ICT and computing in animal production:
AgTech 4.0 for the Animal Industry

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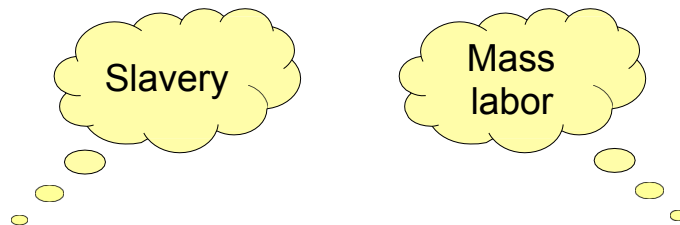Institute of Computer Science, University of the Philippines Los Baños

7th National Congress and 2019 Philippine Agriculturists' Summit
Philippine International Convention Center, Pasay City, 07-11 July 2019

History

- Discovery and innovation of tools resulted into massive industrialization:

Slavery

Mass labor

INDUSTRIAL AGE:
Multiplied human's muscle power

History

- Discovery and innovation of computational processes and tools resulted into massive information:

  - Create
  - Share
  - Access
  }
  - Thoughts
  - Ideas
  - Spurt-of-the-moment utterances
  - Emotions

  Question:
  - Filter
  - Analyze
  }
  In the form of:
  - Texts
  - Images
  - Videos
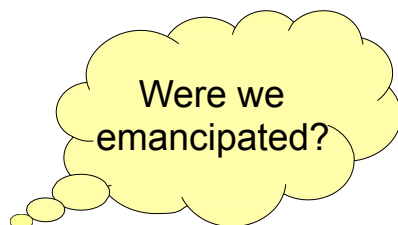 - Artwork ⟶ e.g. 3D printer

History

- Discovery and innovation of computational processes and tools resulted into massive information:

INFORMATION AGE:
Multiplied human's brain power

Were we emancipated?

Current time:
Information economy

- ICT: Use (exploitation) of existing technology
  - Hardware
  - Software
  - Telecommunication options: Internet and telephony
- ICT for Agriculture
  - for Production System Management*
  - for Market Access Services*
  - for Financial Inclusion*

*FAO. 2013. ICT uses for inclusive agricultural value chains

ICT4Agriculture

- ICT for Production System Management*
  - Information that helps farmers improve their productivity, yields, and profitability (also minimizes risks)
  - ICT applications that involve:
    - Short and long-term productivity enhancement
    - Minimize the negative effects of crisis events
    - Improve field-based risk management

*FAO. 2013. ICT uses for inclusive agricultural value chains

ICT4Agriculture

- ICT for Market Access Services*

  – Information on pricing of agricultural products (inputs and outputs)

  – Connection to and knowledge of suppliers, buyers or logistic providers

  – Also information for commercial farms:
    - Who are the processors?
    - Who are the exporters?

*FAO. 2013. ICT uses for inclusive agricultural value chains

ICT4Agriculture

- ICT for Financial Inclusion*

  – Solutions that allow financial institutions to provide financial services in a more convenient, secure, flexible, and low-cost manner

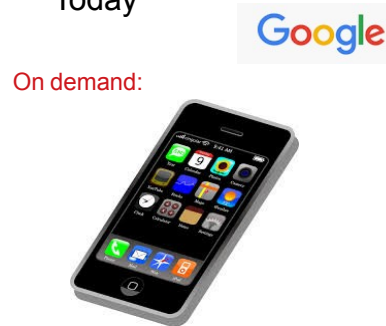*FAO. 2013. ICT uses for inclusive agricultural value chains

Adoption of ICT

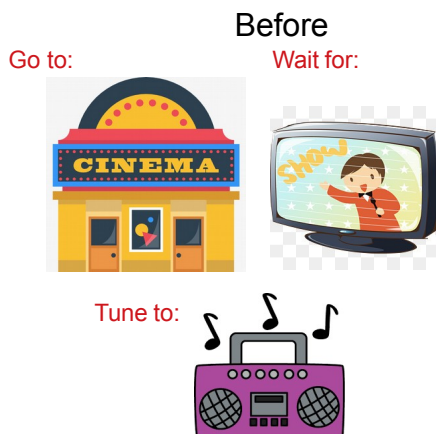- ICT is pervasive:
  - Information:

Before	Today
Go to:	Google
Wait for:	On demand:
Ask:	

Adoption of ICT

- ICT is pervasive:
  - Entertainment:

Before	Today
Go to:	YouTube PH
Wait for:	On demand:
Tune to:	iTunes NETFLIX

Adoption of ICT

- ICT is pervasive:
  - Communication:

Before	Today
	On demand:
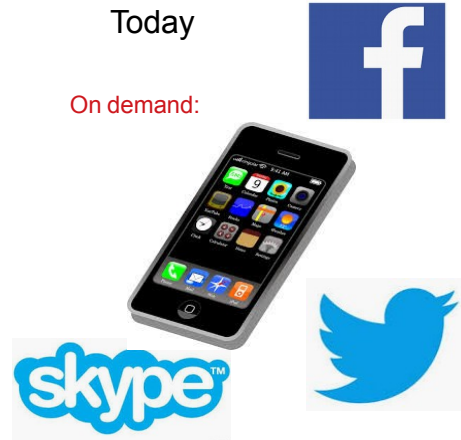
Adoption of ICT

- ICT is pervasive:
  - Extension service:

Before	Today

Adoption of ICT

- ICT is pervasive:
  - Extension service:

Before	Today

Implications: farmers do not need to be able to read and write to be able to learn

VIDEO
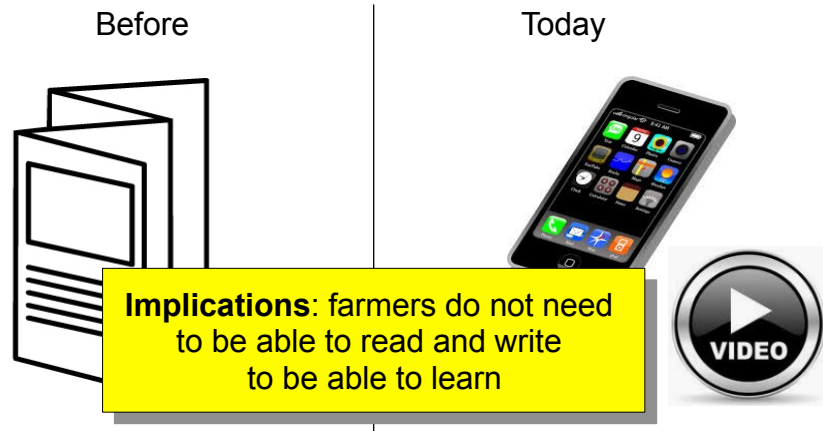
Adoption of ICT

- ICT is pervasive:
  - Finances:

Before	Today

PayMaya

e-wallet
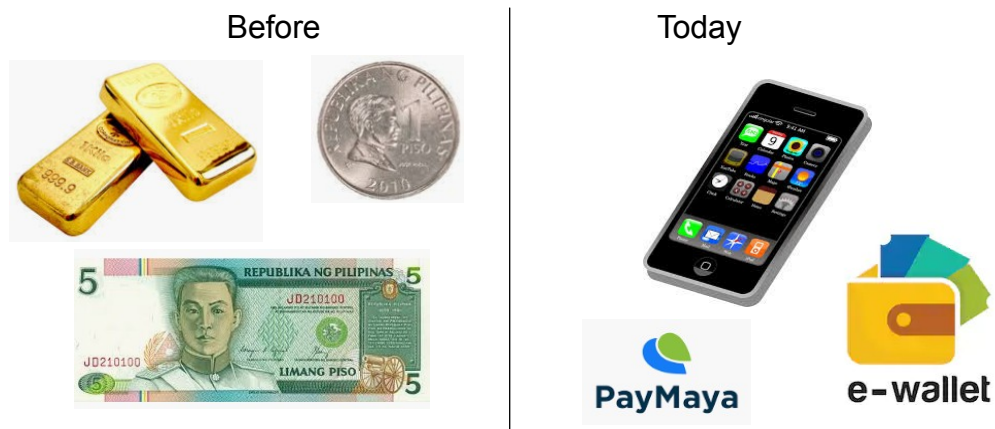
## ICT 4 Animal Production

- Use of ICT for:
    - Archiving and accessing animal production data
    - Modeling and predicting animal health
    - Sensing, surveilling, and forecasting animal diseases
    - Animal farm decision-support
    - Animal production trend analytics
    - Animal science education and training
    - Animal farm practice
    - Animal and animal product trading

