50 YEARS OF MANUFACTURING AT CAMBRIDGE

Evaluating the impact of digital technologies on future food supply chains

Implications for developed and developing markets

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Evaluating the impact of digital technologies on future food supply chains

Developed markets: Rapid growth of e-Commerce

- Consumer benefits of convenience and speed but is this unchecked consumerism environmentally sustainable?
- Do digital platforms provide new opportunities to connect consumers with their local retailers and farmers offering personalisation, a more informed shopping basket and less waste?

Developing markets: Sustainable economic development

- Building attractive markets for farmers without compromising available resources
- Technology solutions e.g. through precision agriculture

Understanding international flows to ensure authenticity and quality

- Complexity of international trade is challenging traceability and provenance

E-Commerce: consumer benefits of convenience and speed

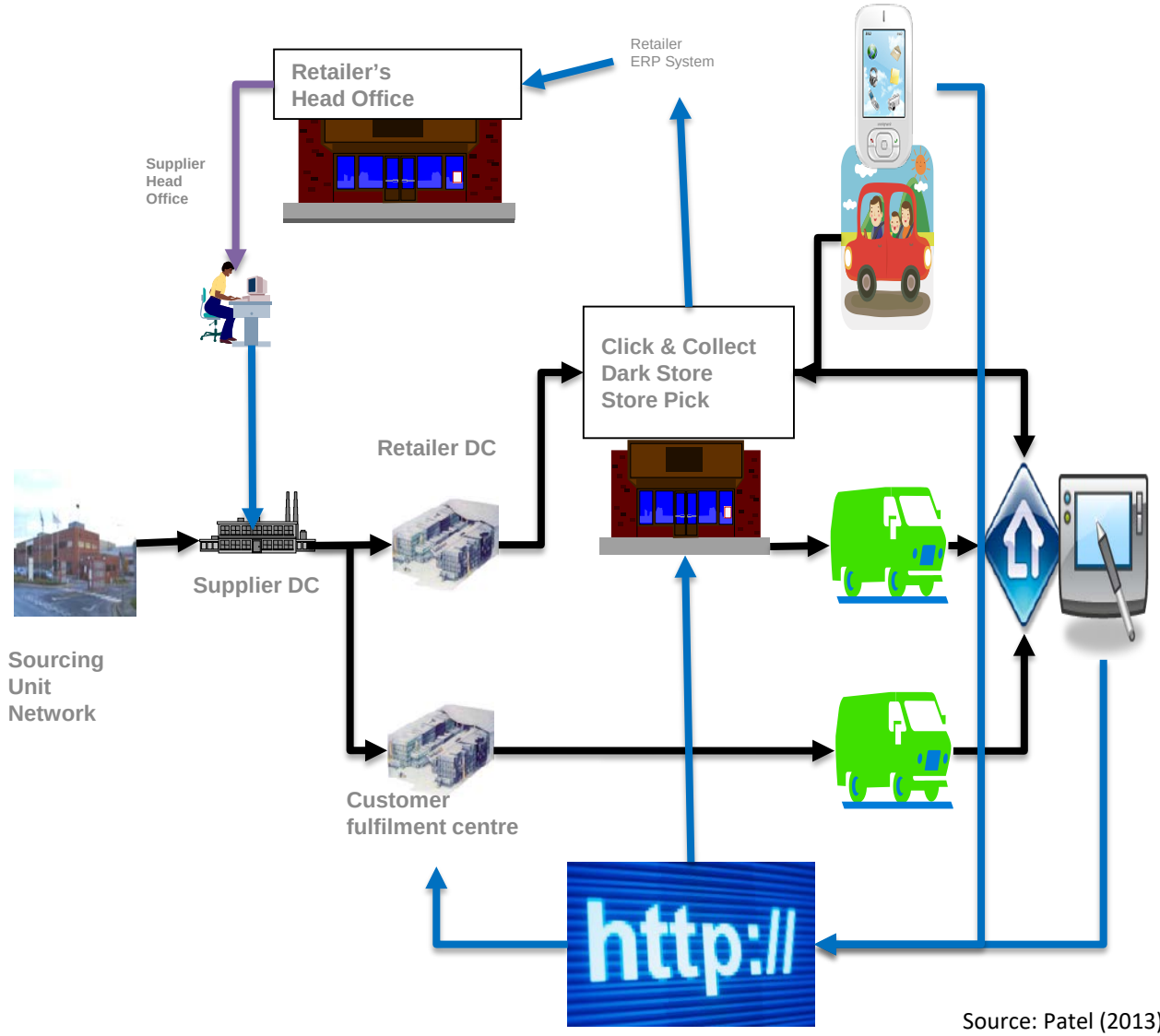
- 2 hour delivery from order placement as is being offered by the pioneers of e-commerce such as Amazon Fresh grocery, Deliveroo and Ocado
  - https://www.youtube.com/watch?v=iogFXDWqDak

