Improving Resources Efficiency of Agribusiness supply chains by Minimizing waste using Internet of Things sensors

REAMIT Project

RAC+WP+RSC Meeting

11-12 September 2019

University of Bedfordshire, Luton

Professor Ram Ramanathan
Project Lead

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Housekeeping and Reminders

- No scheduled fire alarms
- Fire assembly point
- Toilets
- Remember to return the name badges for recycling/reuse

Your Folder

- Your folder contains the following:
  - Agenda
  - Presentation slides of BED and Valorial
  - REAMIT project report
  - Agenda for the REAMIT Kick-Off meeting
  - Feedback form
- The following additional documentation are also available.
  - REAMIT Communication Strategy
  - Sensor Review

Introduction of Attendees

- No slides please

Agenda for 11th September

10.30 – 11.00 am	Registration, networking and refreshments
11.00 – 1.00 pm	REAMIT Advisory Committee (RAC) meeting.
1.00 – 2.00 pm	Lunch and Networking
	WORK PACKAGE MEETINGS
2.00 – 2.30 pm	WP T1: Pilot Tests (Chair: I&R)
2.30 – 3.00 pm	WP T2: Big Data Analytics (Chair: BED)
3.00 – 3.30 pm	WP T3: Business models (Chair: Ulster)
3.30 – 4.00 pm	Coffee/Tea and networking
4.00 – 4.30 pm	WP LT Long Term (Chair: BED)
4.30 – 5.00 pm	WP C Communication (Chair: NTU)
5.00 – 5.30 pm	WP M Project Management (Chair: BED)
5.30 – 6.00 pm	Refreshments and networking

REAMIT Advisory Committee (RAC)

- One representative from each associated partner

Associated Partner	Invitation Responsibility
GIQS	BED
Oost NL	BED
Radboud Universiteit	BED
Terre d'essais	I&R
JEAN ROUTHIAU	UoN
Société Des Transports Européens Frigorifiques (STEF)	UoN
Biosearch NI	UU
Cottagequinn Farms LLP	DNI

Feedback from RAC so far

- From Oost NL
  - Within the open challenge we aim to recruit companies that are involved with the transport and storage of fresh food. We've shared our concern earlier, but **often these companies are not the owners of the food they transport/store, therefore their interest in minimizing waste could be less compared those who own the products**. Not sure this is the reason behind them not responding positively to the call…it could be interesting to discuss this with STEF to hear their advice.
  - What might help is to **have another look at the text of the open call**. Now there is 1) a lot of text 2) a lot of info about Reamit, but it is not so clear **what is the "win"** for the transport/storage company, 3) **it is not clear what they need to contribute** to the project (time, money, expertise,…)
  - I think it would be good to have shorter info (a **checklist/infographic or something**) for these companies to quickly see whether it is interesting for them to participate in the project and how they are expected to contribute.
  - This is also makes it more easy for third parties who are not involved in Reamit to share the open call.

Project Progress so far

- Kick-off meeting in May 2019
  - Finalised memberships of RSC & RAC, agreed dates & locations of all RSC and RAC meetings,
  - Finalised dates & locations of 3 REAMIT networking events.
- Administration & governance
  - Recruited PM and COM Manager; 4 REAMIT positions advertised; 7 PPs appointed FLC, 5 PPs asked
- Project Management
  - Draft of Project Handbook, advanced Key Control Register and Risk

Project Progress so far

- Cooperation
  - Organised 2 project meetings
  - Agreed cooperation plan and most urgent joint tasks
  - Strengthened cooperation spirit within partnership.
- WP Long term
  - Preparations of REAMIT network prospectus has started
  - Dates and locations finalised
- WP Communication
  - Started developing Communication Strategy, purchased domain www.reamit.eu, created REAMIT website
  - under NWE Programme; created REAMIT social media accounts (Facebook, LinkedIn, Twitter) and dedicated email address (reamit4nwe@gmail.com) developed REAMIT poster.

Project Progress so far

- WPT1
  - Open Challenge Call has been published in four languages
  - First pilot study in NI with UU and Dunbia NI to start now.
    - Installation of sensors to be completed during Sep.-Dec. 2019
    - Linking to cloud and data analytics to start in December 2019.
  - Dates finalised for other pilot tests
    - January 2020 (France – STEF?)
    - April 2020 (Ireland – end-user to be recruited)
    - July 2020 (Netherlands – Whysor to help in recruiting the end user)
    - Oct. 2020 (Germany – Whysor to help in recruiting the end user)
    - More can be tried depending on interest of end-users