Examples

Example 1: Traceability
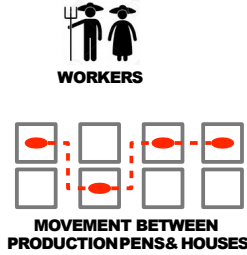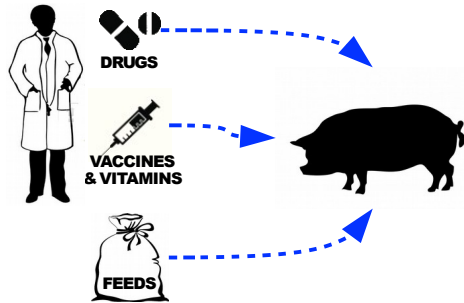
JP Pabico, JB Banayo, MYB de Robles, MGJN Yebron, RSA. Vega, VJS Olazo, AKS Mojar, KN dela Cruz. 2015. *A Pen-to-Plate Tracking and Tracing of Pork Through the National Pork Traceability System*. **82nd Philippine Veterinary Medical Association Scientific Conference and Annual Convention (PVMA 2015),** Radisson Blu Hotel Cebu, Cebu City, 18-20 February 2015
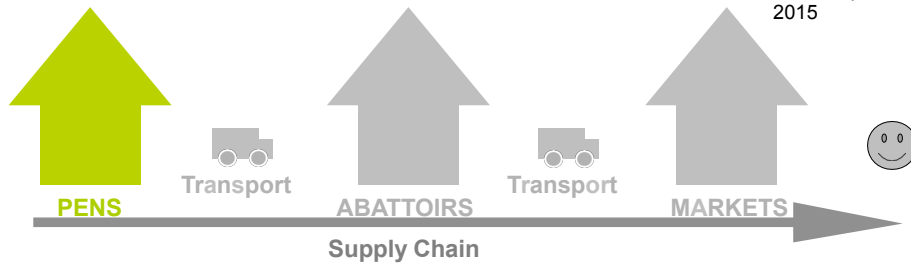
Example 1: Traceability
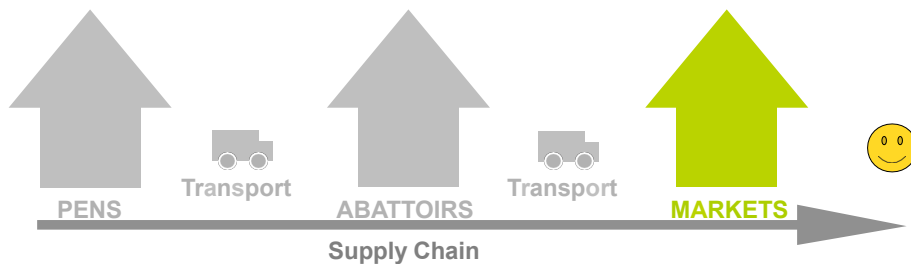
Example 1: Traceability
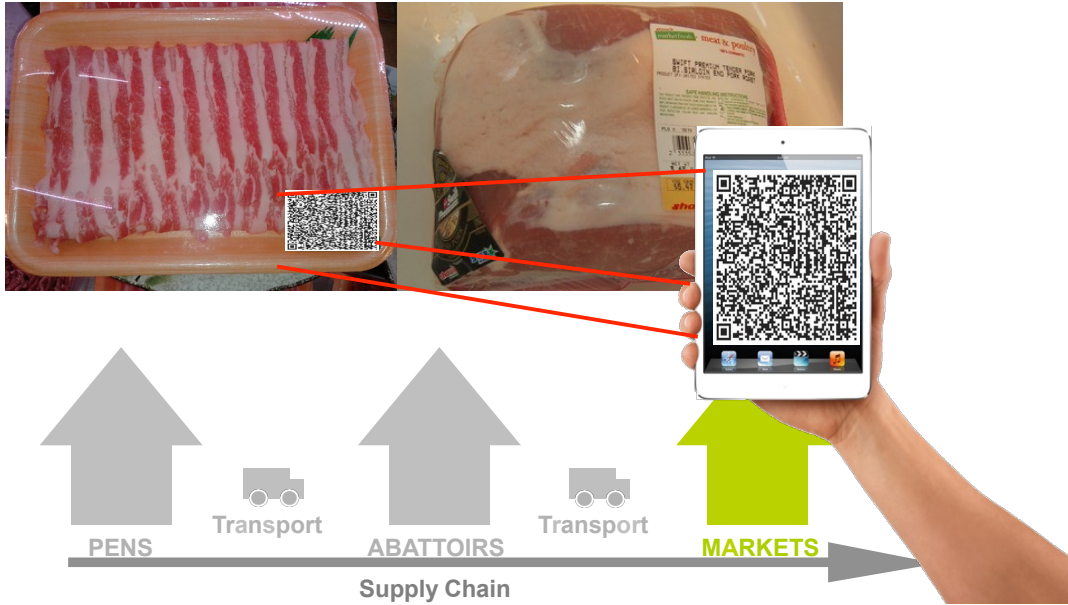
Example 1: Traceability