Last Mile Configurations

c.a. 1860 Last Mile Configuration

Source: commons.wikimedia.org/wiki/File:Pony_ExpressAdvert.jpg

21C e-Commerce Last Mile Configurations

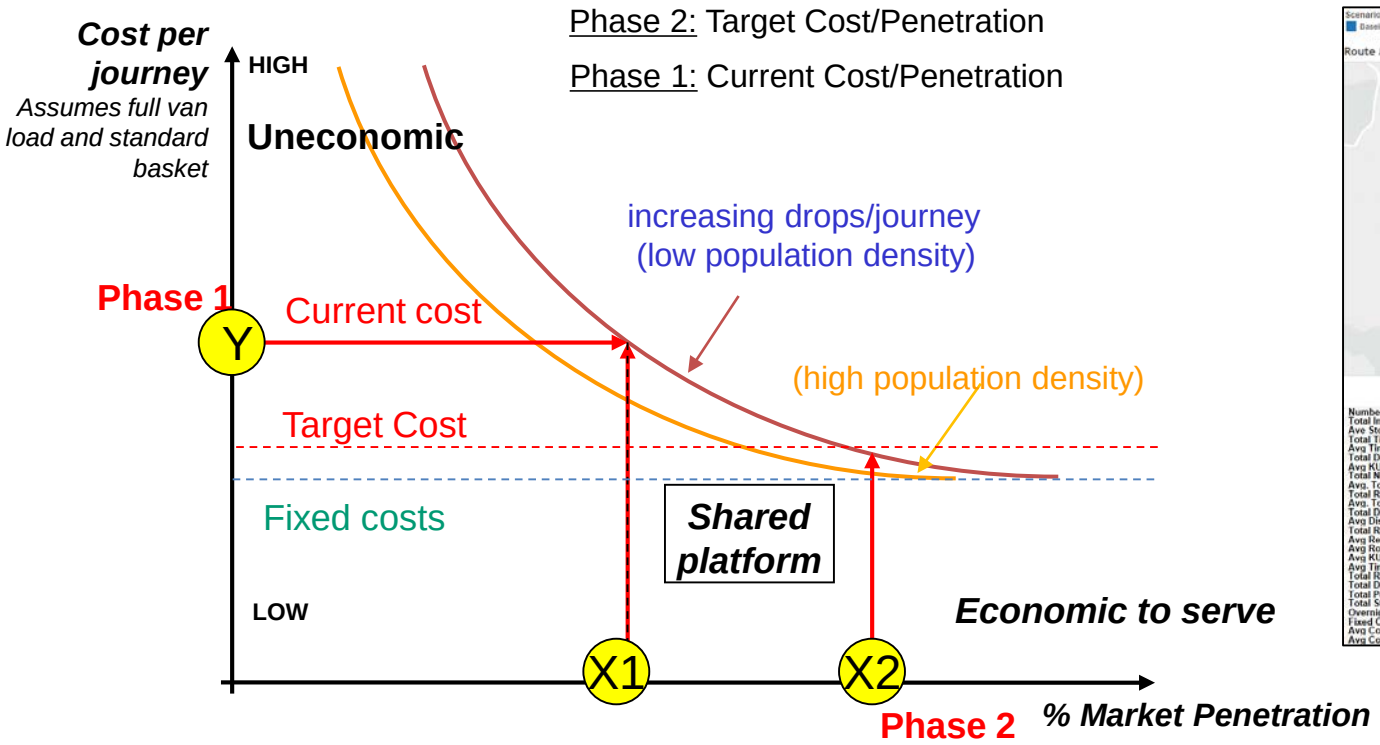


Source: Patel (2013)

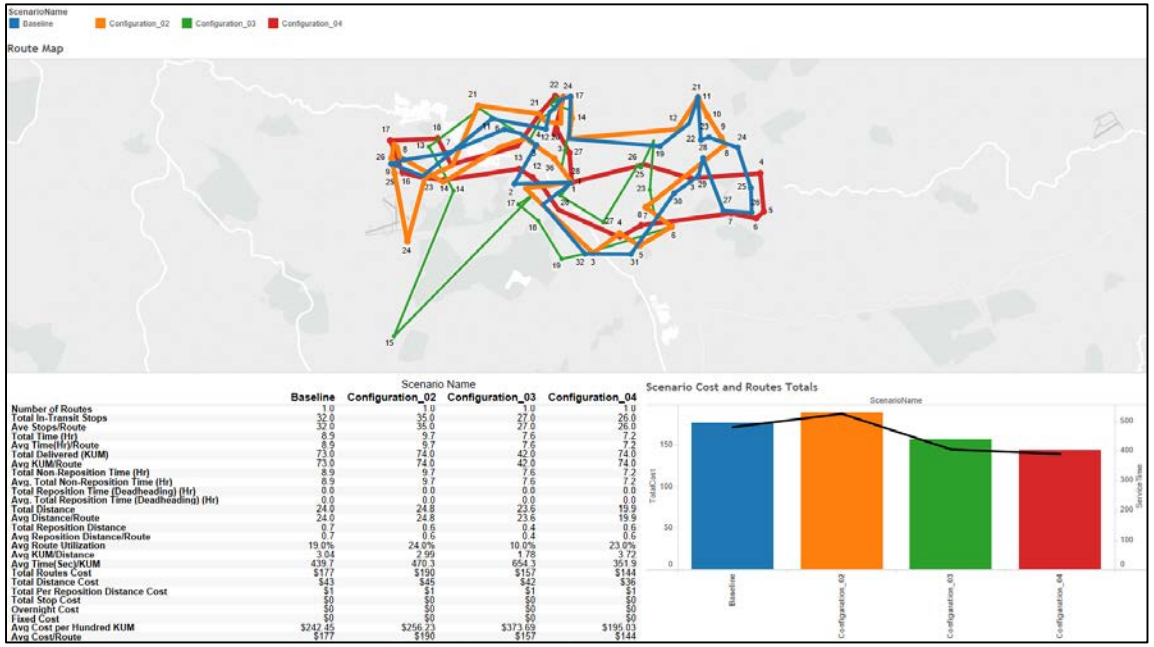
Can this be a sustainable supply model?

Traditional retailers have had to follow suit and develop their own ‘omnichannel’ on-line offerings that sit alongside their store

e.g. From a Cost-to-Serve and resource perspective



e.g. Increasing market penetration scenarios



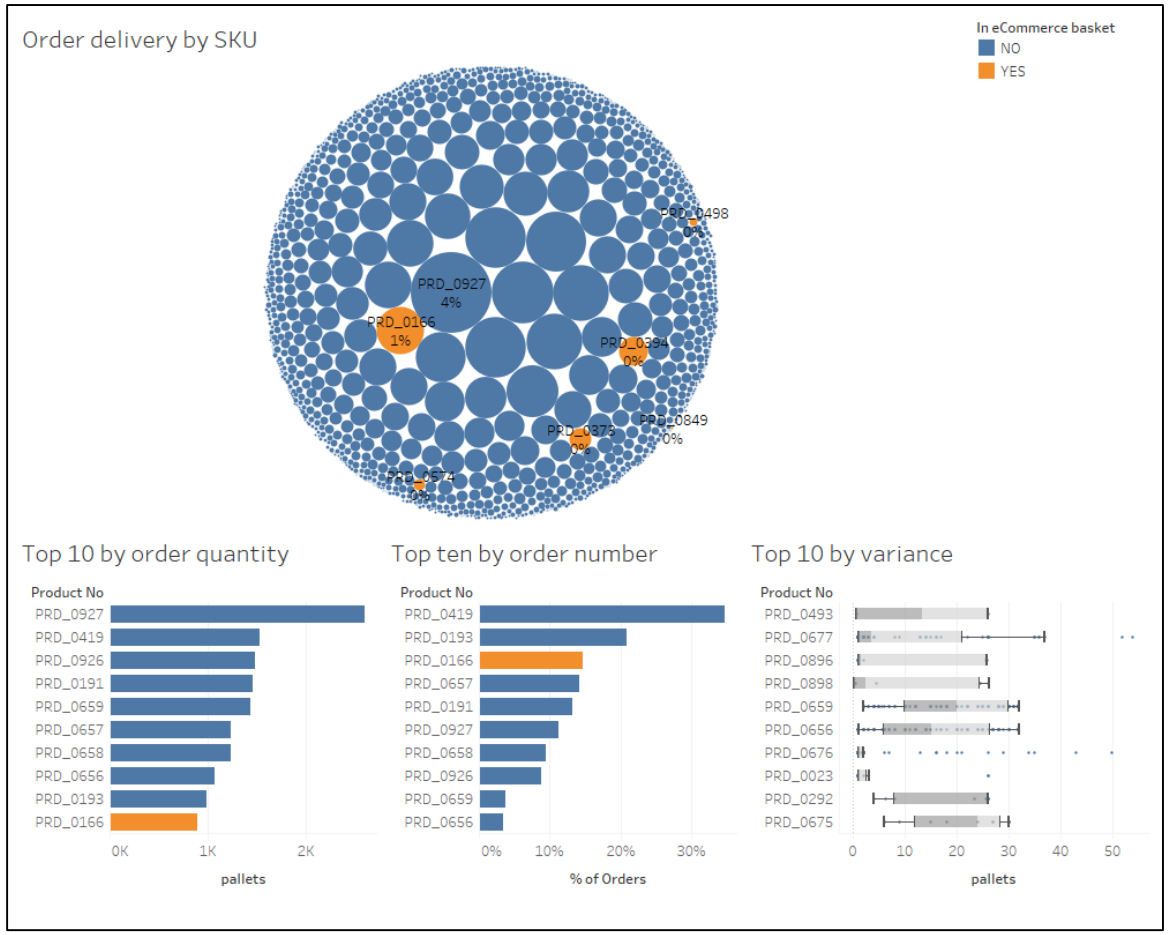
	Baseline	Configuration_02	Configuration_03	Configuration_04
Number of Routes	1.0	1.0	1.0	1.0
Total In-Transit Stops	32.0	35.0	27.0	26.0
Ave Stops/Route	32.0	35.0	27.0	26.0
Total Time (Hr)	8.9	9.7	7.6	7.2
Avg Time(Hr)/Route	8.9	9.7	7.6	7.2
Total Delivered (KUM)	73.0	74.0	42.0	74.0
Avg KUM/Route	73.0	74.0	42.0	74.0
Total Non-Reposition Time (Hr)	8.9	9.7	7.6	7.2
Avg. Total Non-Reposition Time (Hr)	8.9	9.7	7.6	7.2
Total Reposition Time (Deadheading) (Hr)	0.0	0.0	0.0	0.0
Avg. Total Reposition Time (Deadheading) (Hr)	0.0	0.0	0.0	0.0
Total Distance	24.0	24.8	23.6	19.9
Avg Distance/Route	24.0	24.8	23.6	19.9
Total Reposition Distance	0.7	0.6	0.4	0.6
Avg Reposition Distance/Route	0.7	0.6	0.4	0.6
Avg Route Utilization	19.0%	24.0%	10.0%	23.0%
Avg KUM/Distance	3.04	2.99	1.78	3.72
Avg Time(Sec)/KUM	439.7	470.3	654.3	351.9
Total Routes Cost	$177	$190	$157	$144
Total Distance Cost	$43	$45	$42	$36
Total Per Reposition Distance Cost	$1	$1	$1	$1
Total Stop Cost	$0	$0	$0	$0
Overnight Cost	$0	$0	$0	$0
Fixed Cost	$0	$0	$0	$0
Avg Cost per Hundred KUM	$242.45	$256.23	$373.69	$195.03
Avg Cost/Route	$177	$190	$157	$144