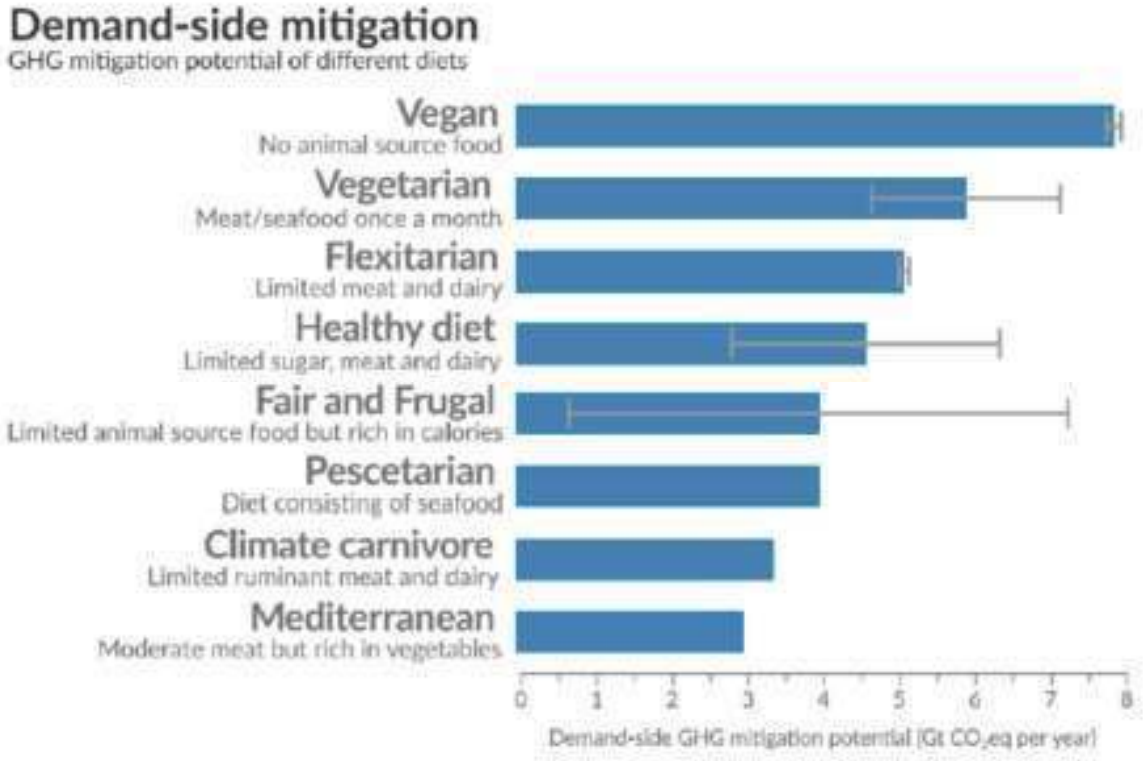
Project Progress so far

- WPT1 – Contd.
  - Levstone started work on miniature IOT platform; adaptation of existing sensor technologies based on optical methods to fit the purpose of Pilot Studies;
  - UoN carried tests on 2 food matrices (shrimps & chicken) resulting in developing technical specification of REAMIT equipment (to be purchased) with optimized parameters;
  - UCD started work on updating CyberBar technology to ensure relevance to Irish Pilot Study; a handbook for the trial of Cyberbar in Irish Pilot Study; preparations of the plan for first Pilot Study in IE
  - Developing a draft White Paper on sensor technologies.

Some supporting data from the recent IPCC report

- Although not prepared to link food waste to the environment, we could use some guidance from the latest IPCC report on Climate Change and Land Use.
  - *"… higher consumption of animal-based foods was associated with higher estimated environmental impact, whereas increased consumption of plant-based foods was associated with an estimated lower environmental impact (Nelson et al. 2016)."*
  - *"…meat – especially ruminant meat (beef and lamb) – was consistently identified as the single food with the greatest impact on the environment, on a global basis, most often in terms of GHG emissions and/or land use."*
- We could interpret this usefully for REAMIT.
  - If we reduce waste of meat products, there will be considerable savings in carbon emissions!

IPCC report ….



- *Source: IPCC report on climate change and land use, August 2019*

- *"… emissions reduction potential of 8 Gt CO2-eq yr-1 from a vegan diet without animal-sourced foods"*
- *"…where reduction in animal protein intake was compensated by higher intake of pulses, emissions reductions by 2050 could be in the 4.3–6.4 Gt CO2-eq yr-1, compared to a business-as-usual scenario."*

Data from a related study …

Table 1 | COCs and global PEMs of major crop and livestock products

	COC[a] (kg CO_2 per kg fresh weight)	PEMs (kg CO_2e per kg fresh weight)	Total (kg CO_2e per kg fresh weight)	Total (g CO_2e per kcal[c])	Total (kg CO_2e per kg protein)
Maize	2.1	0.46	2.6	0.82	29
Rice (rough)	2.6	2.17	4.8	2.0	69
Wheat	1.9	0.69	2.6	0.9	23
Cassava	1.7	0.04	1.7	1.6	160
Potato	0.6	0.09	0.7	1.1	38
Soybeans	5.9	0.26	6.1	1.5	17
Pulses	10.5	0.55	11	3.1	47
Vegetable oils	9.7	1.3	11	1.2	Not applicable
Beef[b]	144	44	188	102	1,250
Cow milk	6.2	2.3	8.4	13.1	260
Pork	14	5.5	20	9.4	150
Poultry meat	11	3.7	14	8.4	110

Values are calculated using the carbon loss method and 4% time discounting.
[a]Includes peatland emissions.
[b]Average, including meat from dairy animals.
[c]1 kcal = 4,184 J.

