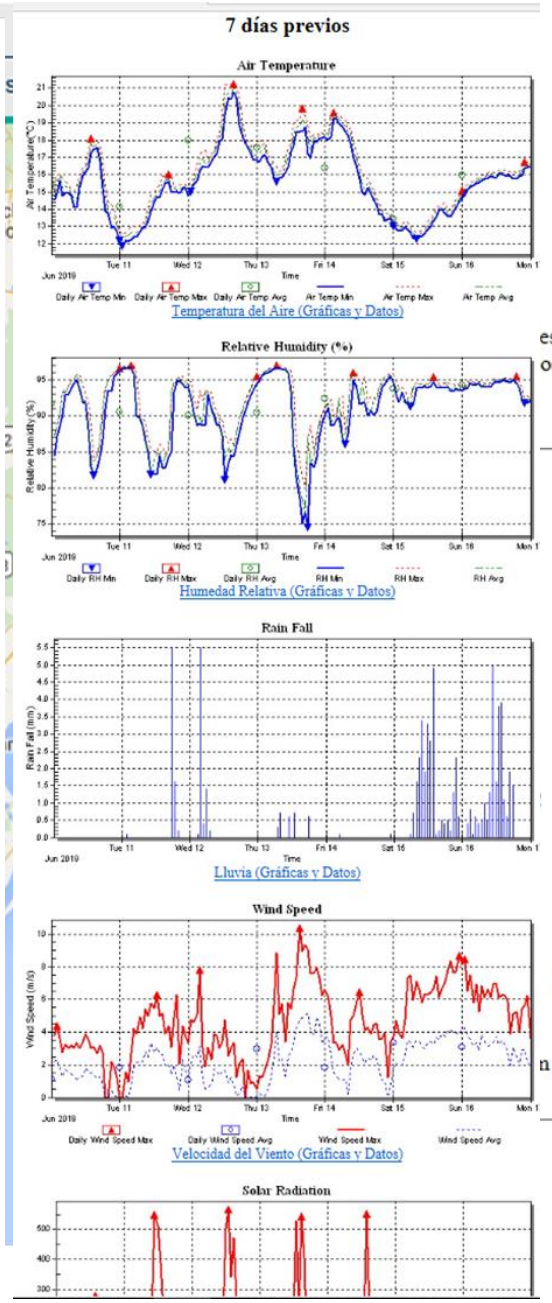


http://www.inia.uy/gras

Weather stations reporting online in real time







Las Brujas

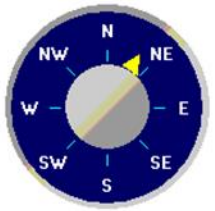
Ruta 48 km 10 - Canelones (34°40'S 56°20'O)

es recabada por una estación meteorológica automática marca CampbellSci, la
os horarios corresponden a la hora solar.

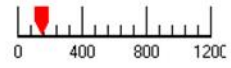
Última Actualización: 17/06/2019 11:02:33

Información en tiempo Real

HR: 91 %

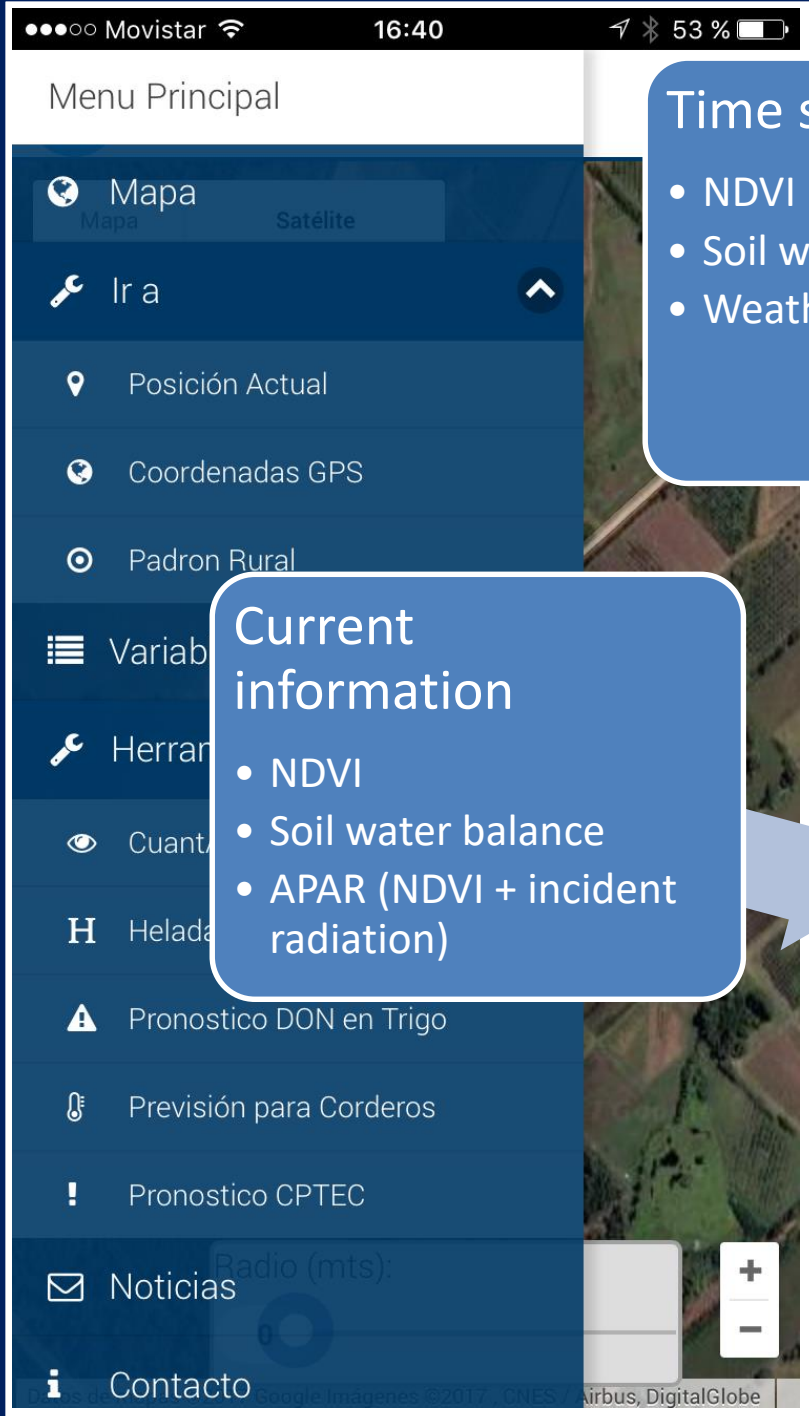


Velocidad del Viento: 2.9 m/s



Radiación: 149 W/m²

Temperatura en el Césped: 20.5 °C



Time series

- NDVI
- Soil water balance
- Weather

Soils characteristics

Current information

- NDVI
- Soil water balance
- APAR (NDVI + incident radiation)

SIGRA
App

INIA
Unidad de Agroclima y Sistemas de Información

MINISTERIO DE GANADERÍA AGRICULTURA Y PESCA

Tools and warnings

AgriTech y Big Data: main themes to approach

Develop systems for remote management of activities and decision-making at the farm level, through the intensive use of ICT.

Better access to information and technologies, and to queries made.

AgriTech

The development and implementation of a system for the remote management of a farm, production unit or plot.

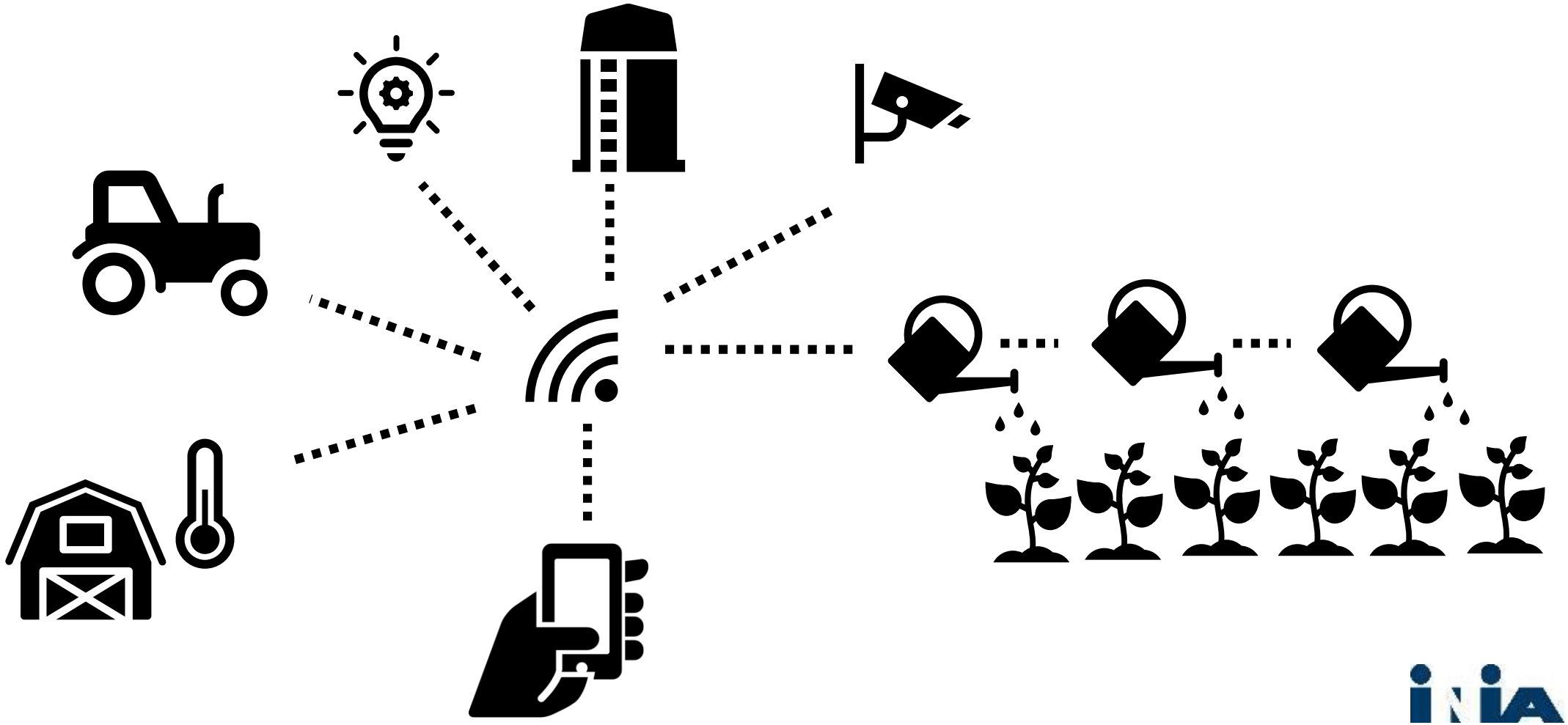
In a productio different ICTs

- Sensors
- Cameras
- Virtual fenc
- Intelligent decision making systems
- Alerts
- Internet of things, etc.