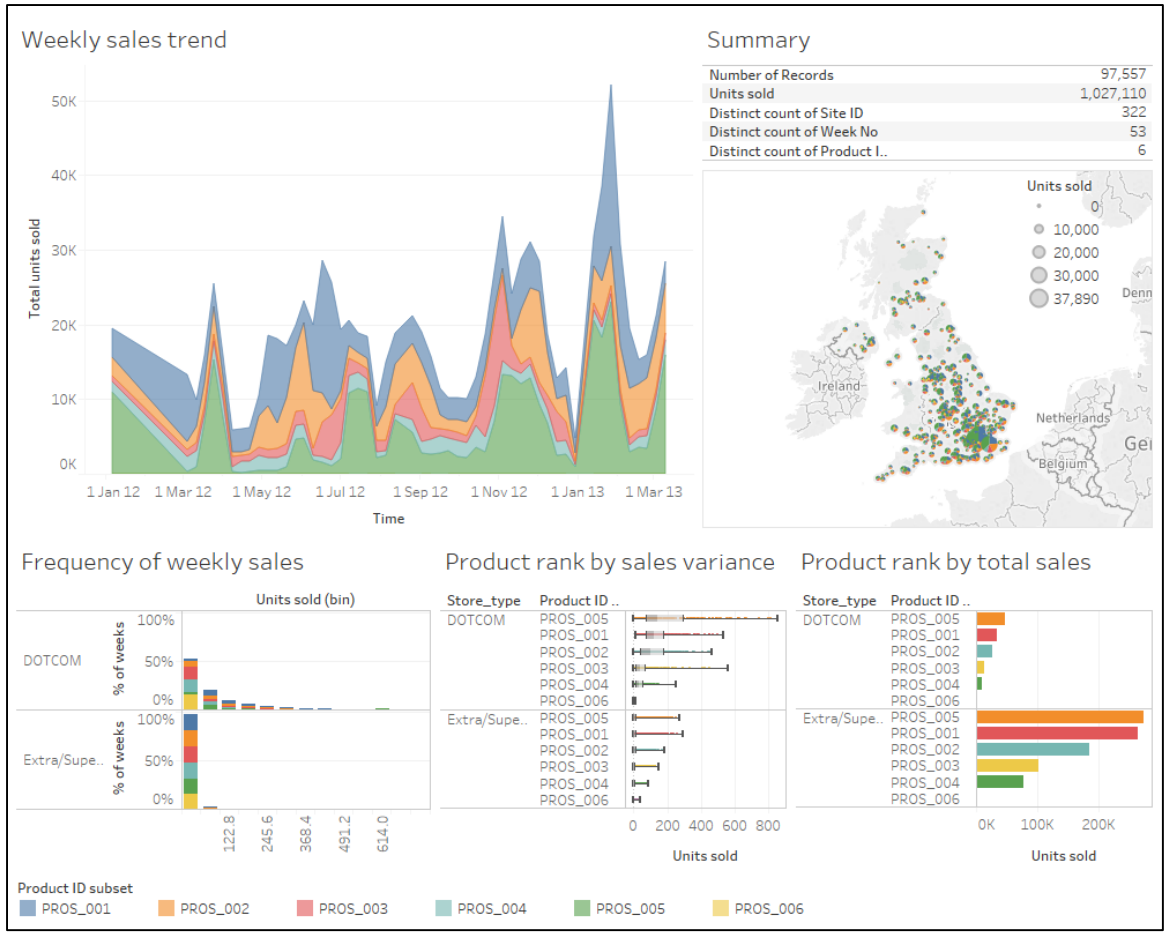
Home delivery OR in-store shop, Click & Collect, Local pick-up points?

Analysing consumer purchase habits

Consumer shopping baskets increasingly delivered direct to doorsteps

(In 2015 e-commerce: 14% of retail and wholesale turnover in UK (c. 21% in the US).





Do these digital platforms provide new opportunities?

- To connect consumers with their local retailers and farmers offering personalisation
- A more informed shopping basket
- Less waste?

EIT Food Programme

- A £340 million EU Innovation programme to change the way we eat, grow and distribute food;
- A consortium of 55+ partners from leading businesses, research centres and universities across 13 European countries;
- A vision to put Europe at the centre of a global revolution in food innovation and production, and its value in society.