- Source: Searchinger, T.D., Wirsenius, S., Beringer, T. and Dumas, P., 2018. Assessing the efficiency of changes in land use for mitigating climate change. Nature, 564(7735), p.249-253.
- Downloaded from URL: https://taa.org.uk/wp-content/uploads/2018/12/Assessing-efficiency-of-land-use-changes.pdf, accessed on 05 Sep. 2019

Another related study …

- Downloaded from: "*Efficiency of land use changes for mitigating climate change*", URL: https://www.fcrn.org.uk/research-library/efficiency-land-use-changes-mitigating-climate-change, accessed on 05 Sep. 2019

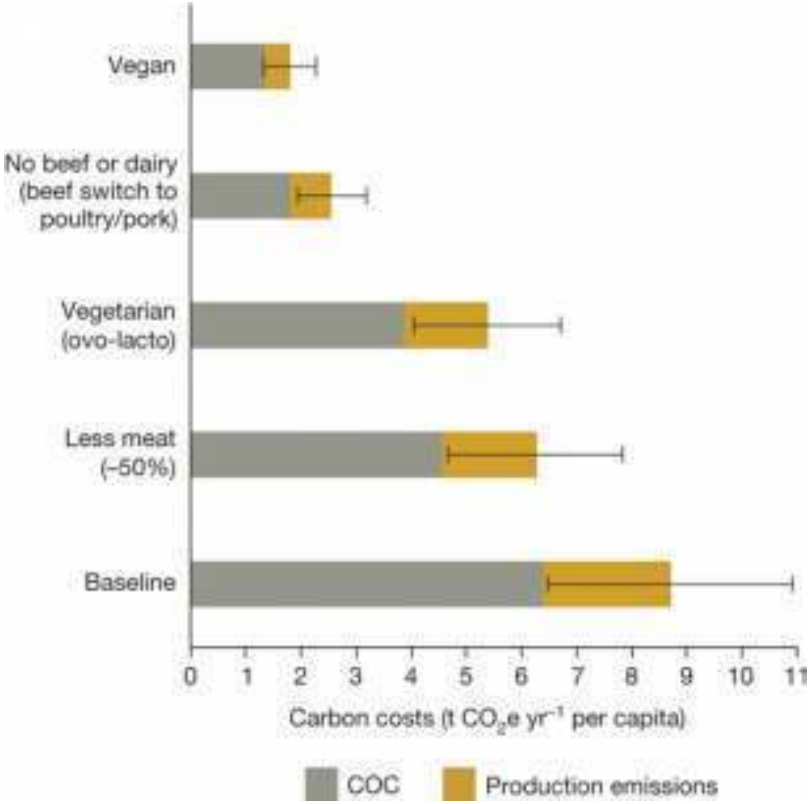


Image: Figure 3, Searchinger et al. (2018). Carbon costs of different diets based on the carbon benefits index. Error bars reflect the range of literature estimates of vegetation and soil carbon stocks used in part to derive the COCs.

WP Meeting for WP T2 (Chair: BED)

- Big Data Analytics
  - Levstone started work on miniature IOT platform
  - More activities will being in the next period

WP Meeting for WP LT (Chair: BED)

- Conference style meetings to be held in every year showcasing REAMIT technologies.
  - Should we call them as REAMIT Symposium or similar?
- Objectives
  - To roll out the REAMIT technologies so they can be used in other companies
  - To roll out the approach of REAMIT to other sectors
  - To further develop the network of partners to ensure continued synergy and joint working
  - To continue to develop the technology mix to ensure its ongoing currency
- Targeting more end-users to reduce Risk 2 and technology firms/users to reduce Risk 3.

Dates for REAMIT Network Events

- Dates and venues decided but exact dates to be decided by the organising partner.
  - January 2020 (to be hosted by NTU)
  - October – December 2020 (to be hosted by I&R/Valorial)
  - October – December 2021 (to be hosted by UCD)
- Preparation of REAMIT network prospectus has been started
  - IoFT Network PI (in University of Lincoln, UK) to be invited for the event for a key-note.

WP Meeting for WP M (Chair: BED)

- Development of Project Handbook and internal management systems
- Suggestions for best practices for project management
- Key control register for Project Management
- Project Handbook
- Risk log

Project Management Issues

- Risk register on key project risks & mitigation actions for each.
  - Risk 1: Technological risk linked to adapting sensor and big data technologies
  - Risk 2: Lack of companies participating in tests
  - Risk 3: Lack of roll-out potential
- Assignment of risk-ownership among partners
- Any other risks anticipated?

Dates for RSC+WP+RAC meetings

- Meetings to be held in every six months. Next meeting dates are:
  - 15 and 16 January 2020 (to be hosted by I&R)
  - 08 and 09 July 2020 (to be hosted by UCD)
  - 20 and 21 January 2021 (to be hosted by Whysor)
  - 07 and 08 July 2021 (to be hosted by Ulster)
  - 19 and 20 January 2022 (to be hosted by NTU)
  - 23 and 24 March 2022 (to be hosted by BED)

The proposed content of REAMIT Project Handbook

Katarzyna Pelc
REAMIT Project Manager

Deliverable 1.1
WP Project Management

Project Handbook

1. Introduction
2. REAMIT project structure
   - REAMIT Steering Committee
   - REAMIT Advisory Committee
   - Meeting schedule
   - Decision making
3. Workplan
   - Workplan baseline
   - Changes to workplan
4. Monitoring
   - Workplan
   - Financial
   - Quality

Project Handbook

5. Reporting, Payment Claims and Reimbursement
    - Process
    - Calendar
6. Sound financial management
    - Requirements
    - Retention periods
7. Evaluation
8. Long term effects
9. List of key documents

Project Handbook

Annexes

1. Subsidy Contract
2. Partnership Agreement
3. Risks Register
4. Key Control Register

What else would you add to Project Handbook?