Ultimate goal: manage activities, information generated and decision making remotely.

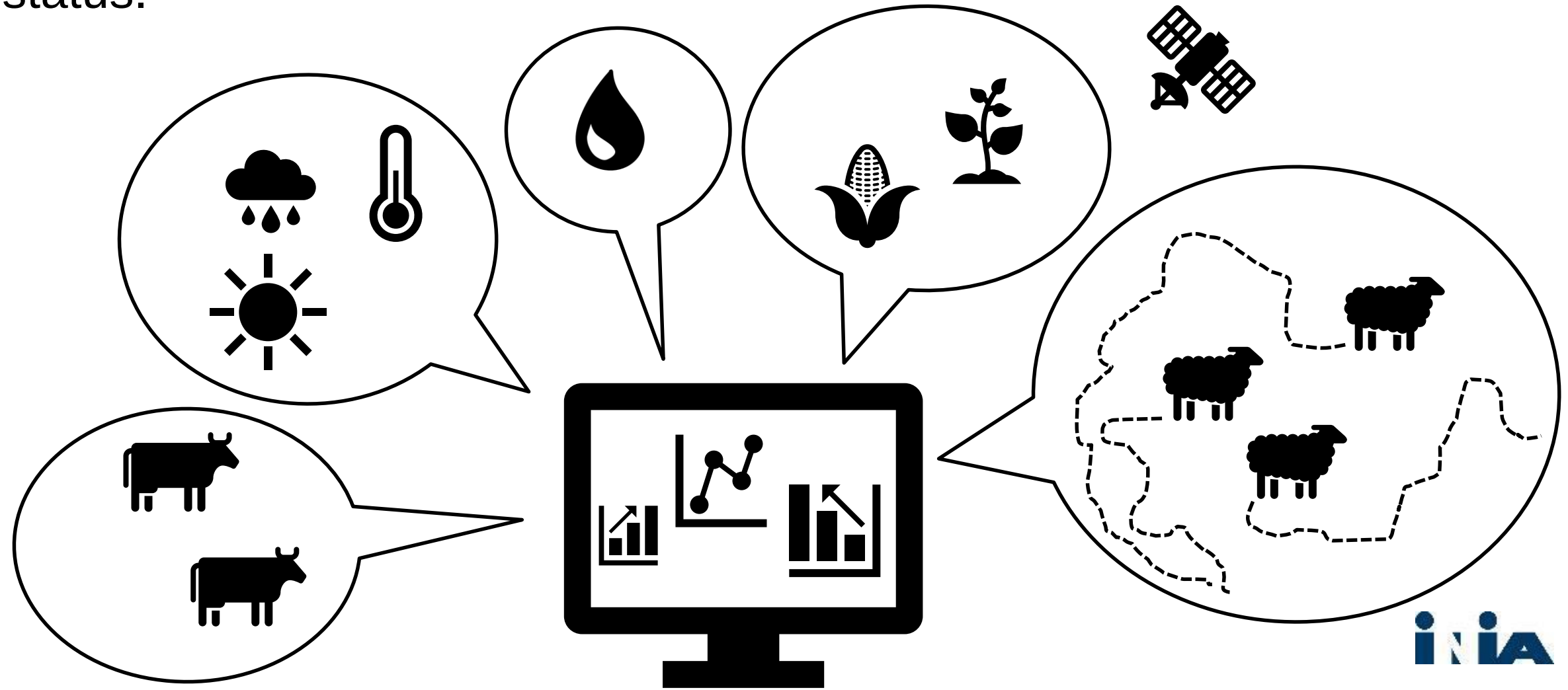
AgriTech: farm level applications

- Internet of things (equipment, lighting, pumps, cooling, etc.).



AgriTech: farm level applications

- Monitoring of climatic variables, soil, water, animal behavior and plant status.

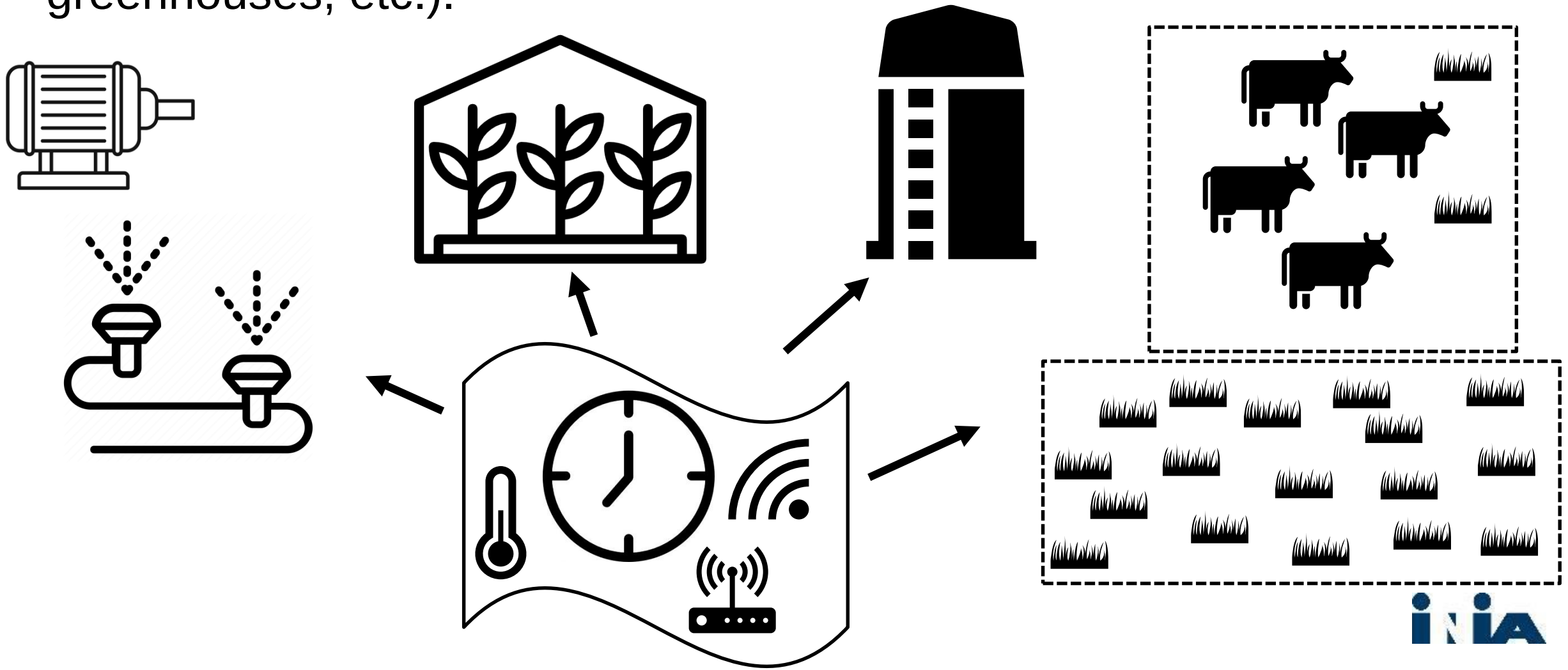


AgriTech: farm level applications

- Alert systems (pests, diseases, weather, surveillance, equipment, etc.).

AgriTech: farm level applications

- Automation (virtual fences, pumps, air conditioning, irrigation, greenhouses, etc.).