Programme pillars

- Overcome low consumer trust
- Create consumer-valued food for healthier nutrition
- Build a consumer-centric connected food system
- Enhance sustainability through recourse stewardship
- Educate to engage, innovate and advance
- Catalyse food entrepreneurship
- Accelerate and customize innovation

Using predictive analytics and ‘nudge’ techniques in eCommerce

- Personalisation
- Using predictive analytics to anticipate consumption & reduce waste through inventory management strategies
- Exploring the use of ‘nudge’ techniques
- Consolidation centres – combining deliveries
- Building shared platforms and leveraging adjacency
- Ability to process and analyse data has become a critical ownership advantage

http://pxhere.com/en/photo/1583503 [CC0]

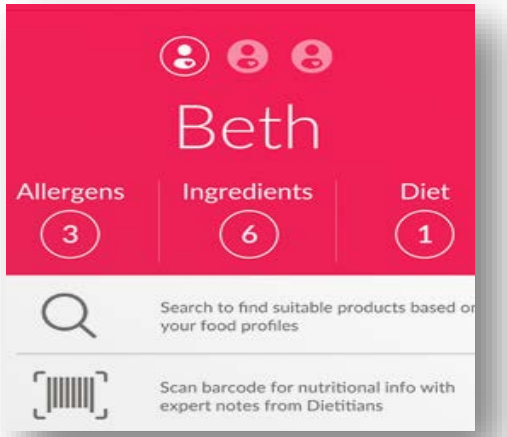
eit Food

Project GLAD - Green Last Mile Delivery: a more sustainable way for food home delivery tailored to consumer needs

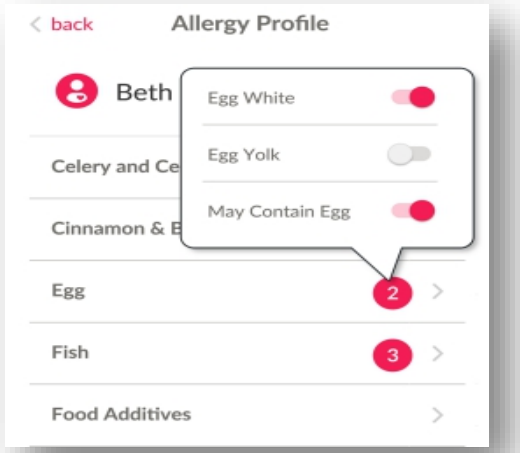
- https://www.eitfood.eu/programmes/glad-green-last-mile-delivery-a-more-sustainable-way-for-food-home-delivery-tailored-to-consumer-needs

Engaging the Consumer – personalisation

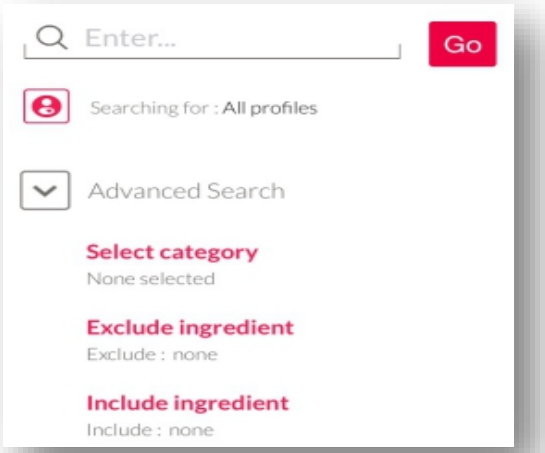
Food App



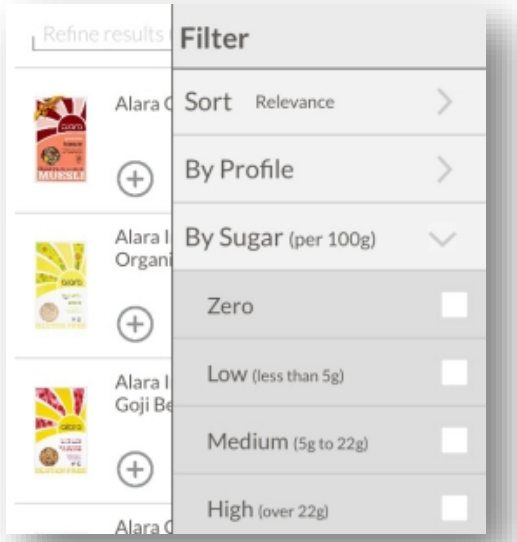
Setup profile



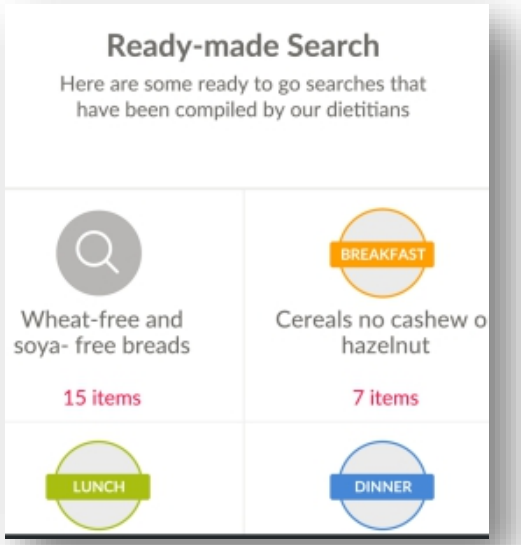
Search or Scan food



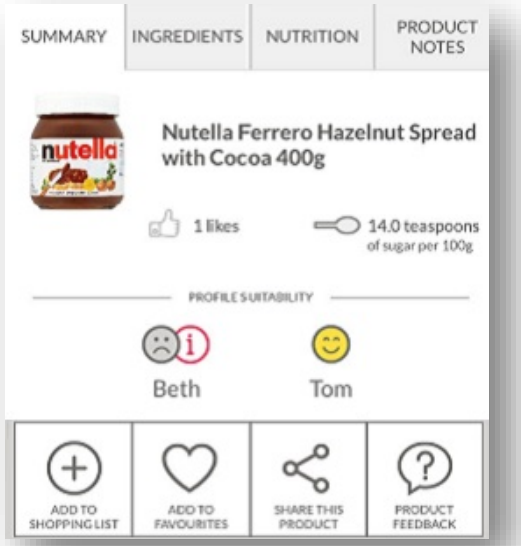
Sugar filters and more



Ready-made lists



Ingredients & nutritional info



http://www.foodmaestro.me/

Developing markets

Sustainable economic development

TIGR²ESS
Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies

- GCRF-funded £7.8 million programme;
- A collaboration of 19+ partner institutions across India, Pakistan and the UK;
- TIGR²ESS aims to improve livelihoods and farming in India:
  - Empower, educate and improve nutrition for farmers
  - Identifying crop types and practices for contrasting climatic regions

GCRF
Global Challenges Research Fund

Structure: Flagship Projects and leads					
FP1: START: Sustainable and Transformative Agrarian and Rural Trajectories	FP2: Improving Water Use and Yield Stability in Millet and Sorghum; Enhancing Photosynthesis	FP3: Heat and Drought Resilience in Wheat	FP4: Water Use and Management in a Changing Monsoon Climate	**FP5: Supply Chains: Modelling Water Use for Sustainable Livelihoods**	FP6: Impacting Wellbeing in Rural and Urban Communities
UoC: Geography	ICRISAT	NIAB	UoC: Archaeology	UoC: IfM	UEA/UoC/NNEdPRO

Includes a 2-way knowledge exchange partnership by growing research capacity to address food security Issues

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FP5 Deliverables

TIGR²ESS
Transforming India's Green Revolution by Research and Empowerment for Sustainable food Supplies