Agenda for 12th September

8.30 – 9.00 am	Refreshments and networking
9.00 – 10.30 am	REAMIT Steering Committee (RSC) meeting
10.30 – 11.00 am	Coffee/Tea and networking
11.00 – 12.30 pm	REAMIT Steering Committee (RSC) meeting Continued
12.30 – 1.30 pm	Lunch and Networking
1.30 – 3.00 pm	Sensors & Big Data workshop.
3.00 – 3.30 pm	Coffee/Tea and networking
3.30 – 5.00 pm	Sensors & Big Data workshop continued.
5.00 – 5.30 pm	Refreshments and networking

REAMIT Steering Committee (RSC)

- One member from each partner
- I think we should allow substitutions in extraordinary circumstances
- Terms of reference is specified in the Partnership Agreement.

PP1	BED	Ram Ramanathan (Chair)
PP2	I&R	Gael Maugis
PP3	UCD	Fionnuala Murphy
PP4	UoN	Gerald Thouand
PP5	Levstone	Simon McGraw
PP6	NTU	Usha Ramanathan
PP7	Whysor	Luuk Rijnbende
PP9	ITT	Pat Doody
PP10	SenX	Herve Rennou
PP11	UU	Joan Condell
PP12	DNI	Colin Potts

Progress Report Revisited

- Minutes of the Kick-off meeting to be confirmed
  - Action log to be updated
- Significant facilitators and barriers so far
  - Potential deviations from original plans
- Significant details from WP meetings
  - Progress on recruiting end-users in partner countries
  - Progress on the first pilot test
  - Timescales for future pilot tests
- Feedback by RAC
- Risk log
- Financials
- Responsibilities of technology partners