Example 2: Monitoring Animal Health and Behavior

Observe → Report

Animal **Farm Workers** **Farm Manager**

Timeline

| est. 24-48 hours | 1-24 hrs | 1-3 hrs |

2 — Ob servable Behavior

3 — Re port Generation

4 — - Recording
- Analysis
- Actionable Plan
- Archiving

1 — Phys iological Changes
- Stress
- Disease
- Estrus

Verban
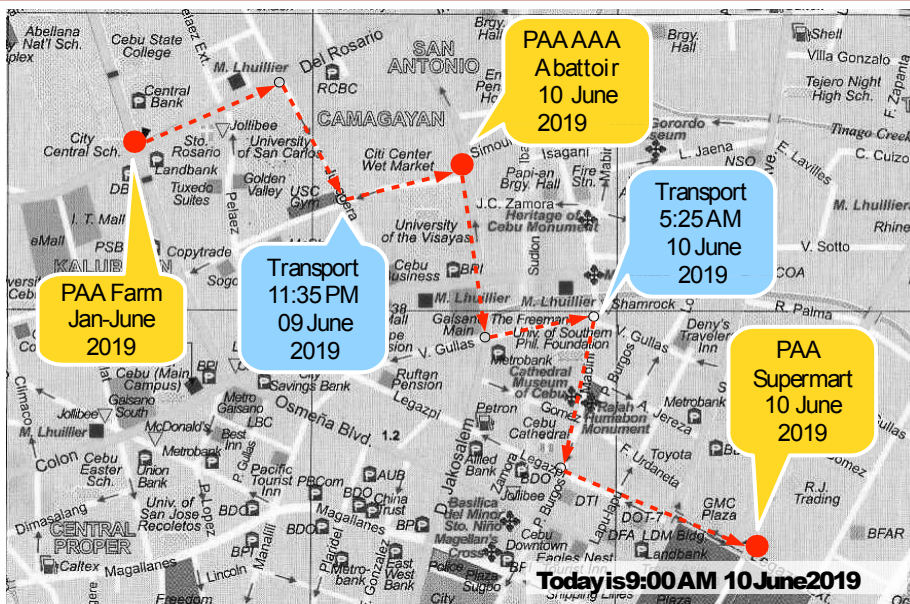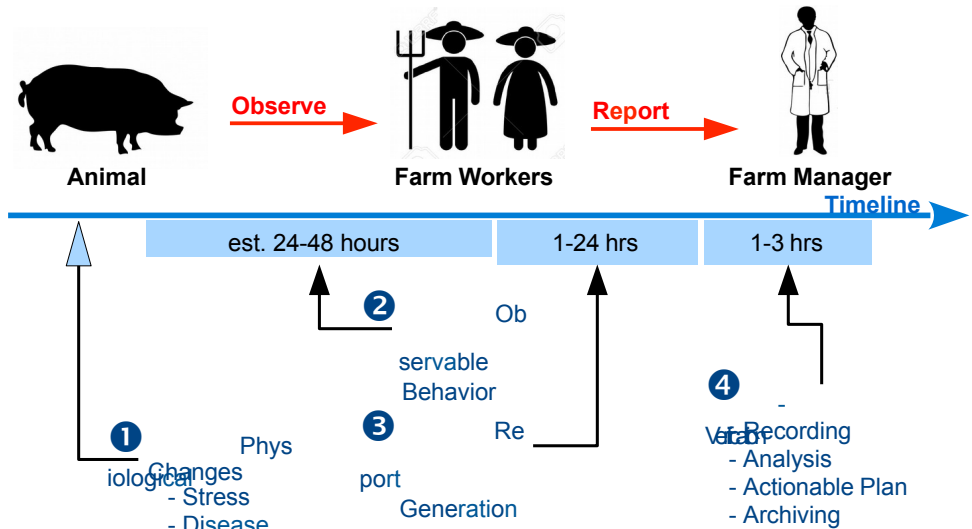
Manual of Things at the Farm

Example 2: Monitoring Animal Health and Behavior

Sense → Transmit → Alert

Animals **Bio Sensors** **Computers & Mobile Devices** **Farm Manager**

Timeline

| est. 1 – 60 sec | max 1 sec | max 15 mins | 15 mins |

2 — - Accessing Archives
- Analytics
- Decision-support
- Report Generation

Ready

3 — - Actionable Plan
- Recording

Anays

1 — Phys iological Changes
- Stress
- Disease
- Estrus
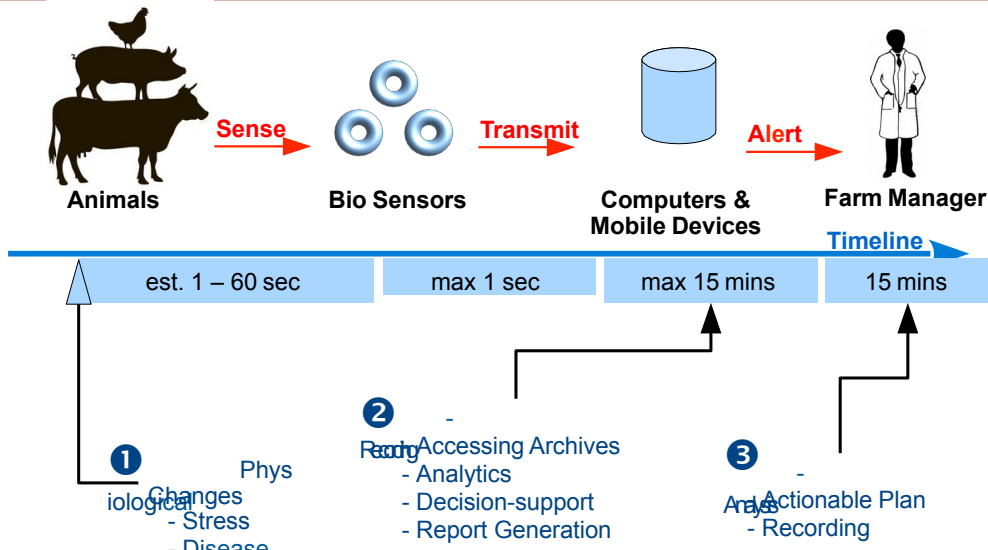
"Internet of Things" at the Farm

