Exploring potential of non-destructive and non-invasive sensors in food supply chains

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Background

Food supply chains are under constant pressure to provide increasingly more food, with better quality and in a sustainable manner, while reducing food losses and delivering a safe product, leading to a healthy consumer. **Data-driven** technological advances, supported by innovations in **sensor technologies**, play a key role in addressing these challenges. We are interested in exploring the potential of sensor innovations and resulting insights to tackle different challenges **across the food supply chain**.

Objective

The **objective** of this project is to be able to <u>measure and make better decisions based on the measured product properties</u>. In particular, the necessity to measure non-destructively, non-invasively and on a smaller scale than is currently common: from batch level to product level; from population segment to an individual.

Five Case studies

Figure 1. Five case-studies have been defined which address different segments of the food supply chain.

The developments and investigations in this project will be demonstrated in **five case studies**

1. Monitoring **animal welfare**
2. Sensing of crop development and performance indicators for **indoor farming**
3. Quality measurements of **fresh food products**
4. Food intake and food properties measurement for **personalized nutritional advice**
5. Non-invasive detection of **food adulteration**

Key Activities

- ❖ Survey and inventory of sensing technologies per case study
- ❖ Data acquisition using novel sensors
- ❖ Data analysis and modeling
- ❖ FAIR data organization
- ❖ Cooperation with OnePlanet Research Center

Results

- ❖Comprehensive surveys of sensing technologies corresponding to Case studies 1-4
- ❖Consolidating FAIR data knowledge across WUR by organizing FAIR data workshop in cooperation with WDCC
- ❖Several experiments were carried out under each case study

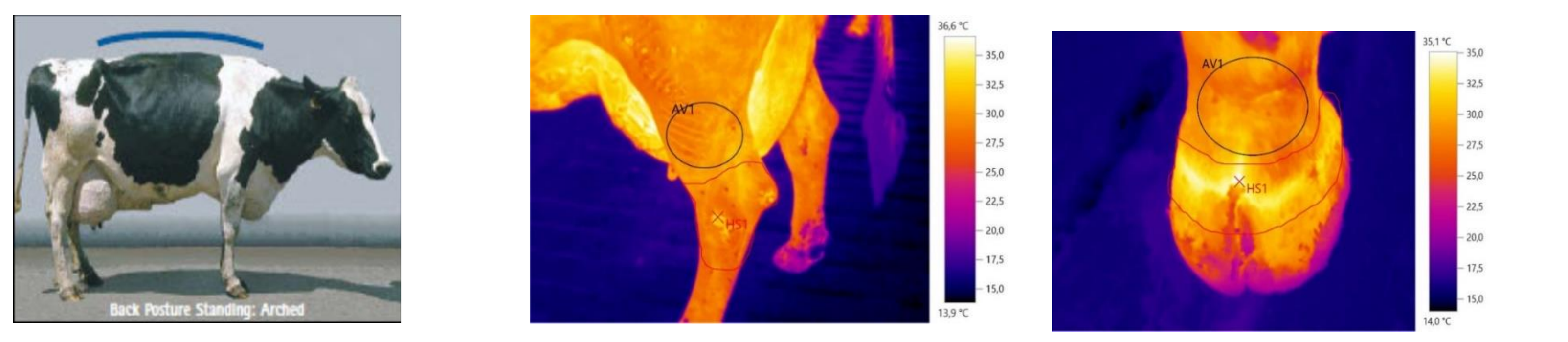
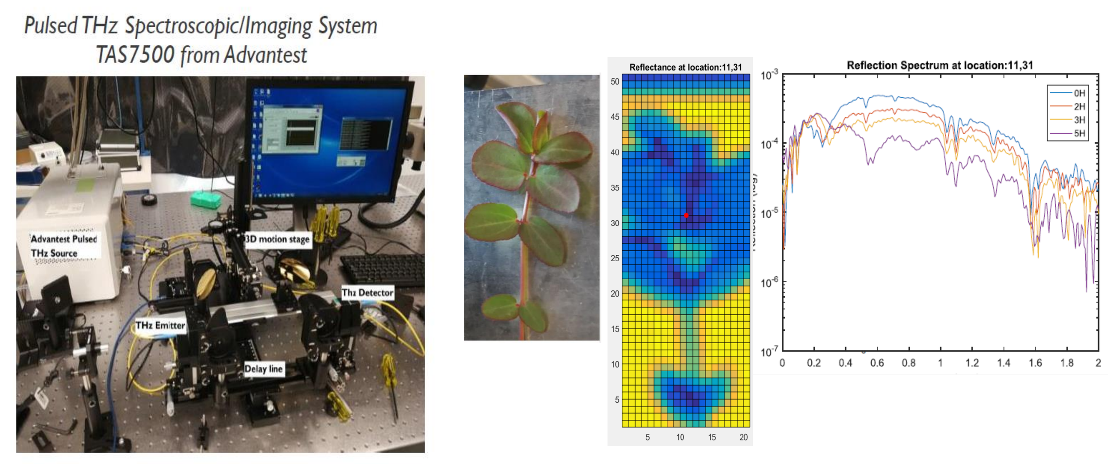


Figure 2. Non-invasive **cow lameness** detection using **thermographic imaging** of legs and claws.

- ❖ No significant differences in features from thermographic images between lame and non-lame cows, likely due to small sample size. A larger study planned in 2020.

Figure 3. Investigation of **THz technology** for **leaf water stress** measurement. Research carried out in collaboration with OnePlanet.



- ❖Strong correlation observed between leaf water stress and the THz reflection
- ❖THz technology can provide a non-invasive tool for measuring and monitoring the water content of leaves and plants.