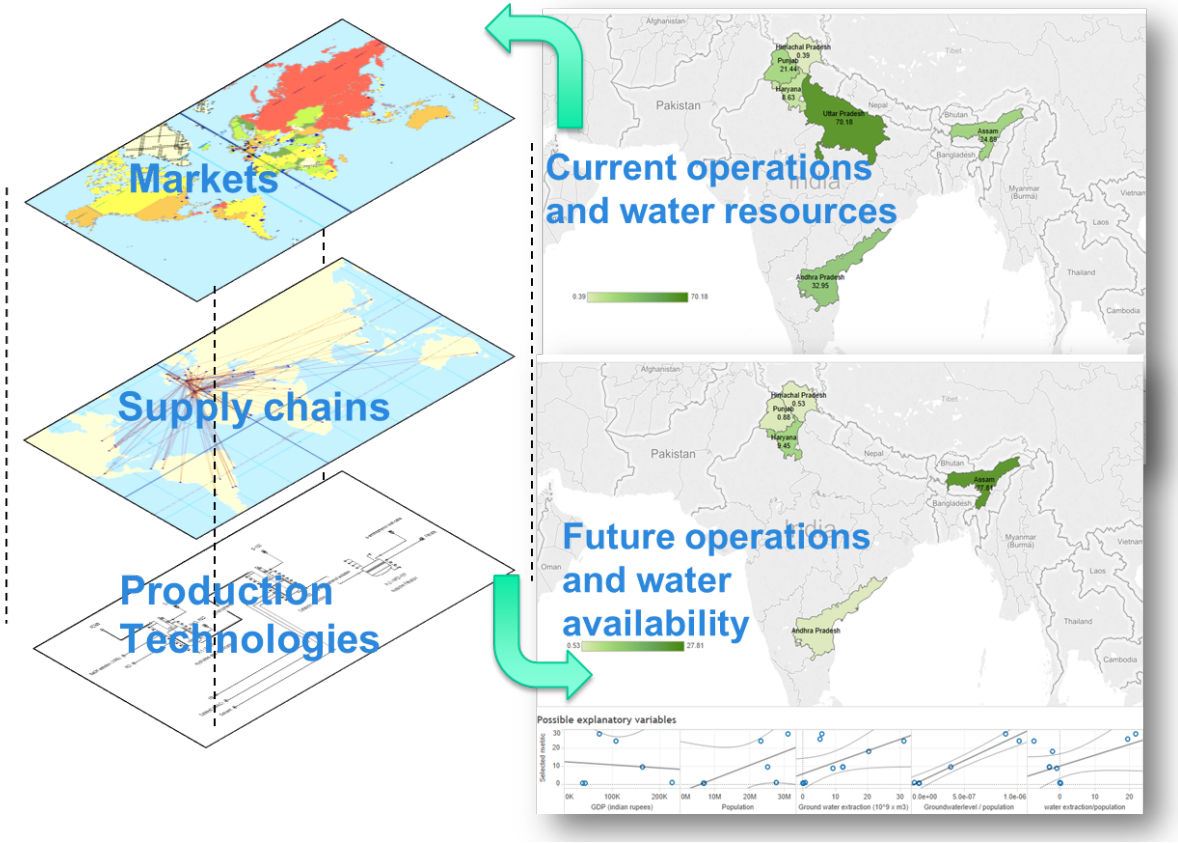
Objectives

- *Analyse, design and operate more resilient (resource efficient) food supply network models;*
- *enabled by new crop, production process and digital technologies*

Outputs

- *Food supply network design, water-resource assessment, resource/water stewardship,*
- *suggest interventions for future regional (State) products and their e-Commerce supply chains*

Multi-echelon Supply Network modelling



Deliverables are linked to the analysis and design of alternative food supply network models enabled by new crops, production processes and digital technologies to support more resilient, resource efficient food systems

FP5 Supply Chains: Modelling Water Use for Sustainable Livelihoods

TIGR²ESS

- Inform the sustainable use of water, and build resilience in supply chains for food producers and consumers alike.
- Future regional (State) interventions to influence institutional/industrial/user behaviours and transform livelihoods

UoC

- Water embodiment in trade under alternative crop policies
- Human-robot synergistic logistics for high-value sustainable crops
- Building product supply chains from agrifood waste
- Multi-layer resource and technology assessment modelling platform for agrifood supply chains

IIT Ropar

- farmer learning system using technological interventions based on crop selection
- Comparative life cycle assessment of Kinnow /irrigation systems
- Solar integrated scalable aquaponics systems for Indian Agriculture

PAU

- Identification of resource efficient crops/cropping systems for extreme water stress /climate change
- Modelling impact of sowing/transplanting techniques on water balance
- Mapping of Wheat, Basmati, Milk and Meat Value Chains
- Identification of water efficient marketable crops
- Nurturing FPOs: testing technologies to increase famers' income

UEA & Hull

- Socially responsible supply networks (UEA)
- Value chain and life cycle assessment for sustainable water usage (Hull)
- Sustainable societal change in the usage of natural resources (Hull)

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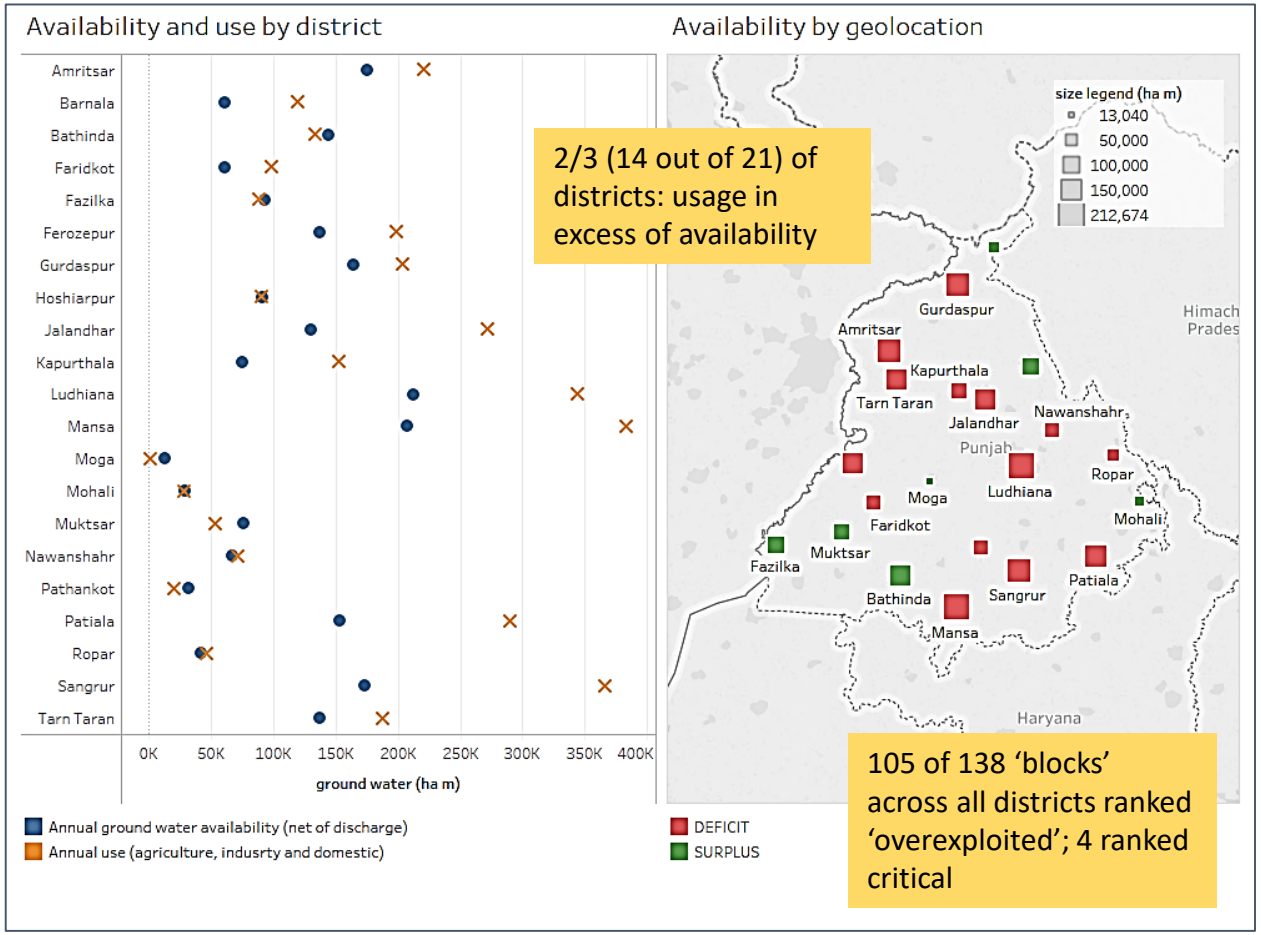
Punjab – 2/3 of districts in water distress!