Technology Demonstration

- Demonstration by Review-Displays

Sensors & Big Data Workshop

- To be led by Ulster, ITT and Levstone

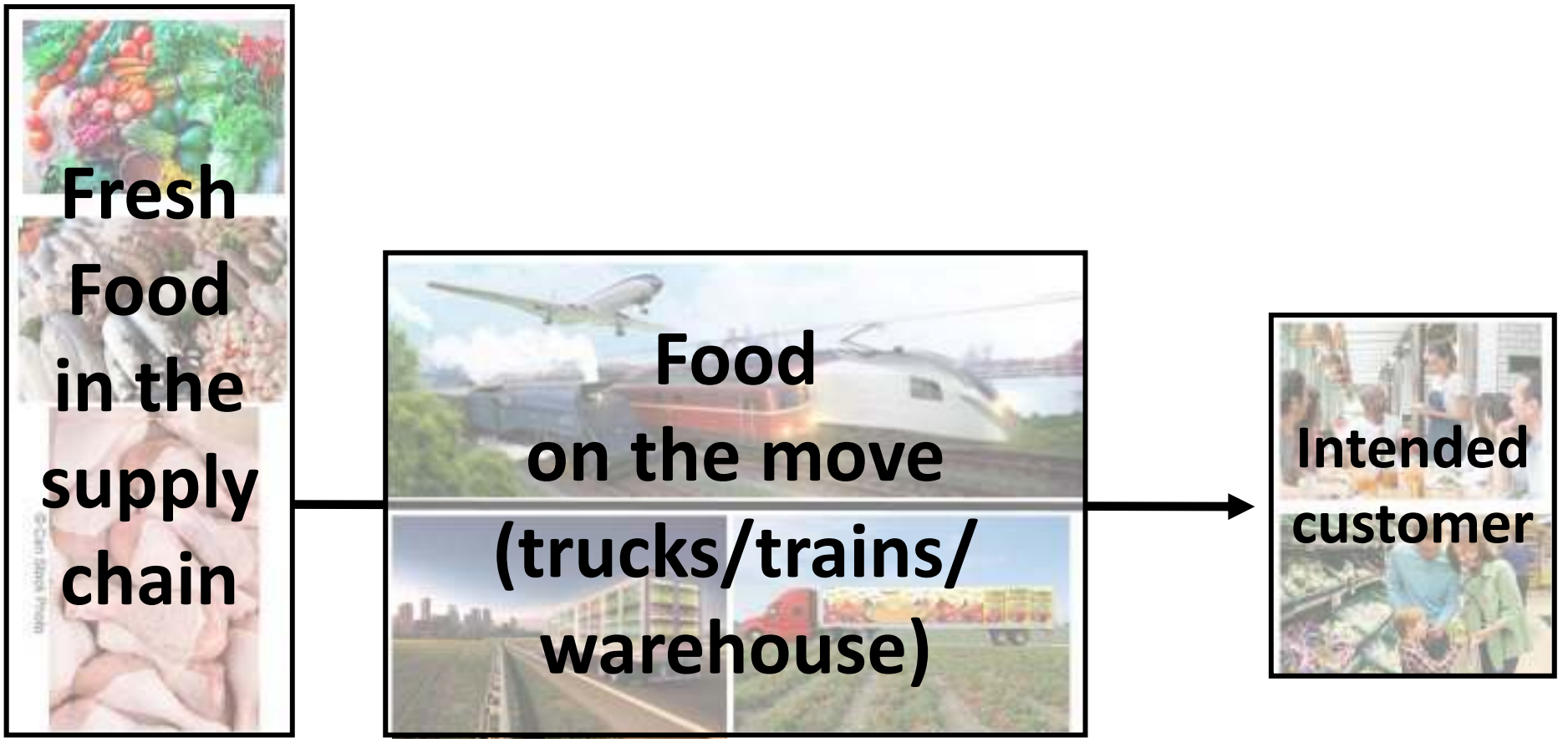
REAMIT – The Challenge

- Food waste is a global problem and is particularly high in the developed world (North West Europe)
  - 88M tons or € 143B wasted per year
  - 35% of food waste in EU-28 has occurred in agri-supply chains
- We focus on fresh food (fruits, vegetables, fish, meat)
- To demonstrate the power of IoT sensors and Big Data technologies in improving resource efficiency of agri supply chains.
  - To deploy IoT sensors for reducing waste and hence improving resource efficiency of the agribusiness supply chains (dairy products/meat/fish) until food is finally consumed.
  - To collect the data in the cloud and conduct big data analytics to identify sources and patterns of food waste with a view to tacking them.

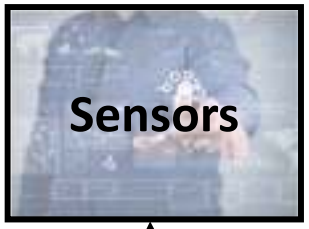
REAMIT – The Objectives

- Reduce waste of fresh food in agri-supply chains of North West Europe by at least 10%
  - Save 1.8 Mt of food waste or €3B per year
  - Avoid 5.5 Mt/yr of CO_2 emissions
- Any reduction in food waste will increase productivity.
  - Due to the amount of resources (water, nutrients, fertilisers, etc.), food waste saved is much more than the value of waste and can have significant social and environmental benefits.
  - Link to CO_2 emissions above

REAMIT – Approach



REAMIT – Approach



REAMIT – Approach

- Sensors will monitor and record food quality along the supply chain
  - Traditional temperature/humidity/etc.
  - Raman Spectroscopy
  - 3D Fluorescence
- Waste reduction is achieved by supporting owners of food at risk using :
  - Big Data Analytics
  - Artificial Intelligence
  - Decision Support Systems.

REAMIT – Approach

- Big Data Analytics
  - Identify patterns of food waste in NWE for supporting suitable policy actions
  - Identify “food at risk”
- Artificial Intelligence and Decision support systems
  - Decision support to food owners for making rapid decisions to save food including redistribution to nearby consumption points (local stores and food charities).
  - Optimisation of food delivery points based on real time food quality monitoring
  - Increased food shelf life using real time cold chain monitoring.
- Food owners, truck drivers and warehouse managers will be connected using a dedicated Smartphone APP.

REAMIT – Partners

- 12 Project Partners and more Associate Partners across North West Europe
  - 6 Universities
  - 5 SMEs working in sensors, big data, blockchain and analytics
  - 1 large logistics company to act as a user
- More end-users will be recruited using an open call

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WP T1 : Pilot Tests
11th Sept-2019

University of Bedfordshire Business School
ir ingeos réseaux
UCD DUBLIN
UNIVERSITÉ DE NANTES
LEVSTONE
NOTTINGHAM BUSINESS SCHOOL
NOTTINGHAM TRENT UNIVERSITY
WHYSOR
TRALEE
SenX
Ulster University
dunbia
Valorial
ActionSense

- Publication of open challenge :
  - English and French documents uploaded in June 2019
  - Dutch and German documents uploaded in September 2019

- Pilot test / FRANCE : 1st Pilot identified with STEF, UoN, Jean Routhiau

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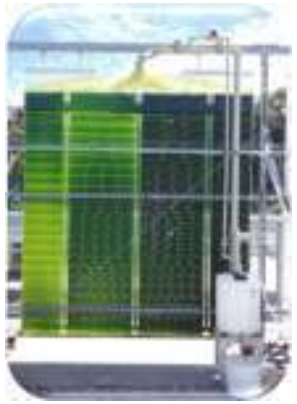
Pilot test / FRANCE : 1st Pilot

210

Photobioreactors



GEPEA

One of the leading group in bioprocess engineering in France

Five locations/ 5 teams

Air depollution

Food processing

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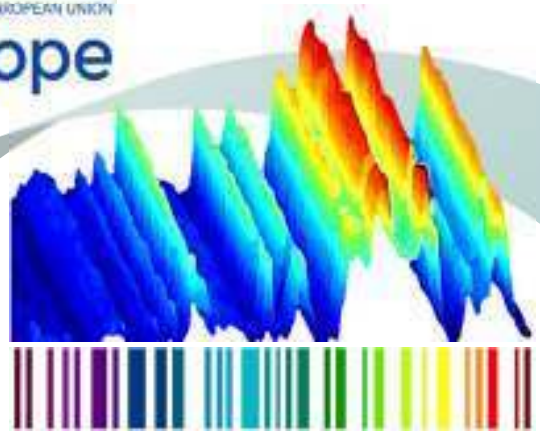
OPTICAL ANALYSIS: research topics

Optical methods
Raman, Fluorescence, Photoluminescence, …



Raman spectra

- **Pollution fingerprints, toxicity, biodegradation**
- **Microalgae process monitoring**
- **Microorganism's detection**
- **Food characterization**
- **+ other applications**