Example 2: Monitoring Animal Health and Behavior

Sense → Transmit → Alert →

Animals — Bio Sensors — Computers & Mobile Devices — Farm Manager
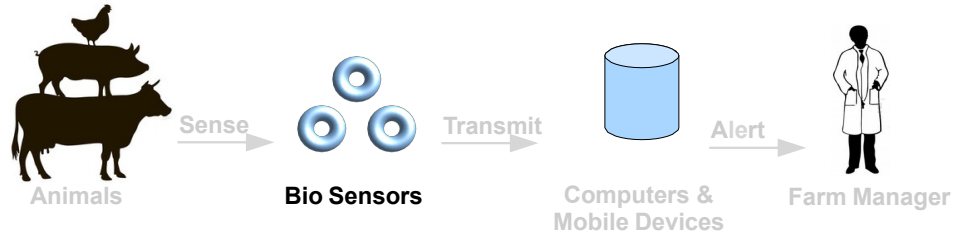
Types of Biosensors
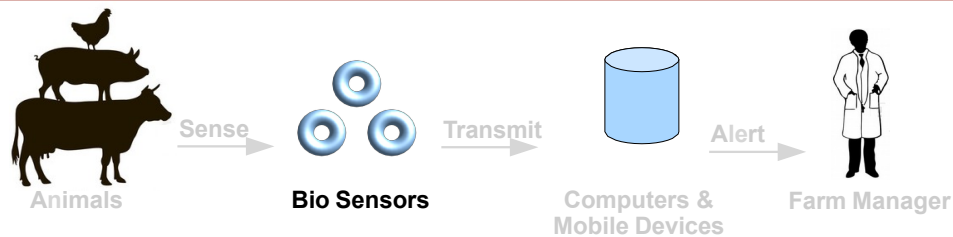- Wearable
- Non-invasive/non-wearable

S Vigneshvar, CC Sudhakumari, B Senthilkumaran, H Prakash. 2016. *Recent Advances in Biosensor Technology for Potential Applications - An Overview*. **Frontiers in Bioengineering and Biotechnology** 4(11)

Example 2: Monitoring Animal Health and Behavior

Sense → Transmit → Alert →

Animals — Bio Sensors — Computers & Mobile Devices — Farm Manager
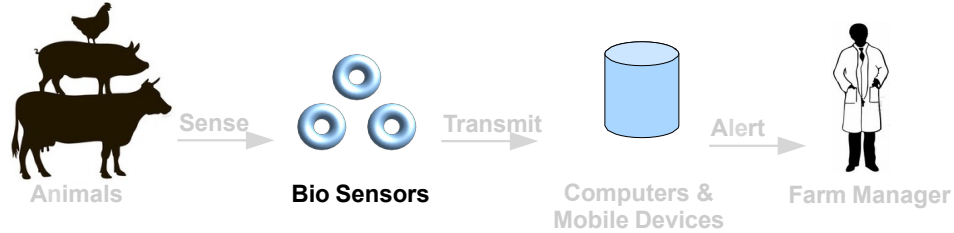
Biosensing what?
- Temperature

N Sellier, E Guettier, C Staub. 2014. *A review of methods to measure animal body temperature in precision farming*. **Am. J. Agric. Sci. Technol.** 2(2):74-99.

H Nogami, H Okada, T Miyamoto, R Maeda, T Itoh. 2014. *Wearable wireless temperature sensor nodes appressed to base of a calf's tail*. **Sensor. Mater.** 26(8): 539-545.

Example 2: Monitoring Animal Health and Behavior

Sense → Bio Sensors → Transmit → Computers & Mobile Devices → Alert → Farm Manager
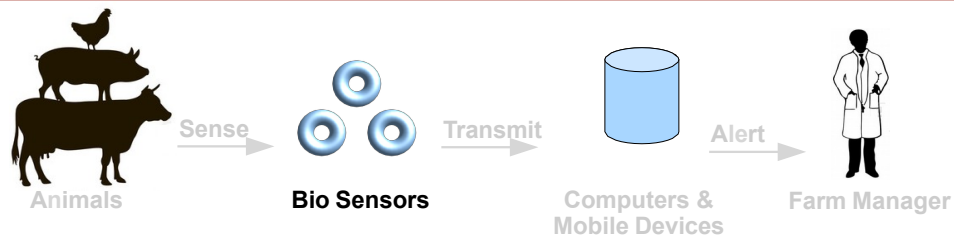
Animals

Biosensing what?
- Sweat constituents

T Glennon, C O'Quigley, M McCaul, G Matzeu, S Beirne, GG Wallace, N Stroiescu, N O'Mahoney, P White, D Diamond. 2016., *'SWEATCH': a wearable platform for harvesting and analysing sweat sodium content.* **Electroanalysis** 28:1283-1289.