Local groundwater availability and use (ref. year: 2013)



Raw data source: Central Ground Water Board, Government of India (2017) Dynamic ground Water resources of India as on 31st March 2013. Faridabad

- Contributes major share of rice and wheat production
  - 19% of India's wheat; 10% of rice
  - Ranks 7th as gross producer of wheat in the world
- However Punjabi Agriculture is facing a crisis
  - Unprofitable: declining contribution to the State's VA (**15.4%** in 2017-18)
  - Issue of small and marginal farmers debt linked to worrying suicide rates: introduction of Crop Loan Waiver Schemes
  - Excessive dependence on rice and wheat, and over-exploitation of resources: rapidly depleting water table calls for micro-irrigation solution
  - Over-use of fertilizers and pesticides contributing to cancer and kidney failure.
  - Paddy straw burning widespread practice is causing major air pollution

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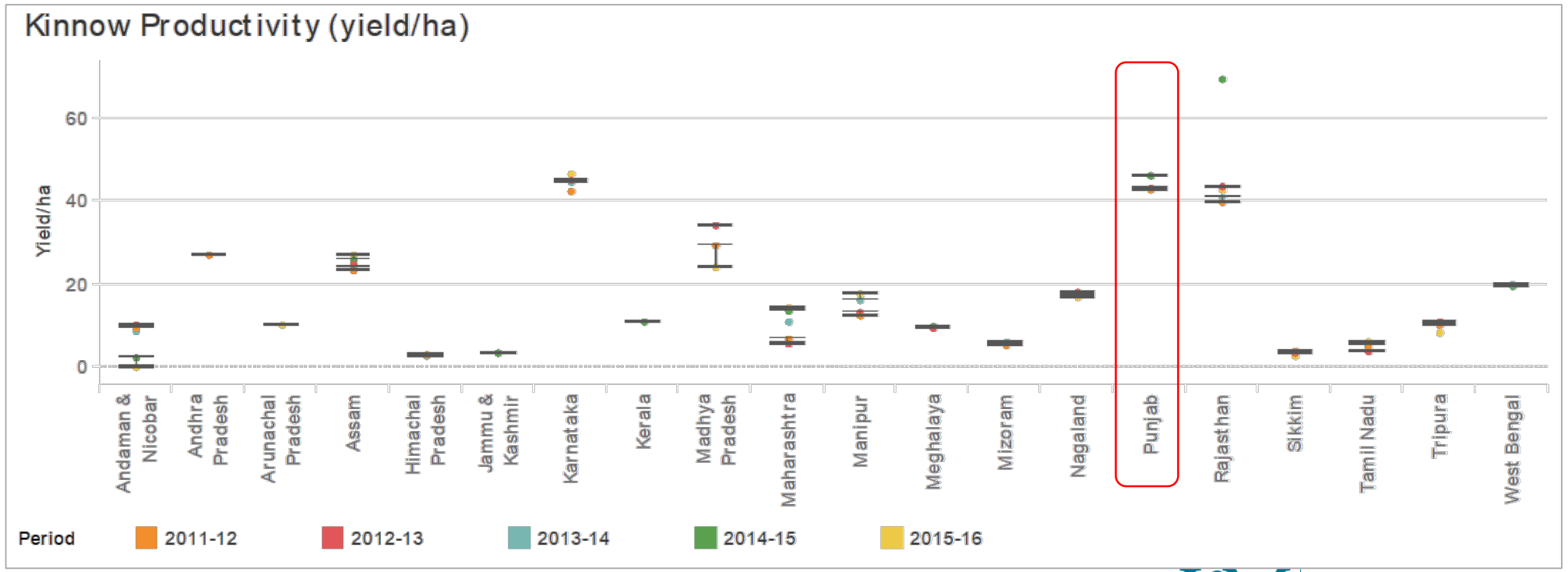
High-value Crops in India: The case of Kinnow

- Fruit & vegetables regarded as viable diversification options for 'paddy-wheat' rich Punjab
- Case Example (PAU*): kinnow
  - high productivity in Punjab – see chart
  - target: exporting 20,000 tonnes

- However, potentially high water requirement:
  - **539 - 1,276 liters** p.a. for a 6-year old Kinnow tree
  - 2,000+ trees/orchard: ~ **225-247 trees/ha**;
- **Need for precision irrigation** to ensure **increased yields** and **fruit quality**.

***PAU Kinnow**

- Less seeds
- 48.5% juice content



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Precision agriculture ‘digital twin’: simulation model (cyber-space)