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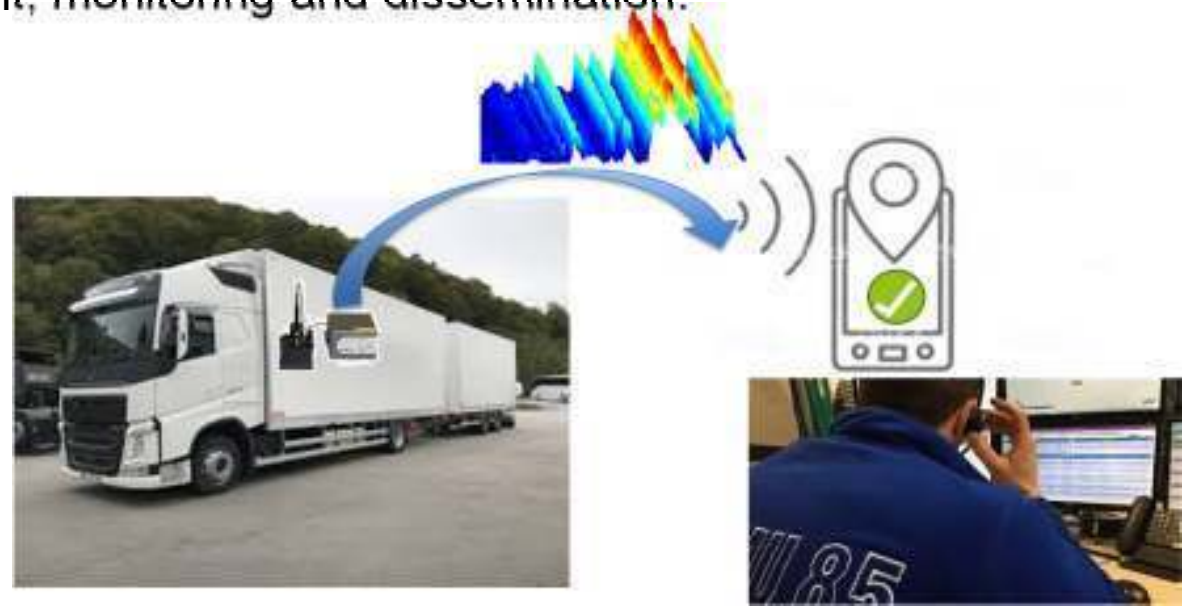
UoN will perform the following activities in REAMIT

(i) Raman Spectroscopy technology for monitoring food quality in the supply chain

(ii) Send the sensor data to Big data platforms for further analytics

(iii) Conduct technology testing and piloting

(iv) Help in project evaluation, technology evaluation, risk assessment, overall assessment, monitoring and dissemination.



Pilot test / FRANCE : 1st Pilot

Action 1: Research of new REAMIT partners & selection of food matrices

- **Routhiau**. Main activities: Meat products; appetisers and desserts, cooked fruits and vegetables. Country: FR

- **STeF**. Main activities: cold logistics for temperature sensitive and agro food products. Country: FR

- **NUEVA PESCANOVA GROUP**. Main activities: Conception, packaging sea food. Country:

beef

seafood

More than 20 companies were contacted

Action 2: Technical specification of REAMIT equipment's

- Portable devices suitable to cold transportation & best optical configuration
- Purchase operation is now ready (public call)

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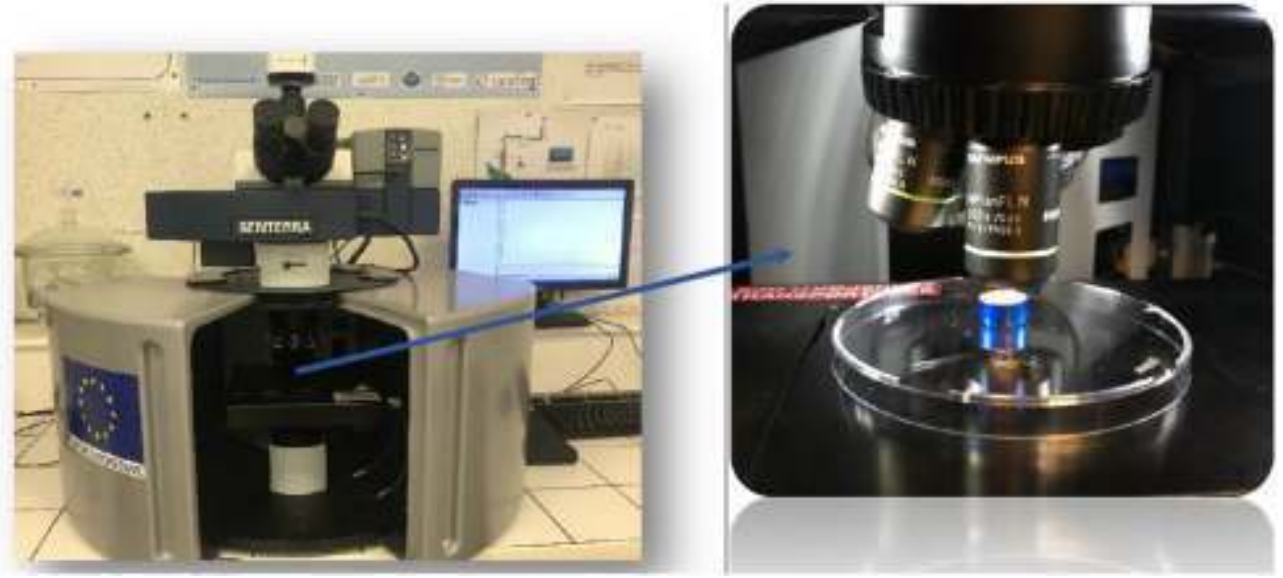
Action 3: Starting the optimization of optical parameters on 2 food matrices



Settings to optimize

- Optical parameters: λ, p, t, r, …,
- Biological: living samples variability
- Statistical: nb of spectra, data, reliable model, ….