J. Heikenfeld. 2016. *Bioanalytical devices: Technological leap for sweat sensing.* **Nature** 529(7587):475-476.

SO Garcia, YV Ulyanova, R Figueroa-Teran, KH Bhatt, S Singhal, P Atanassov. 2016. *Wearable sensor system powered by a biofuel cell for detection of lactate levels in sweat*. **Eur. J. Sol. State Tech.** 5(8):M3075–M3081.

Example 2: Monitoring Animal Health and Behavior

Sense → Bio Sensors → Transmit → Computers & Mobile Devices → Alert → Farm Manager

Animals

Biosensing what?
- pH

J Kim, TN Cho, G Valdés-ramírez, J Wang. 2016. *A wearable fingernail chemical sensing platform: pH sensing at your fingertips*. **Talanta** 622-628.

Example 2: Monitoring Animal Health and Behavior

Animals → Sense → **Bio Sensors** → Transmit → Computers & Mobile Devices → Alert → Farm Manager
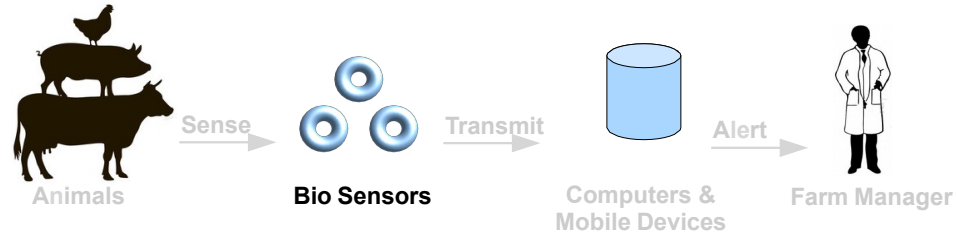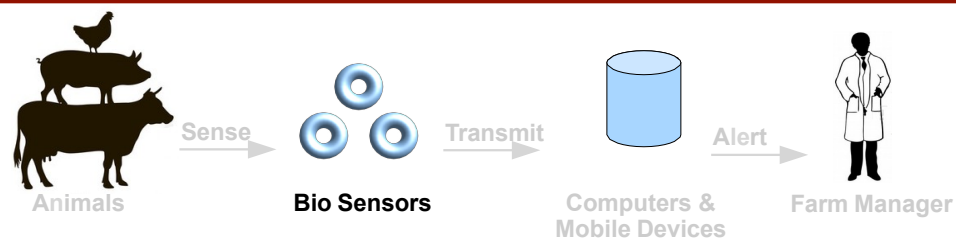
Biosensing what?
- Analytes, Viruses and Pathogens

NA Mungroo, S Neethirajan. 2014. *Biosensors for the detection of antibiotics in poultry industry-A review*. **Biosensors** 4(4):472-493.

BV Ayyar, S Arora. 2013. *Antibody-based biosensors for detection of veterinary viral Pathogens*. **Adv. Anim. Vet. Sci.** 1:37-44.

NA Mungroo, G Oliveira, S Neethirajan. 2016. *SERS based point-of-care detection of food-borne pathogens*. **Microchim. Acta** 183(2):697-707.

Example 2: Monitoring Animal Health and Behavior

Animals → Sense → **Bio Sensors** → Transmit → Computers & Mobile Devices → Alert → Farm Manager
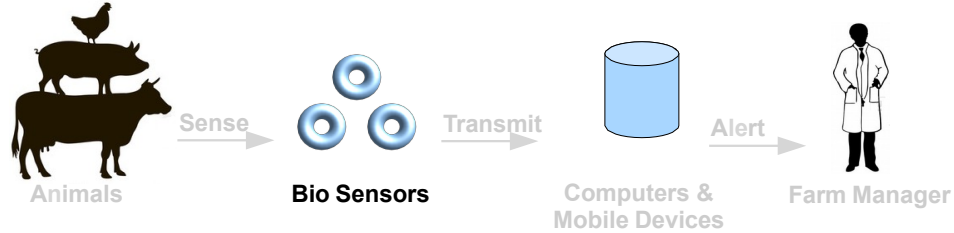
Biosensing what?
- Behavior and Movement

A Van Nuffel, I Zwertvaegher, S Van Weyenberg, M Pastell, VM Thorup, C Bahr, B Sonck, W Saeys. 2015. *Lameness detection in dairy cows: part 2. Use of sensors to automatically register changes in locomotion or behavior*. **Animals** 5(3):861-885.

KJH Magno, PJR Cajano, JG. Jesuitas, RSA Vega, JP Pabico. 2015. *Geometric Modeling of an Array of Convex Filters: A Case Design for the Real-time Automated Detection of Animal Behavior Using a Video Camera Array System*. **MSP-CALABARZON Scientific Convention**.