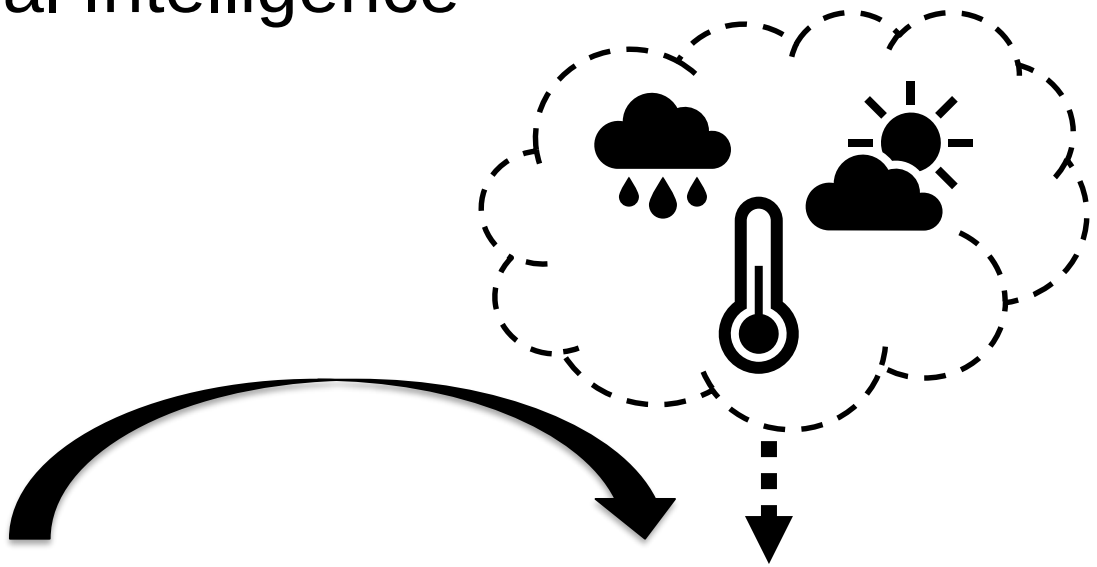


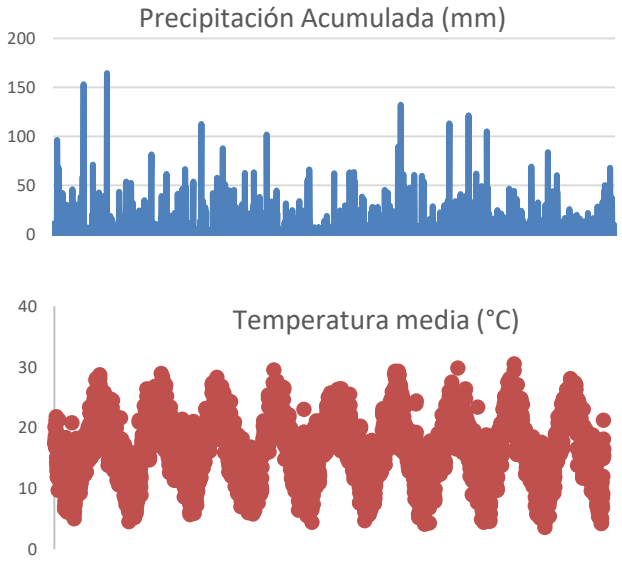
AgriTech: farm level applications

- Robotization (greenhouses, milking, agricultural machinery, etc.).

AgroTic – aplicación a nivel de predio

- Artificial Intelligence

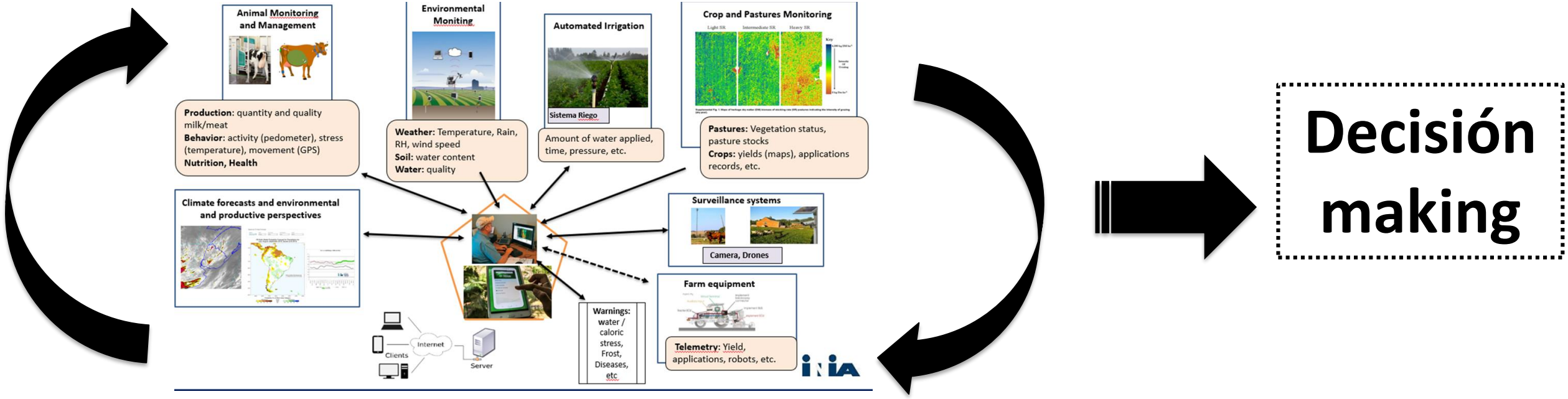




Predictive models

AgriTech: farm level applications

- Intelligent decision-making systems (crop management, animal management, financial and economic management, etc.).



Animal Monitoring and Management

Production: quantity and quality milk/meat
Behavior: activity (pedometer), stress (temperature), m
Nutrition, Health

Environmental Moniting

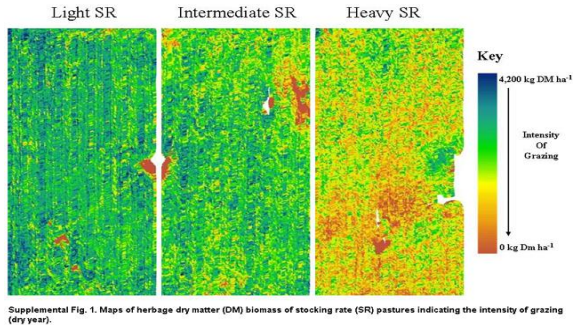
Weather: Temperature, Rain, PH, wind speed

Automated Irrigation

Sistema Riego

Amount of water applied,

Crop and Pastures Monitoring



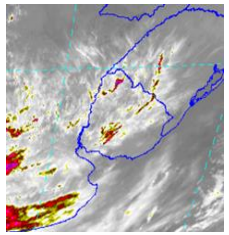
Supplemental Fig. 1. Maps of herbage dry matter (DM) biomass of stocking rate (SR) pastures indicating the intensity of grazing (dry year).

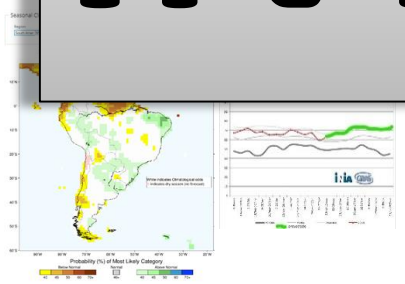
Pastures: Vegetation status, pasture stocks

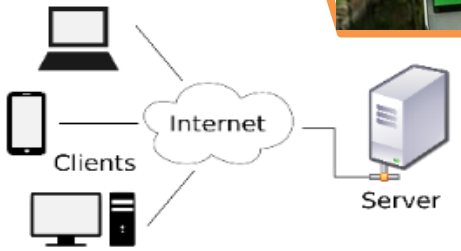
aps), applications

INTEGRATION

Climate forecasts and producti

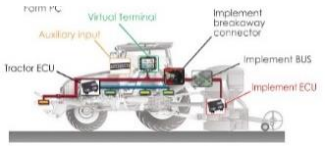






Warnings: water / caloric stress, Frost, Diseases, etc

Farm equipment



Telemetry: Yield, applications, robots, etc.

Camera, Drones

Cyber physical systems aplication at farm level: The Dairy farm

Along the "Information Superhighway"

Precision Dairy Farming

- “The use of information technologies for assessment of fine scales animal and physical resource variability aimed at improved management strategies for optimizing economic, social and environmental performance”

Eastwood et al 2004

AgriTech – factors that promote its use in agriculture

d) **Generational shift** (farmers and technicians).

e) **Labor shortage** for specific tasks.

f) Demand / need / regulations for less adverse, healthier, more attractive **working conditions.**