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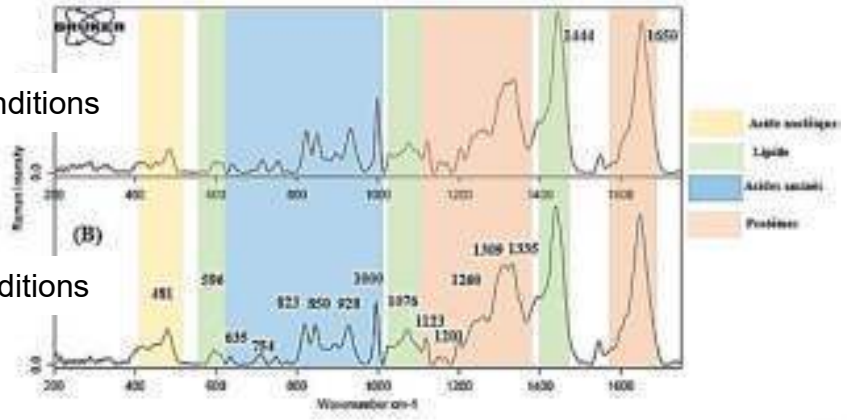
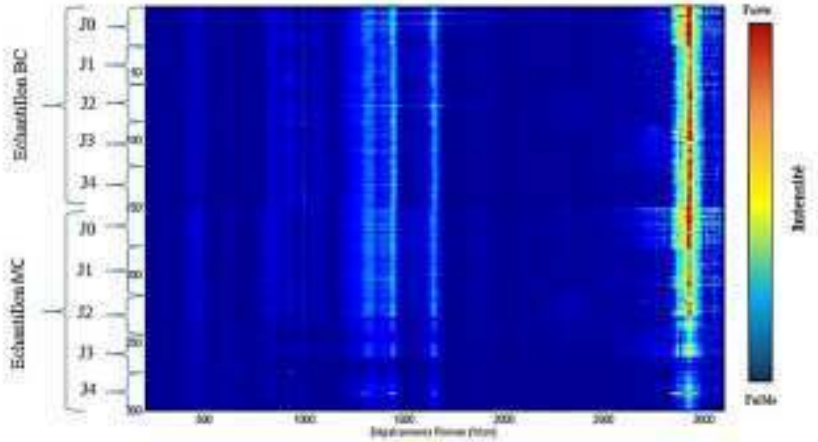
Pilot test / FRANCE : 1st Pilot

Example : Evolution of the meat quality according to storage days

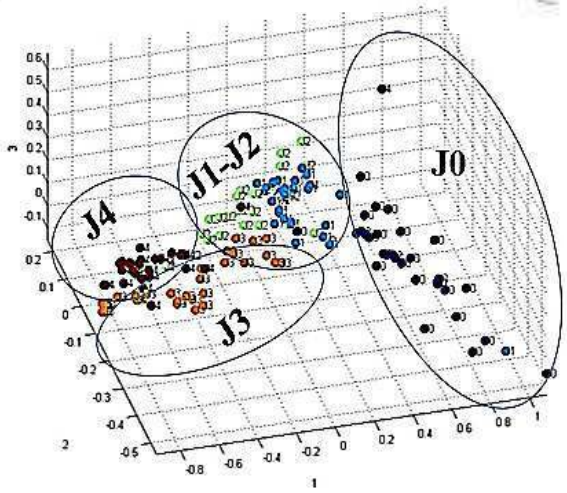
Good conditions

Bad conditions





Chicken matrices



J0= Fresh samples

- Begin 2020 (Action 3) : Lab test for DB feeding & RAMAN calibration
- May-June 2020 : Truck installation and starting of measurement
  - Issue : transmission of the data in real time to the BIG DATA platform

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Pilot test / FRANCE : 2nd Pilot

UCPT
UNION DES COOPERATIVES DE PAIMPOL ET TREGUIER
Du terroir et des hommes

- UCPT would be interested to participate (Vegetables cooperative) :
  - ➢ Collect the vegetables from the producers
  - ➢ In charge of the packaging & cold chain

  - ➢ Challenge : to be able to identify and be notified when threshold temperature is reached in order to :
    - ✓ Save the quality of the vegetables
    - ✓ Avoid to lose an important part of the production

- Does the Big Data and App’ would be able to answer these expectations ?
- Need to revert back to UCPT in order to provide more information on the Big Data Platform and App’

- Few actions launched in order to recruit more end-users using Valorial Network :
  - **Procsea** has been approached (Online fish market)
  - **IDEA emballage** (Packing) :
    - ✓ traditionnal sensors : chocs + humidity + temperature + GPS/GPRS sensor

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Welcome

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ir images & réseaux
UCD DUBLIN
UNIVERSITÉ DE NANTES
LEVSTONE
NOTTINGHAM BUSINESS SCHOOL
NOTTINGHAM TRENT UNIVERSITY
WHYSOR
TRALEE
SenX
Ulster University
dunbia
Valorial
ActionSense

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Daniel Kelly
Ulster University

First Pilot in Conjunction with Dunbia

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First Pilot: Ulster + Dunbia

Dunbia Process

- All transport is temperature controlled
- Three different Categories of Meat Product
    1. Vacuum Packed
    2. Retailer ready packaging (Modified Atmosphere)
    3. Carcass export (*lamb mainly*)
- Transport is outsourced to a 3rd party company
    - Problem: After delivery, lorry may not return to source
        - Solution: Focus only on inter-company transactions (between different Dunbia sites)
    - Problem: Cannot mount sensors on walls.
        - Solution: Must therefore create a container to house sensor and power supply.