Example 2: Monitoring Animal Health and Behavior

Sense → Transmit → Alert →

Animals — **Bio Sensors** — **Computers & Mobile Devices** — **Farm Manager**

<u>Biosensing what?</u>
- Weight

J Sa, M Ju, S Han, H Kim, Y Chung, D Park. 2015. *Detection of low-weight pigs by using a top-view camera*. **Proceedings of The fourth International Conference on Information Science and Cloud Computing** (ISCC2015).

MUL de Ramos, KJH Magno, PJR Cajano, JGC Jesuitas, JP Pabico, RSA. Vega. 2015. *Pig's Weight Estimation Through Digital Image Processing*. **PSAS 2015**.

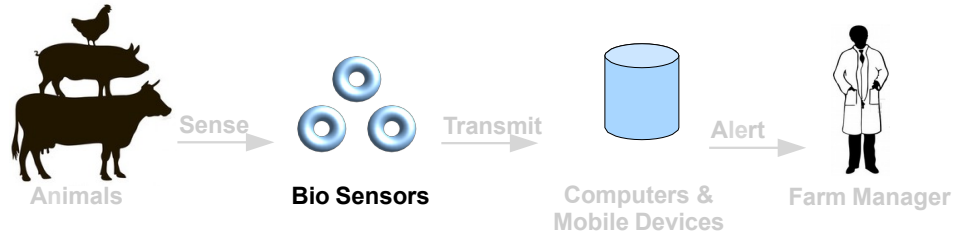# Example 2: Monitoring Animal Health and Behavior

Live weight estimation using a smart phone

MUL de Ramos, KJH Magno, PJR Cajano, JGC Jesuitas, JP Pabico, RSA. Vega. 2015. *Pig's Weight Estimation Through Digital Image Processing*. **PSAS 2015**.

Example 2: Monitoring Animal Health and Behavior

Animals → **Sense** → **Bio Sensors** → **Transmit** → Computers & Mobile Devices → **Alert** → Farm Manager
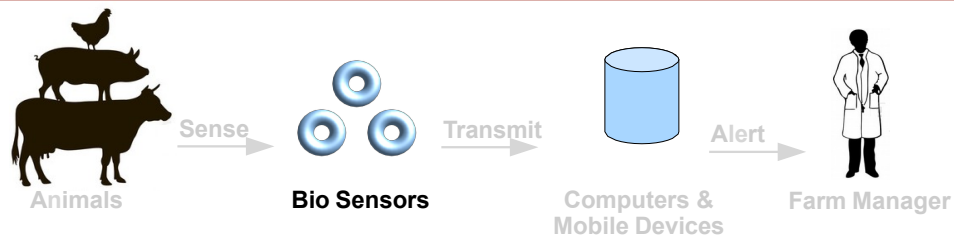
Biosensing what?
- Stress

J Lee, B Noh, S Jang, D Park, Y Chung, H. Chang. 2015. *Stress detection and classification of laying hens by sound analysis*. **Asian. Australas. J. Anim. Sci.** 28(4): 592.

JP Pabico, KJH Magno, EM Agbisit, Jr., RSA Vega. 2014. *Design of a Near Real-time Remote System for Precision Breeder Farming*. **7th UPLB CAS Student-Faculty Research Conference** (SFRC 2014)

Example 2: Monitoring Animal Health and Behavior

Animals → **Sense** → **Bio Sensors** → **Transmit** → Computers & Mobile Devices → **Alert** → Farm Manager

Biosensing what?
- Heart and Lung Movement

O Boric-Lubecke, VM Lubecke, AD Droitcour, BK Park, A Singh. 2015. **Doppler Radar Physiological Sensing**. Wiley, pp 304.

M Zakrzewski. 2015. **Methods for Doppler Radar Monitoring of Physiological Signals**. (Tampere University of Technology. Publication; Vol. 1315). Tampere: Tampere University of Technology.

Example 2: Monitoring Animal Health and Behavior

Sense → Transmit → Alert →

Animals · **Bio Sensors** · **Computers & Mobile Devices** · **Farm Manager**
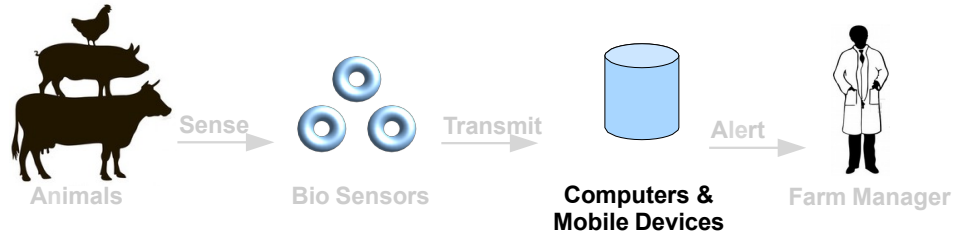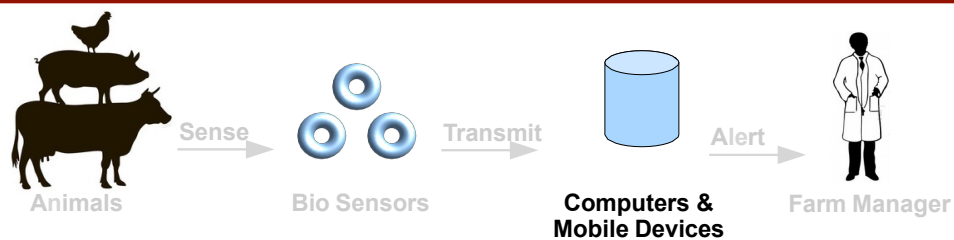
<u>What can computers do?</u>
- Allows for the easy recording of data from field