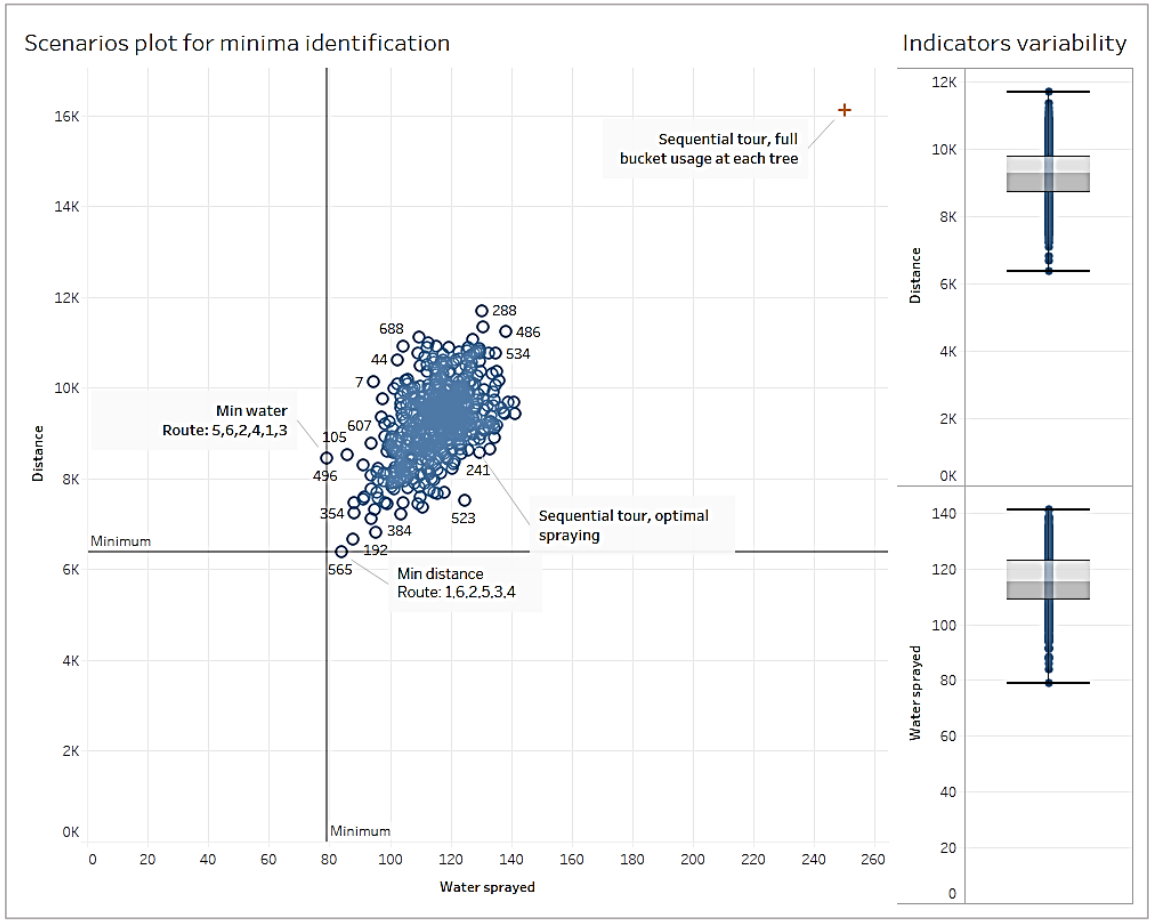
- Use of sensors and AGV to evaluate each plant’s specific water requirement

Example of single simulation run

Plants

Possible irrigation paths

Example of multiple simulation runs: distance/water use plot



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Precision agriculture ‘digital twin’: physical model (application)

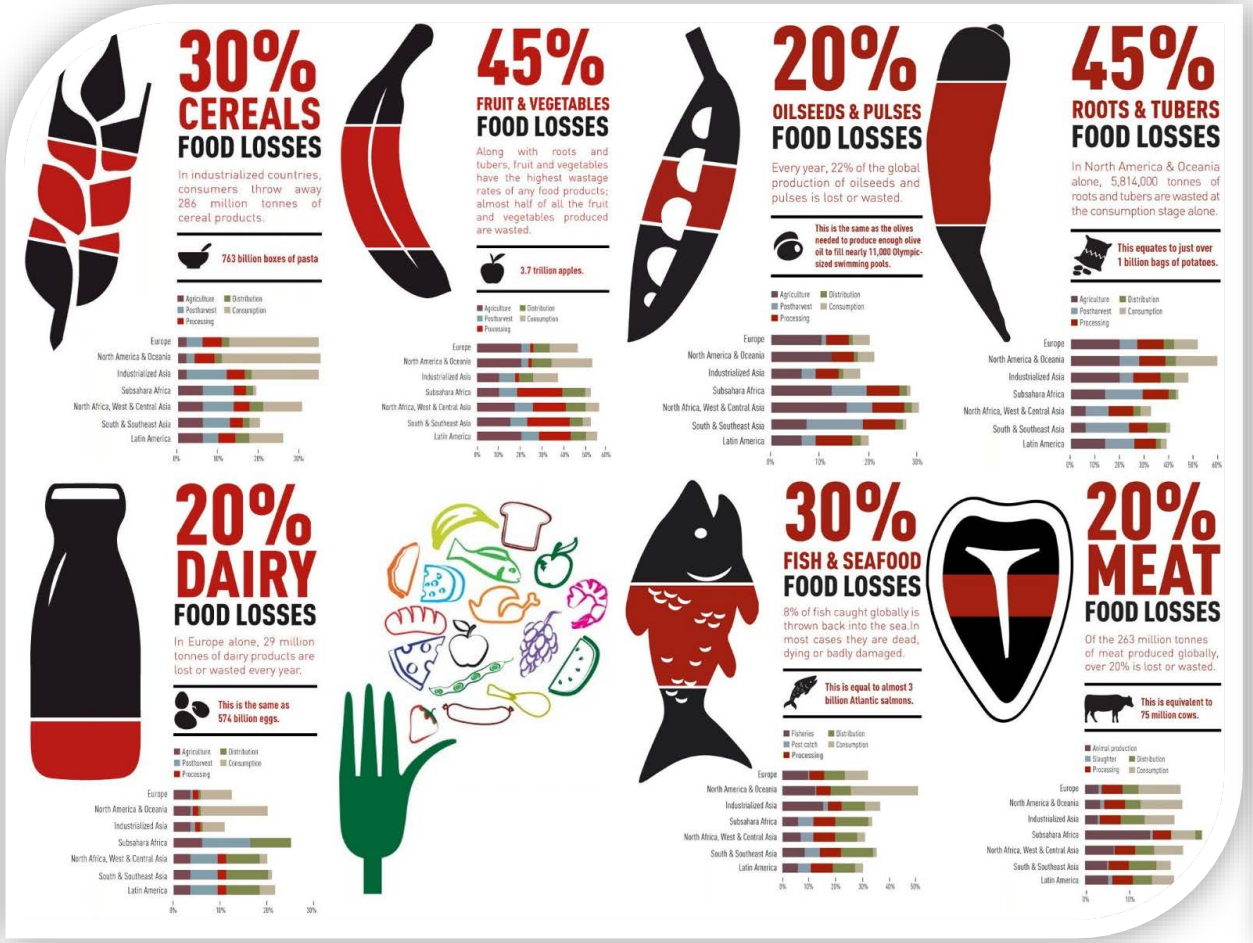
- Industry 4.0 Technologies in Agriculture: from computer simulation to physical system application!
- Mock-up: recreate environment (e.g. orchard) & construct/program intelligent vehicles for testing
- Colour recognition (e.g. tree needing water) + real-time collision detection (vehicle ‘knows’ when to turn)