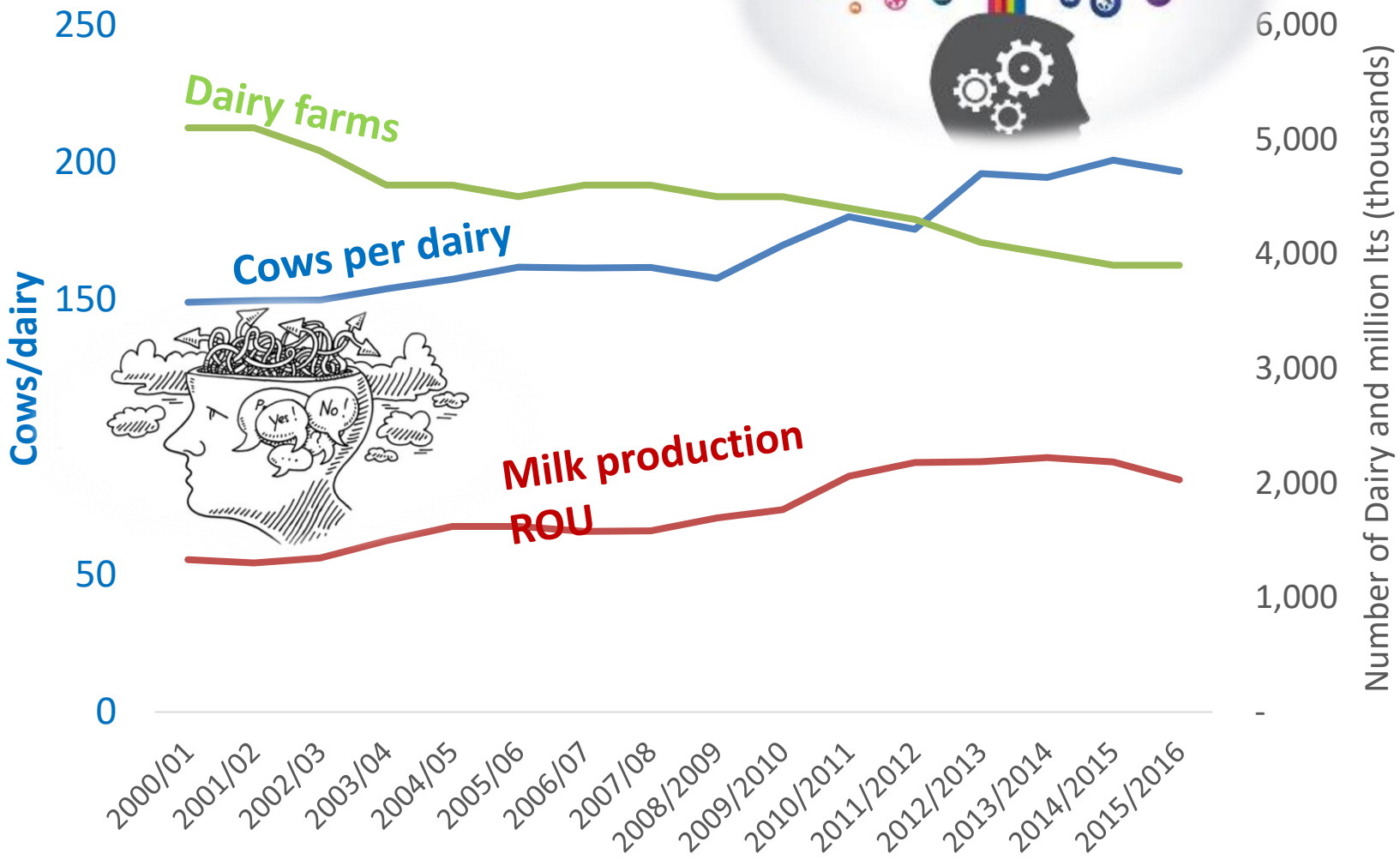
g) **Routine work**

Dairy

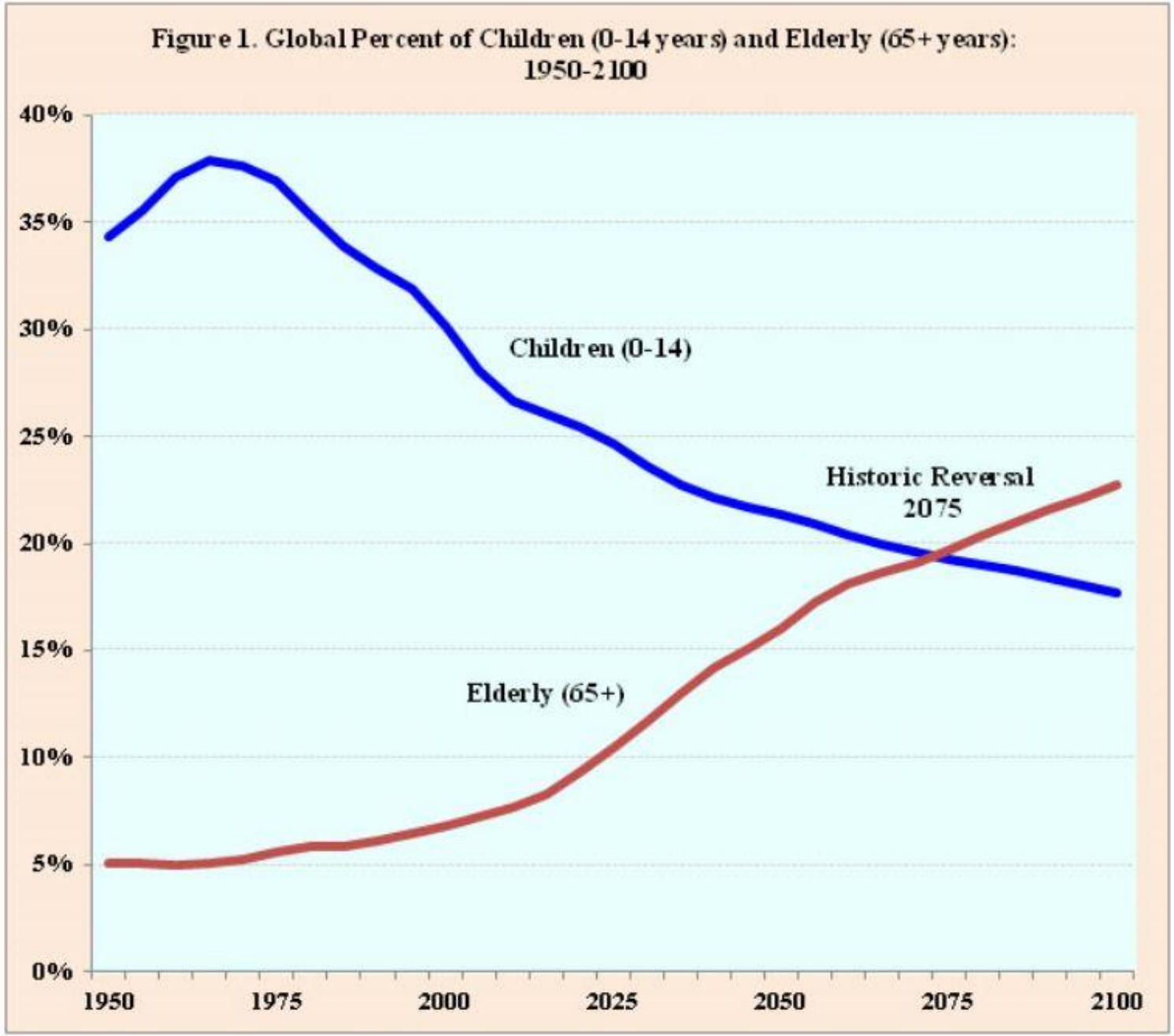
Global trends (exporters)

- Fewer farms
- Need for greater efficiency
- Price volatility
- More animals per dairy farm
- Higher production (per dairy and per animal)
- Trouble finding personnel.

SUSTAINABLE Intensification in the human area ?

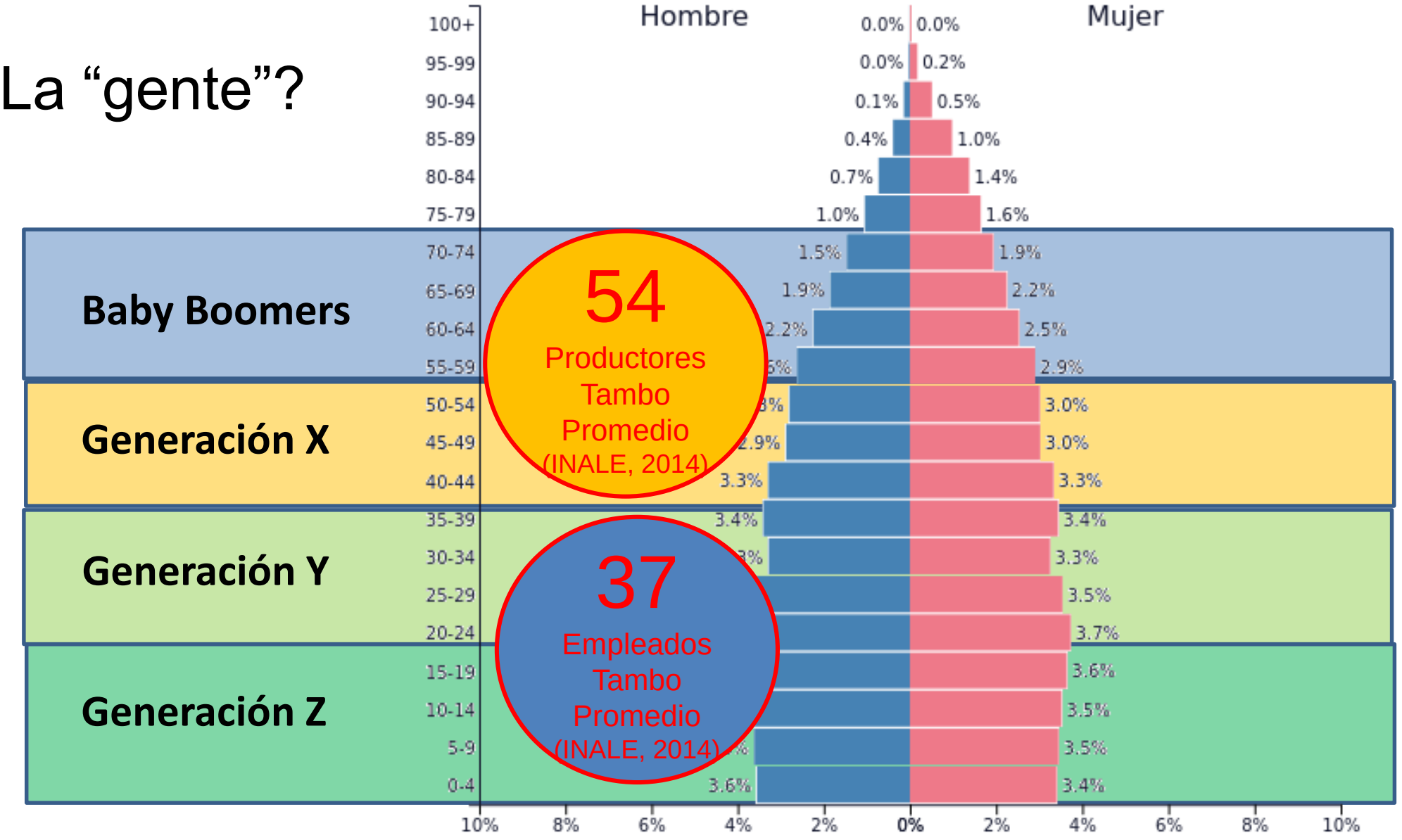


DIEA (2017)

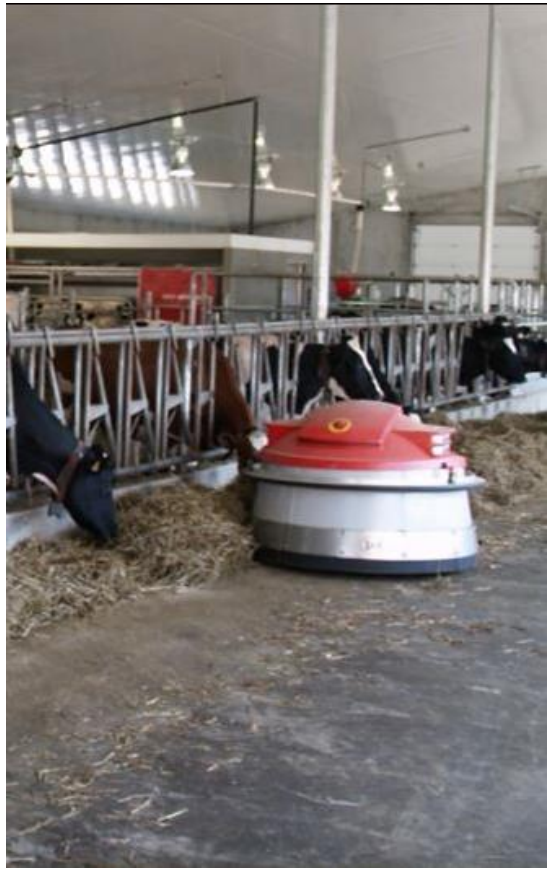


Source: United Nations Population Division.