MAR Magno, BEC Rivera, CR Emia, AK. Mojar, JP Pabico. 2016. *Mobile Device for Collecting Farm and Field Data: User Interface Design and Device Size Preference* . **9th UPLB CAS Student-Faculty Research Conference** (SFRC 2016)

Example 2: Monitoring Animal Health and Behavior

Sense → Transmit → Alert →

Animals · **Bio Sensors** · **Computers & Mobile Devices** · **Farm Manager**

<u>What can ICT and computers do?</u>
- Easy access of archival animal data
- Autonomous computers can perform analytics
- Use results from analytics to suggest some decisions
- Use mobile devices to alert the farm managers/owners
- Use GIS to visualize spatio-temporal data

Example 3: Trading of Live Breeder Swine and Semen
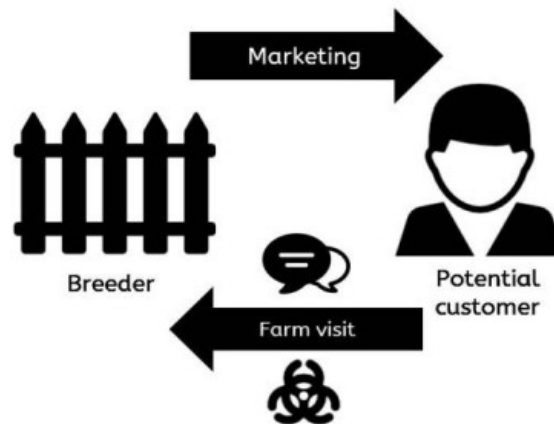
Traditional swine commerce in the Philippines

C.M.B. Arkaina, E.N.A. Tolorio, K.J.H. Magno and J.P. Pabico. 2016.
A Shift from Traditional to Electronic Commerce: Enhancing the Efficiency of Live Breeder Swine Commerce through Web Technology. **66th Philippine Society of Agricultural Engineers (PSAE) National Convention** (PSAE 2016)

Example 3: Trading of Live Breeder Swine and Semen

Marketing and sales transaction between breeders and buyers

C.M.B. Arkaina, E.N.A. Tolorio, K.J.H. Magno and J.P. Pabico. 2016.
A Shift from Traditional to Electronic Commerce: Enhancing the Efficiency of Live Breeder Swine Commerce through Web Technology. **66th Philippine Society of Agricultural Engineers (PSAE) National Convention** (PSAE 2016)

Example 3: Trading of Live Breeder Swine and Semen

E-Commerce of Breeder Swine and Boar Semen

e-Commerce

Buyer   Breeder
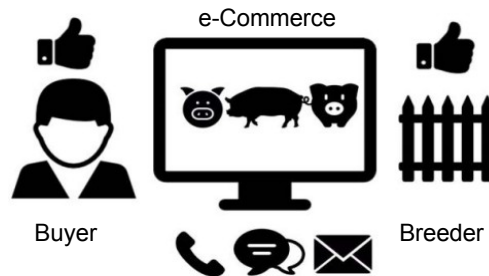
Features:
• Product showcase
• Breeder and customer registration
• Communication
• Feedback and evaluation

Parting Words

Thank God it's over

Parting words

- Need to introduce/propose **Animal Science Information Technology** as a new subfield of study for the modern animal scientists and agriculturists
  - Develop a graduate study program Master of Science in Animal Informatics?
  - Start as a subfield of study and practice before formalizing to a graduate level instructional program

Parting words

- Need to introduce/Propose **Animal Science Information Technology** as a new subfield of study for the modern animal scientists and agriculturists
  - Example subsubfields:
    - ANSC Geographic Information System
    - ANSC Analytics and Informatics
    - Computational ANSC
      - *In Silico* animal farm design and development for efficient and environment-friendly houses
      - Morphological Modeling and 3D Printing of Animal Braces/Prosthetics

Acknowledgements

PCAARRD

Questions?

- Email to <jppabico@uplb.edu.ph> for:
  - Questions requiring detailed answers
  - Proposals for research collaboration
    - Soft computing and machine learning HPC/
    - scheduling and dynamic load balancing
    - Wireless adhoc networks
    - Computer security and forensics
    - Information visualization
- http://www.ics.uplb.edu.ph/jppabico