First Pilot: Ulster + Dunbia

Objectives

1. Determine the ability of ambient VOC to detect changes in food quality
2. Determine the effect packaging has on the ability to detect VOC changes

Prior to the protocol being conducted Trial run will first be required in empty truck with no food product.

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First Pilot: Ulster + Dunbia

Data Collection Protocol Overview

1. **Source** (Dunbia Dungannon)
    - Take measure of food quality (hyperspectral imaging, tenderness etc)
    - Enable sensors and place sensor container in lorry leaving Dunbia Dungannon
2. **During Transportation**
    - Take VOC readings at a continuous rate over course of transportation (24-48hrs)
3. **Destination** (Other Dunbia Site)
    - Take measure of food quality
    - Retrieve sensor container and stop sensor recording
    - Transport container back to source

Protocol to be performed *N?* times on two different meat categories:

- Packaged (Vacuumed packed)
- Non-packaged (Carcass)

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First Pilot: Ulster + Dunbia

Data Analysis

1. Analyse correlations between VOC measures and food quality measures
2. Compare VOC data between vacuum packed and caress.

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First Pilot: Ulster + Dunbia

Volatile Organic Compounds

- Spoilage of highly perishable food products such as fresh meat is typically due to microbial activity that leads to the generation of volatile organic compounds (VOCs).

- These compounds could be used as spoilage indicators and thus for quality monitoring of the food product.

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First Pilot: Ulster + Dunbia

Sensor Requirements

- Volatile Organic Compound Sensor
  - High sensitivity to small changes in VOC (Photoionization Detector?)
  - Parts per billion (PPB)
- Continuous Monitoring
- Can be secured to a fixed location
- Data export
- Battery life
- < €5000

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First Pilot: Ulster + Dunbia

Sensor Requirements

- Volatile Organic Compound Sensor
  - High sensitivity to small changes in VOC (Photoionization Detector?)
  - Parts per billion (PPB)
- Continuous Monitoring
- Can be secured to a fixed location
- Data export
- Battery life
- < €5000

First Pilot: Ulster + Dunbia

Elements NOT included

- 3D Fluorescence Spectrometry
  - *Hardware availability???*
- Connecting outputs to Cloud


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RAC+RSC+WP meeting
Luton
11-12 Sep. 2019

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Work Package C – Communication

Dr Usha Ramanathan

Professor of Sustainability and Supply Chains

Nottingham Trent University

Staffs from NTU and main objectives

- Usha Ramanathan – Project Partner
- Communication Manager- Sasha Bennett

Main objectives of WP-C are to:

- Influence agribusinesses to decrease amount of food waste in food supply chains by 10% by 2021
- Raise awareness of the potential from combined technologies
- Convince agribusiness users of the value of REAMIT's technologies (aimed at reducing Risk) and increase knowledge

All partners in Communication activities!!

- All partners will be involved in the Communication ..
- **REAMIT communication strategy will be developed jointly, led by NTU**.
- The Communications strategy will outline external communication to inform stakeholders
- The target groups are (i) actors in the food supply chain (e.g. food producers, food distribution & logistic companies, retailers and wholesalers), (ii) policy and support agencies (e.g. local authority, business support organisations, policy makers), and (iii) knowledge institutions and technology firms (e.g. laboratories, universities, firms that develop IoT and big data technologies).

Our role in the project (activities started and on-going)

- Coordinating the process of designing the project's communication strategy in close cooperation with the Project Coordinator/Lead Partner and project partners (examples, kick-off meeting, network meetings)
- Coordinating the implementation of communication activities
- **Managing REAMIT's web space and social media**
- Liaising with JS on project/programme communication.
- Several ways of communication will be used in engaging the target groups:
  - Installing project banners and signboard
  - Project web space, discussion forum in websites and social media – to connect industries with academics and general public
  - Exhibitions, flyers and posters in Industrial and academic events – to reach wider community with results and relevant materials
  - Press & media (Newsletter, TV programmes, Journal articles)
  - Annual conferences

Social media presence

To update our webpage with recent information, if there is any

Exploring other options ??

Email account- : reamit4nwe@gmail.com

NTU will create online presence to reach out many stakeholders

www.nweurope.eu/reamit

www.reamit.eu

https://www.linkedin.com/company/reamit/

twitter: #reamit4nwe

www.facebook.com/reamit4nwe

NETWORKING EVENT

- One day NETWORKING event in Nottingham

  Preferred dates : 9 Jan 2020 or 14 Jan 2020 or 16 Jan 2020

  Preferred time : 10 am – 5pm

  Invitees

  Food SMEs

  IoT companies

  Data analytics companies

  Academics

  Professionals working in IoT and food supply chains

  Local city council and food authority representatives

  ???