¿La “gente”?


Hombre
Mujer
100+
95-99
90-94
85-89
80-84
75-79
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
0-4
0.0% 0.0%
0.0% 0.2%
0.1% 0.5%
0.4% 1.0%
0.7% 1.4%
1.0% 1.6%
1.5% 1.9%
1.9% 2.2%
2.2% 2.5%
2.9%
3.0%
3.0%
3.3%
3.4%
3.4%
3.3%
3.5%
3.7%
3.6%
3.5%
3.5%
3.6%
3.4%
10% 8% 6% 4% 2% 0% 2% 4% 6% 8% 10%
Baby Boomers
Generación X
Generación Y
Generación Z
54
Productores
Tambo
Promedio
(INALE, 2014)
37
Empleados
Tambo
Promedio
(INALE, 2014)
PopulationPyramid.net
Uruguay - 2016
Población: 3,444,070

There is worldwide greater interest in automating and/or robotizing routine tasks.

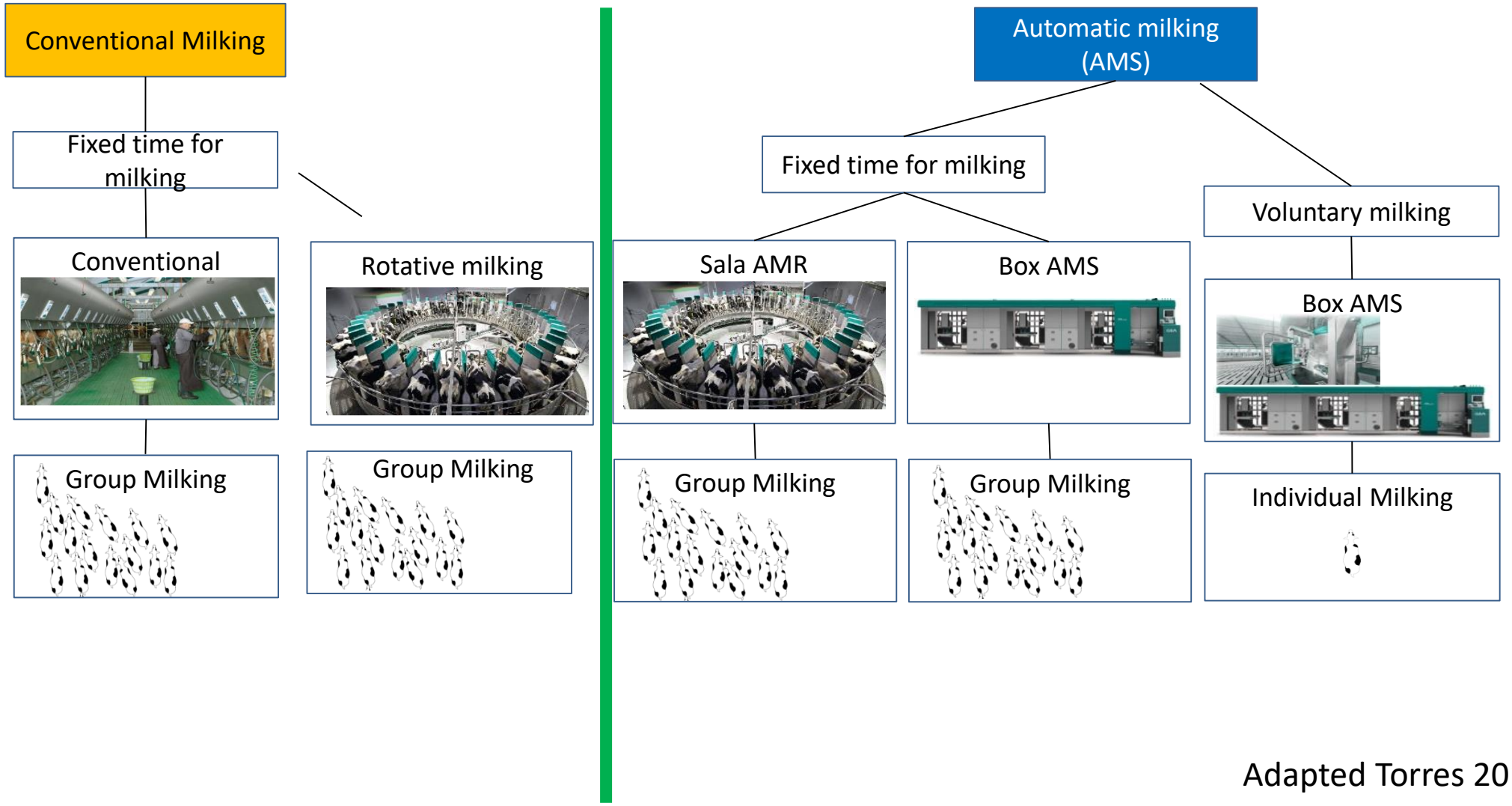


Use of robots to push food increase in milking AMS or robotized in 352 kg per robot or 4.9 kgs-cow per day in 33 dairy's of MN and WI (Siewert et al., 2018 JDS 101 8327)

What producers and consumers demand

- Dairy Farmers
  - Simplicity
  - Attractive for new generations
  - Automation of routines and tasks
  - Profitable with low environmental impact
- Consumers
  - Animal Welfare
  - Food safety
  - Environmental stewardship

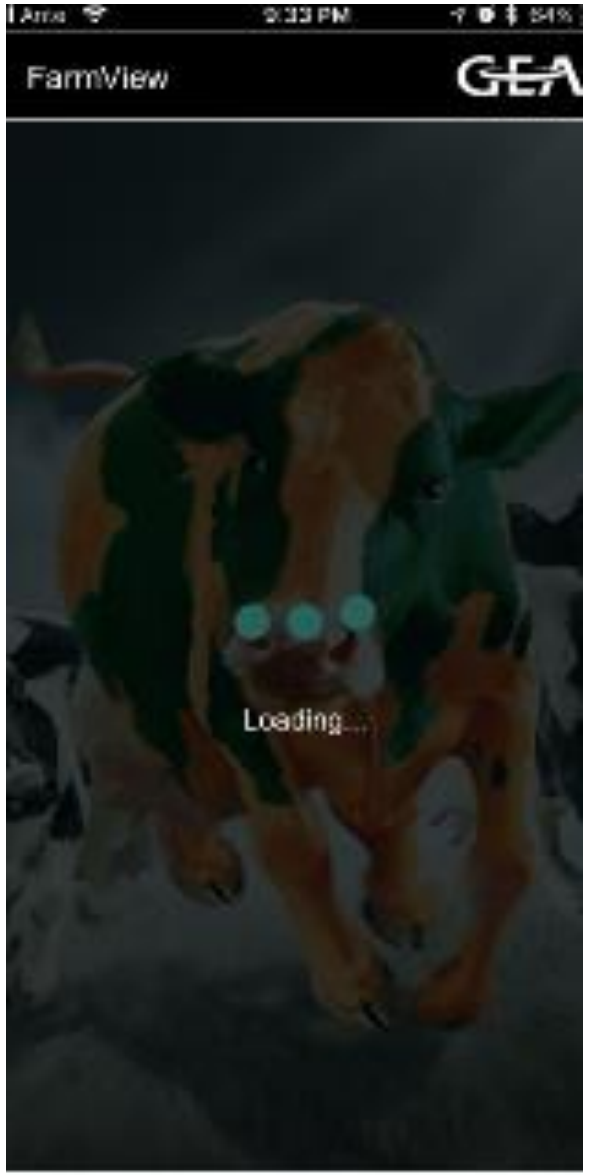
Systems currently available for milking

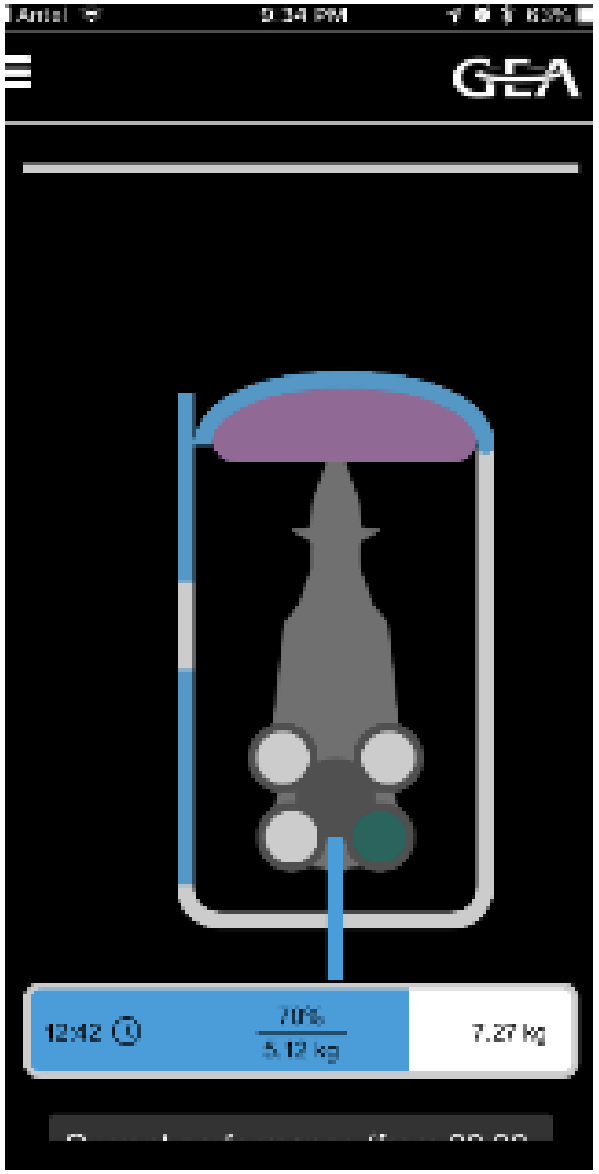


Adapted Torres 2015

AUTOMATIC MILKING (ROBOTS)

Mirror facility with two systems
Different carrying capacity


FarmView
GEA
Loading...