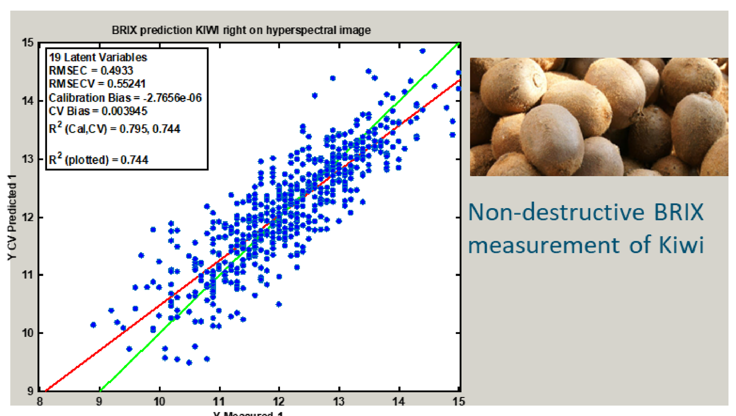


Figure 4. Non-destructive **Brix** measurement of Kiwi using **Hyperspectral imaging**.

- ❖High correlation found between the spectral data and the Brix content of Kiwis
- ❖Another experiment, using Hyperspectral imaging, was carried out for **Avocado stem-end rot** detection with mixed-results.

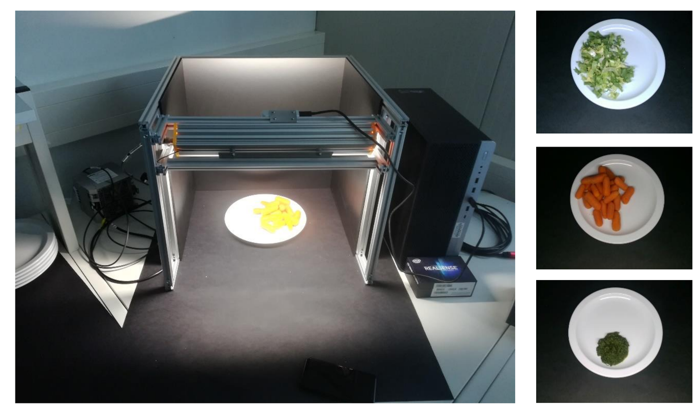
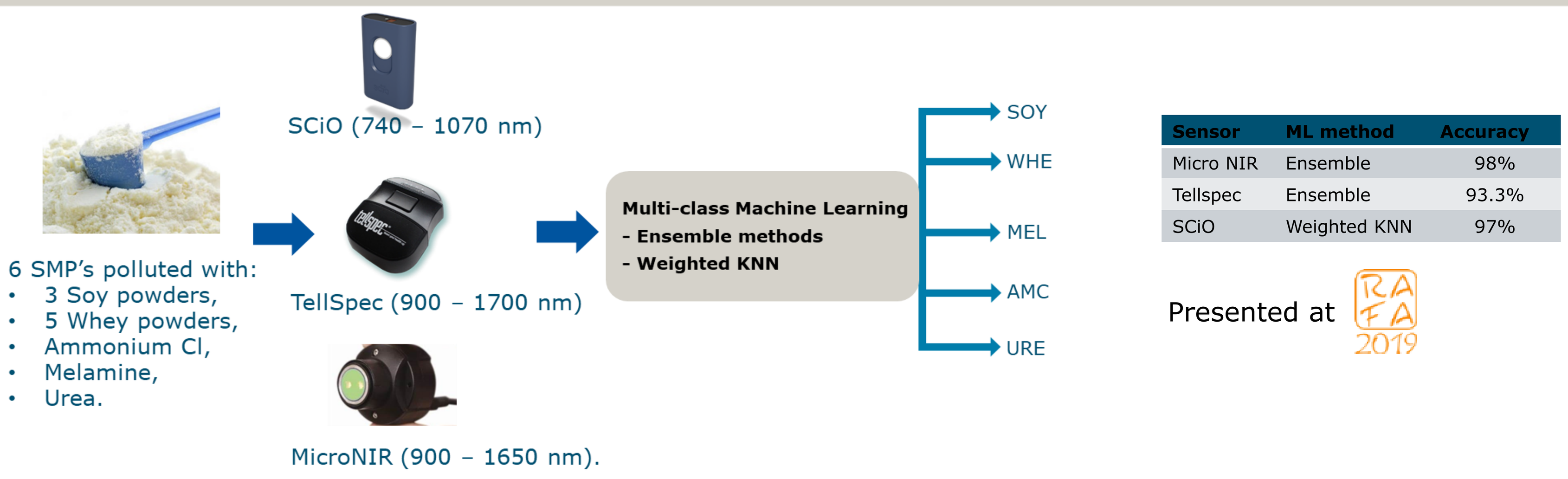


Figure 5. Experimental setup designed for measuring **food intake** using **RGBD sensor**.

- ❖An experimental setup constructed for food-intake data acquisition for content classification and volume prediction
- ❖First set of data collected. Further data collection and analysis planned in 2020.



Sensor	ML method	Accuracy
Micro NIR	Ensemble	98%
Tellspec	Ensemble	93.3%
SCiO	Weighted KNN	97%

Figure 6. Skimmed-milk powder **adulterant detection** using **handheld NIR** devices.

- ❖Three hand-held NIR (Near-Infrared) sensors were investigated
- ❖Multi-class ML methods were used for detecting six types of adulterants in skimmed milk powder
- ❖Results demonstrated highly confident predictions reaching up to 98% accuracy

Key next steps The promising investigations from 2019 will progress into 2020 along with new investigations using novel sensing technologies identified in the surveys

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