GEA
12:42
7.27 kg


GEA
Current performance (from 00:00 o'clock until now)
System
Total number of milkings per day
147
Total milk amount per day
2145.24
Total number of visits per day
154
Total milking duration per day
Total milking duration per day in minutes
1013.43
Total automatic attachment time per day
Total automatic attachment time per day in minutes
System alarms

Voluntary Milking Systems (robot)

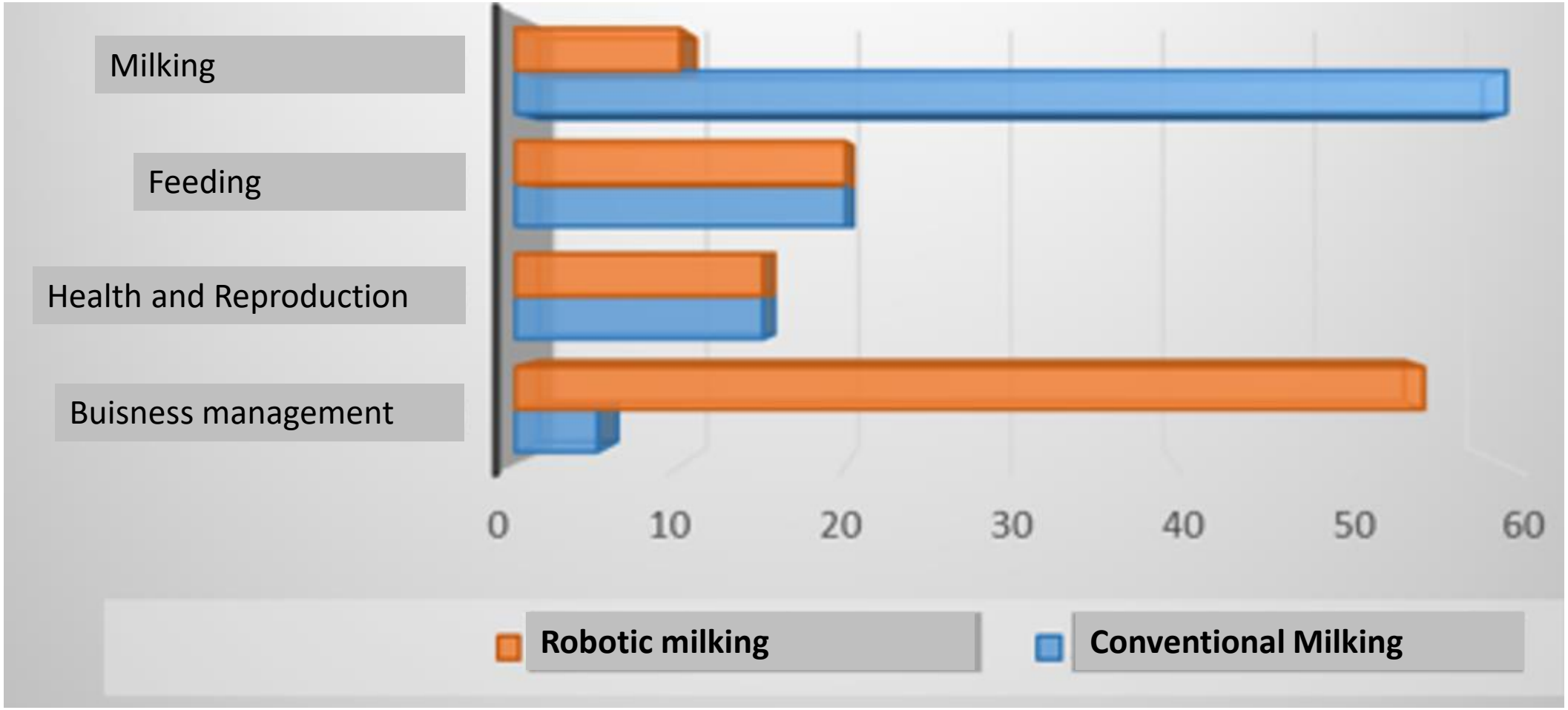
- VMS


Colocación de pezoneras

What would the robot bring

- Less routine work
- There is more time for “business thought" rearrangement of tasks

Time dedicated to different activities



What would the robot bring

- Less routine work
- There's more time for business feed.
- Less stressful schedules
- A cow who decides (we have to learn the motivating behavior)
- Less stress for the cow “we don't push it"
- Standardization of the milking routine
- Increased production
- More data

Advantages of VMS

- Automatic Sensors
  - Udder health (allows you to differentiate by quarters)
  - Milk production
  - Reproductive status
  - Individual consumption
  - Weight change

Multiplied by 4 the first two

Available technologies

Allow to control some processes

- Nutritional (individual food, mixers, water)
- Productive (quantity of milk, composition, weight of cattle)
- Health (mastitis, body temperature)
- Fertility (heat detection, fertility)

Available technologies

- They collaborate in improving the public perception of the dairy
  - Animal welfare
  - Innocuousness
  - Animal health
  - Sustainability of the dairy farms
  - Environment
  - Product and process quality

IMPROVE EFFICIENCY: USE OF SENSORS AND TECHNOLOGIES

- Daily milk production
- Pedometers
- Caravans
- Necklaces
- Accelerometers
- GPS (animal positioning)

SCR by Allflex
Make every cow count

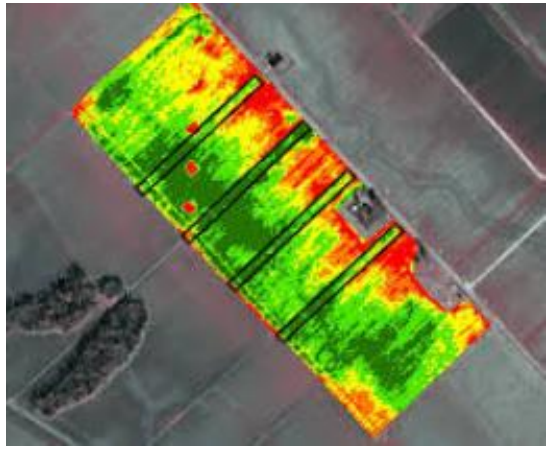
Silent Herdsman

IMPROVE EFFICIENCY: USE OF SENSORS AND TECHNOLOGIES

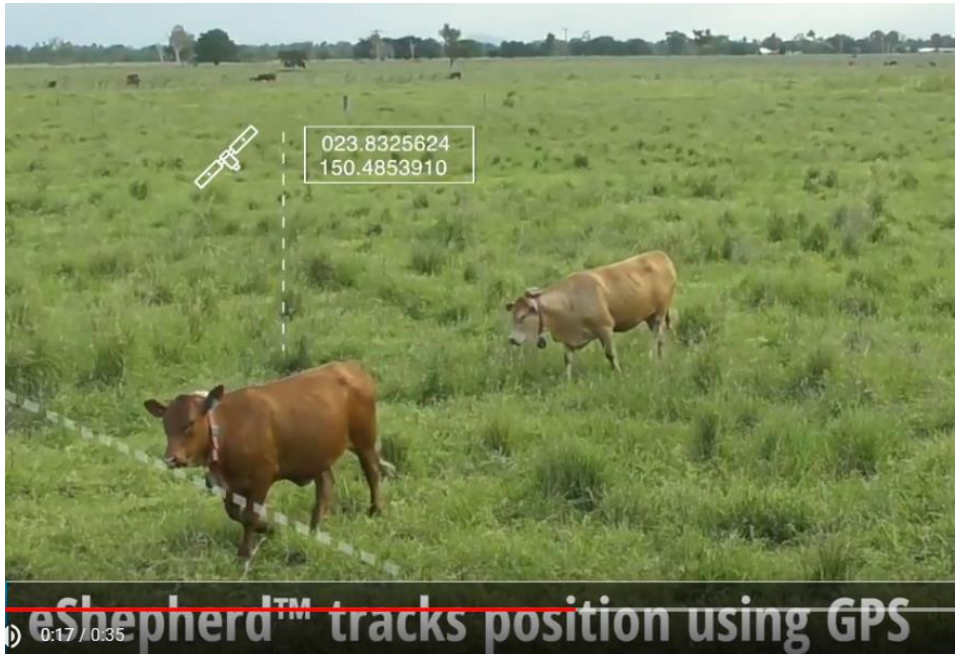
- Behavior
  - Ruminal
  - Consumption
- If they're lying down or standing still.
- Milk composition
- Somatic cells
- Teat cup remover
- Daily Weight

OTHER TOOLS

- Drones
- Multispectral cameras make it possible to collect images using different wave frequencies simultaneously.
- Satellite Images



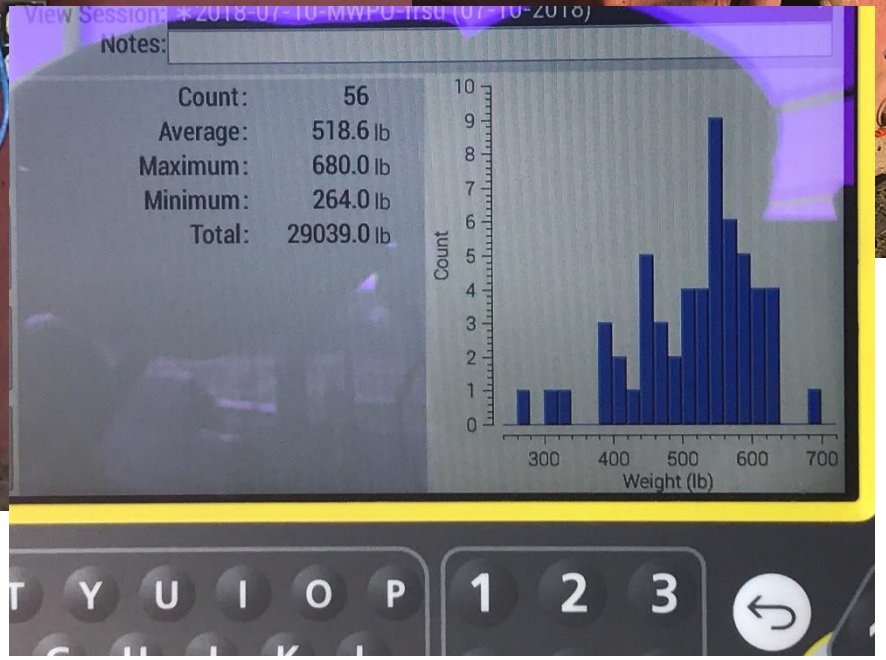
VIRTUAL FENCING



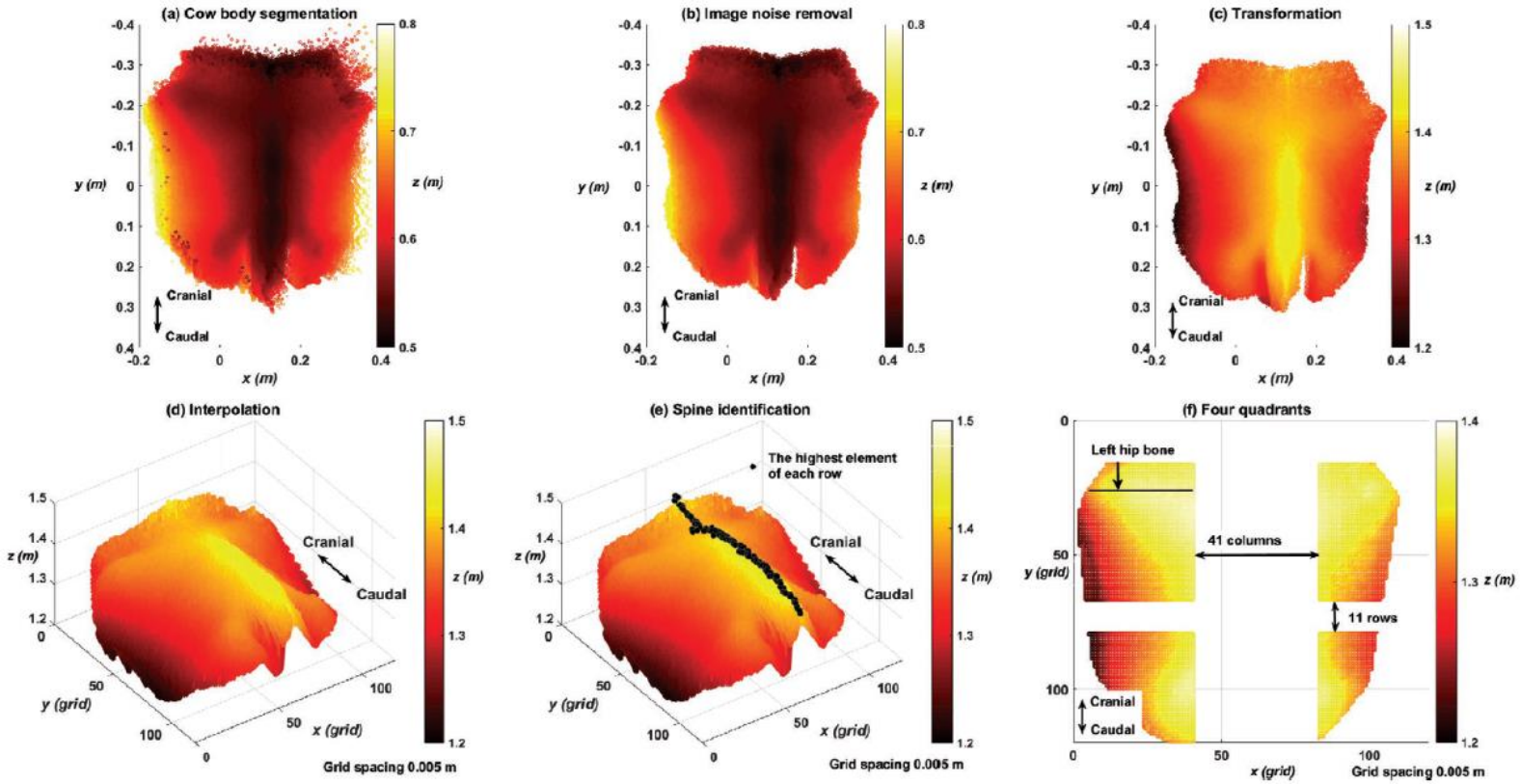
Smart Doors

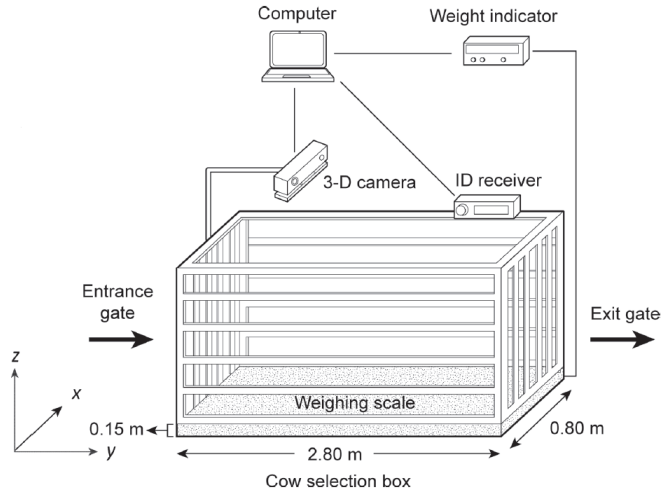

XR5000
TRU-TEST


552


Notes:
Count: 56
Average: 518.6 lb
Maximum: 680.0 lb
Minimum: 264.0 lb
Total: 29039.0 lb
Count
Weight (lb)
300
400
500
600
700
T Y U I O P
1 2 3

Sensors are evolving towards 3-D and non-invasive imaging

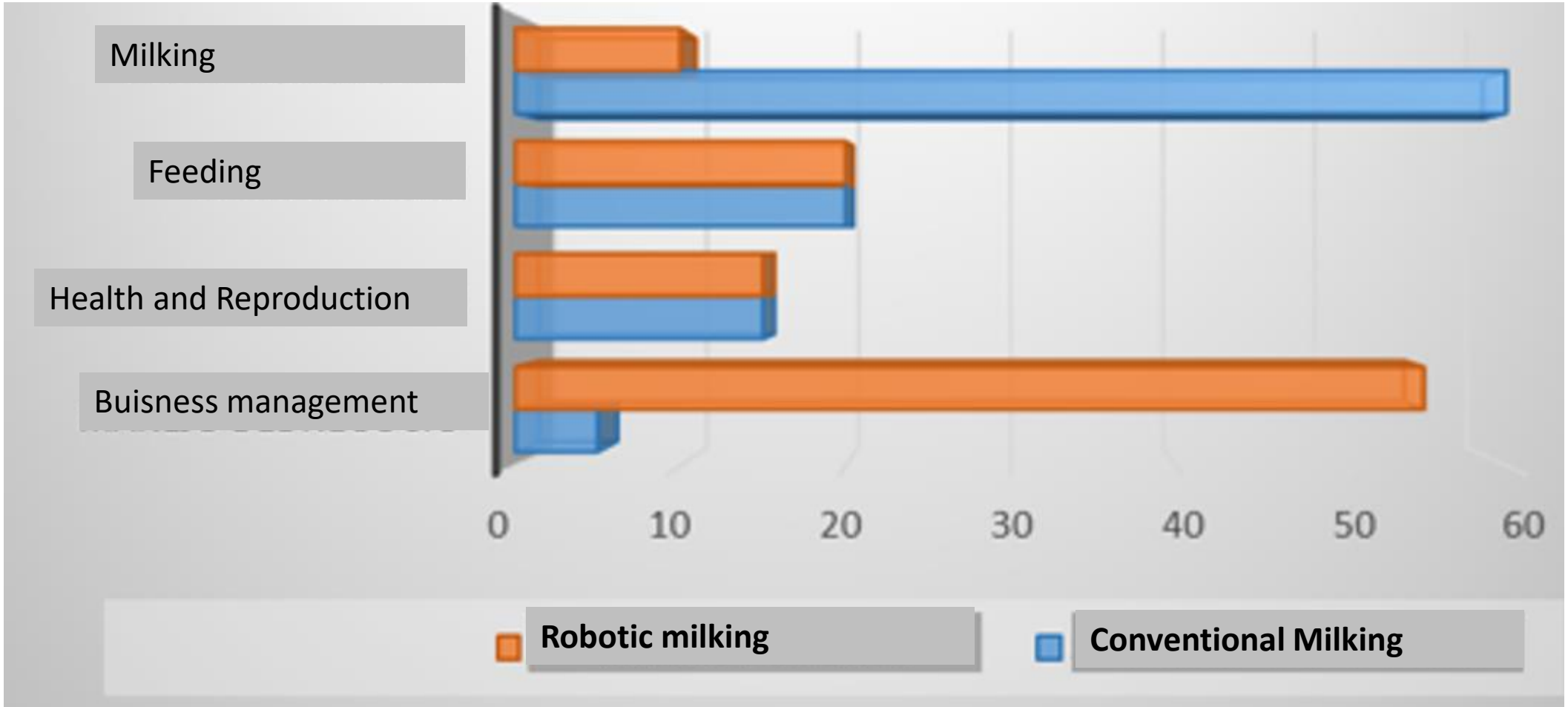




Song et al 2018 JDS

What is going to change

- Time dedicated



WHAT IS GOING TO CHANGE

- Time dedicated
- The knowledge that the staff, manager, producer and consultant must have
- Education in general and digital education in particular Are we responding to these changes?

WHAT IS GOING TO CHANGE

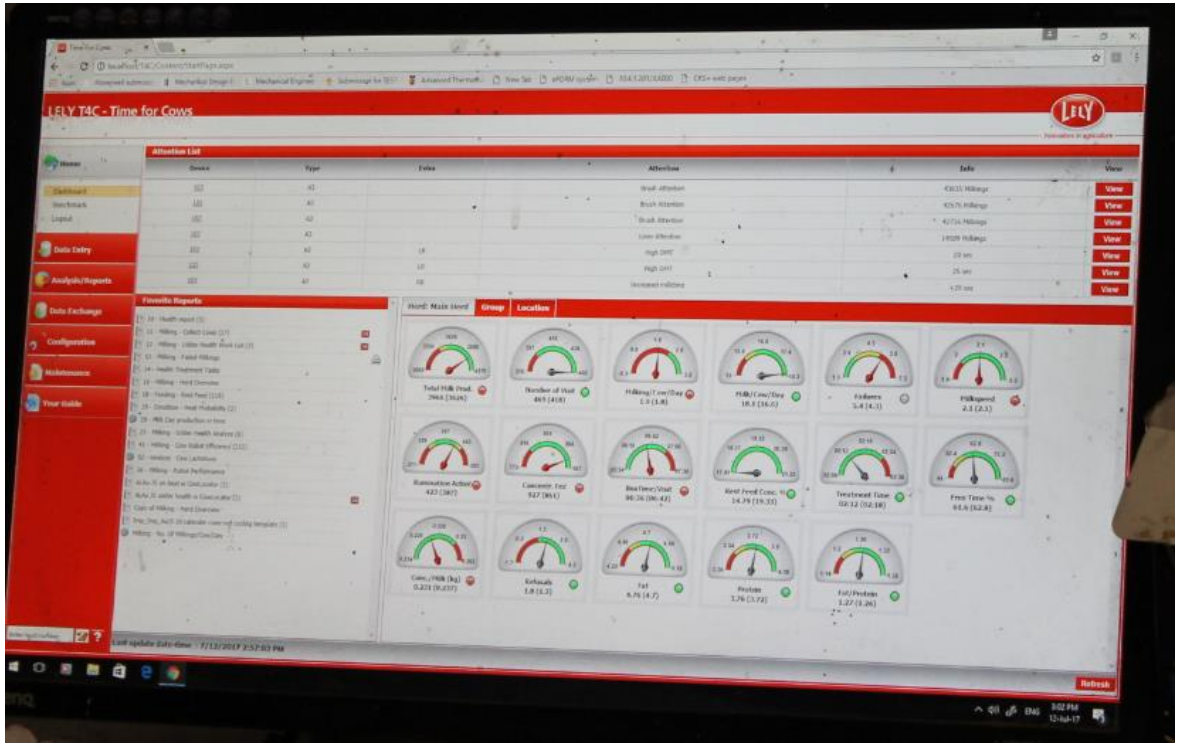
- Work on robotic dairy's in other countries (Belgium, Germany, Denmark and the Netherlands has led to a 20% reduction in work) Mathijs, 2004
- Paid work on Dutch dairy´s shows no differences between conventional and robotics (Steeneveld et al 2012)
- Work conditions improve and there is less staff turnover

WHAT IS GOING TO CHANGE

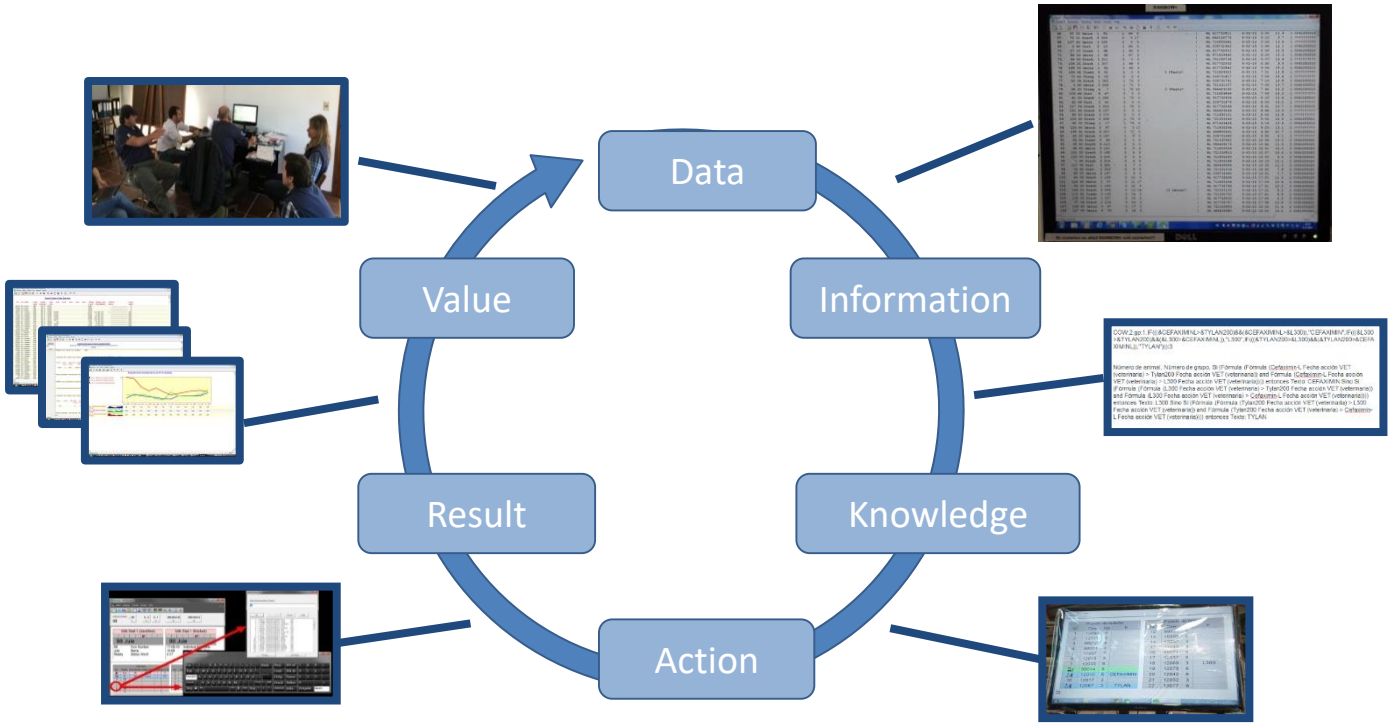
- How do we see the cow

WHAT IS GOING TO CHANGE

- The amount of data that we are going to have to deal with (in excess)



Greater amount of DATA



FACTORS THAT INFLUENCE THE DETECTION ABILITY OF A TECHNOLOGY

- How strong is the association between the event of interest (eg heat) and the measured parameter (this is determined using experience, observations, correlation, research and laboratory)
- How accurate are the parameters measured by technology (validation)
- If the algorithm used is accurate enough to give the correct alarms (companies and is not open)

Dolecheck et al, 2015

Data

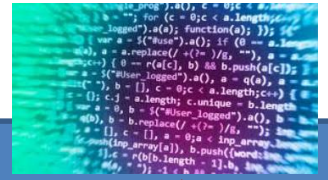
- At a basic level, the statistical process can monitor and detect changes if we have upper and lower limits based on the mean and the variation between observations but also knowledge.
- When an observation leaves these limits an alarm is triggered

DISADVANTAGES TO BE SEEN

- False Alarms
  - Type I error False Positive. May cause economic losses by mistakenly treating healthy animals
  - Type II. False Negative. Error can cause us to leave sick animals untreated bringing health problems during lactation, well-being, decreased milk among others

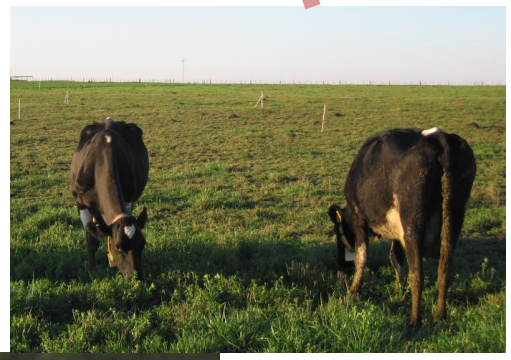
DISADVANTAGES TO BE SEEN

- False alarms
- Data ownership (company, producer) Legal issue
- Unsupported software between companies
- Analysis of data



Real Time Sensors + Remote Data + Previos Models

Decision model



FINAL CONSIDERATIONS

- These technologies do not replace a mismanagement of resources in those cases surely aggravate them. They improve in those well managed systems where knowledge is applied (nutrition, physiology, biochemistry, behavior etc) therefore they give more "precision"
- The use of these are evident where they are more profitable, increase production and / or reduce costs (that serve us)

FINAL CONSIDERATIONS

- More attractive for new generations
- The sensors are moving more to images and measurements in milk (non-invasive)
  - Artificial intelligence
  - Machine learning
- Change the education / preparation for use we will need more knowledge
- The Data generated by these technologies has no value unless we transform it into information. It will not replace the common sense and knowledge of the producer but will help you make informed decisions

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THANK YOU!