Blue canopy: no water needed

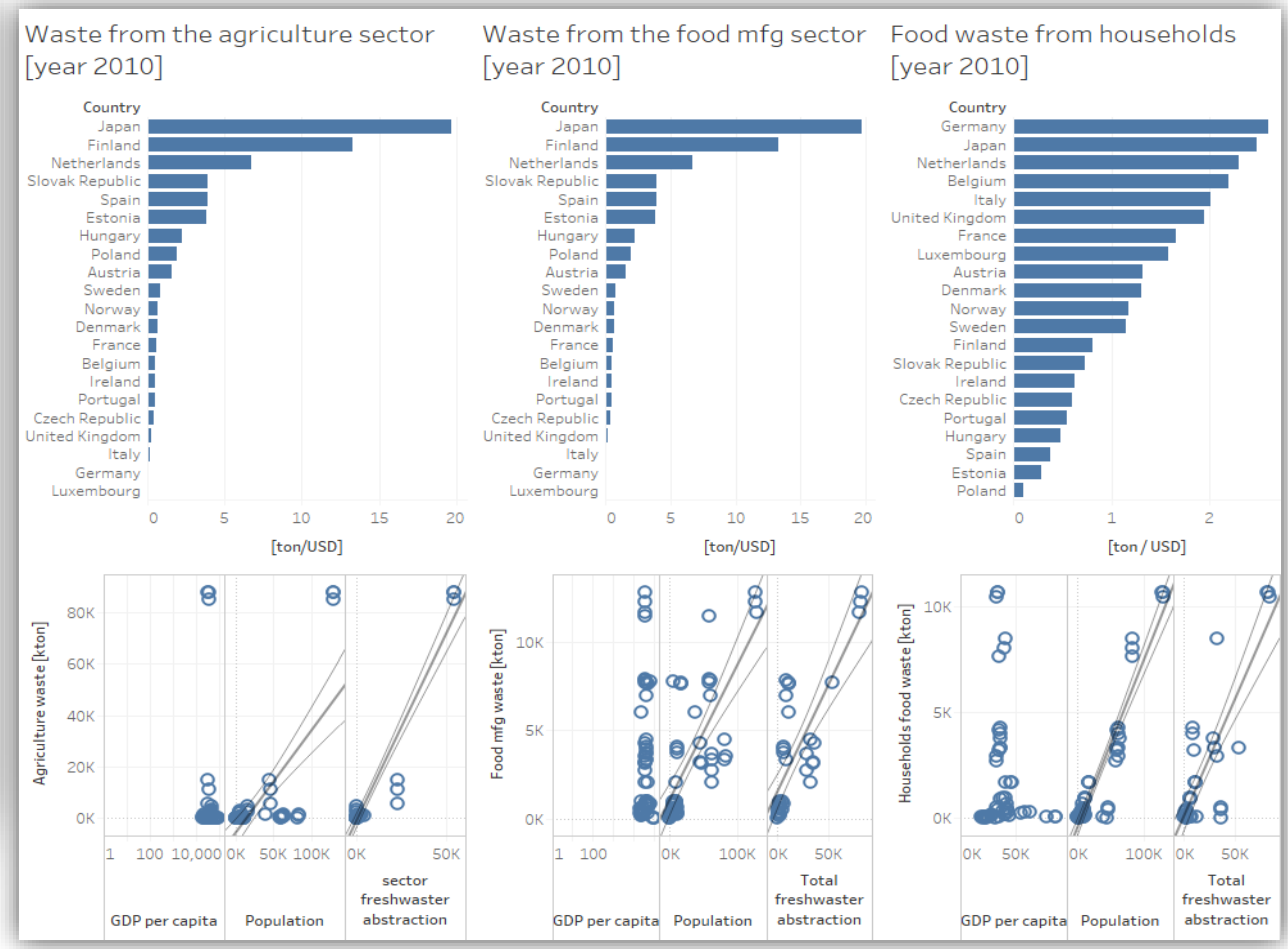
Red canopy: water needed (audio/visual clues to signal action needs to be taken)

Real-time recording and display of sensory data

Reducing Waste in Food Supply Chains

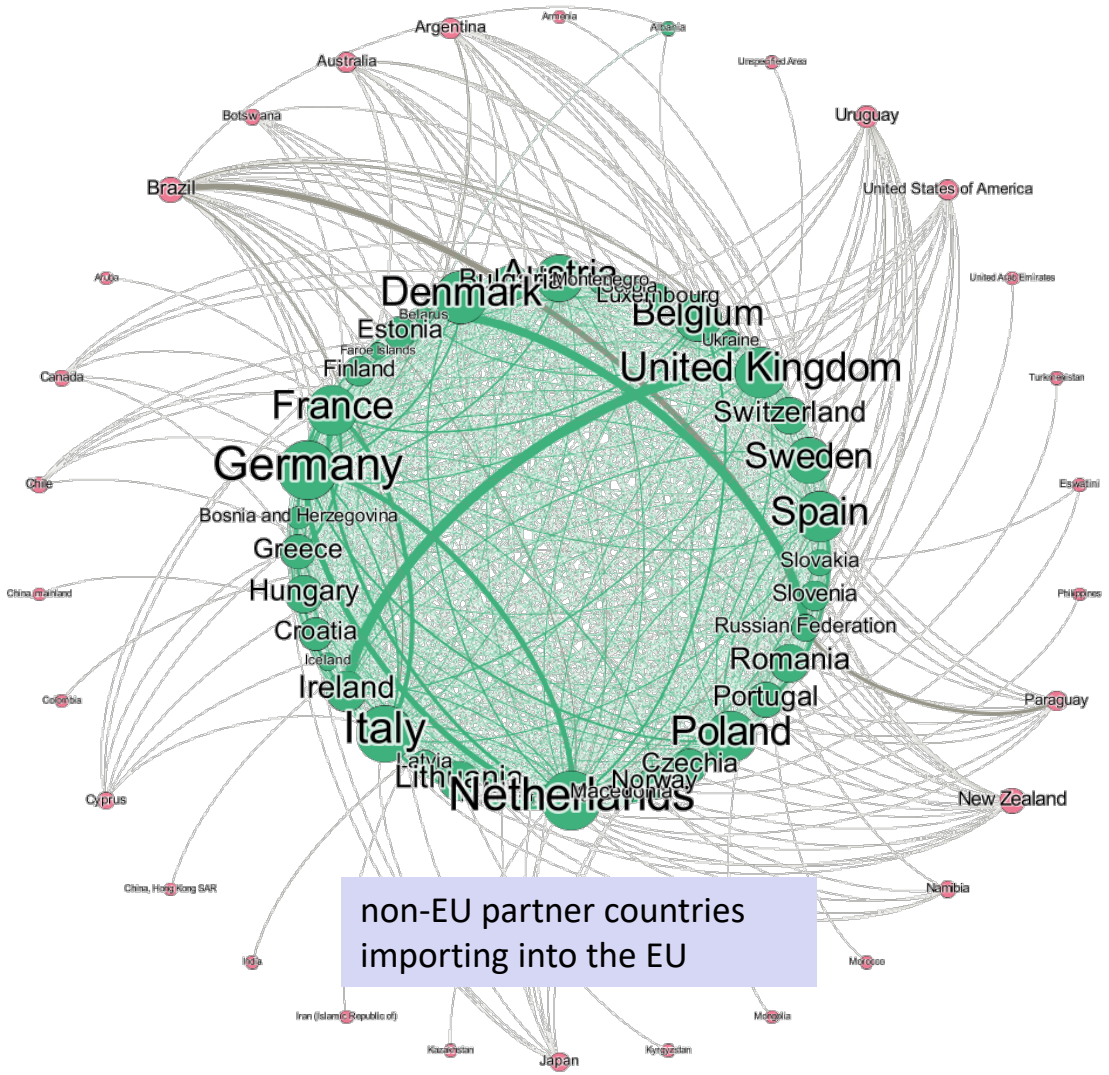


World Food Wastage. Image credit: Infographics by FAO



CIM Analysis on OECD data

International trade – food product (supply chain adjusted)



non-EU partner countries importing into the EU

Example focuses on Imports into the EU in 2016

- physical quantities of specific products imported for domestic consumption or processing shipped into a country.
- Includes re-imports

Network analysis of these data can help identify where most products of interest originate

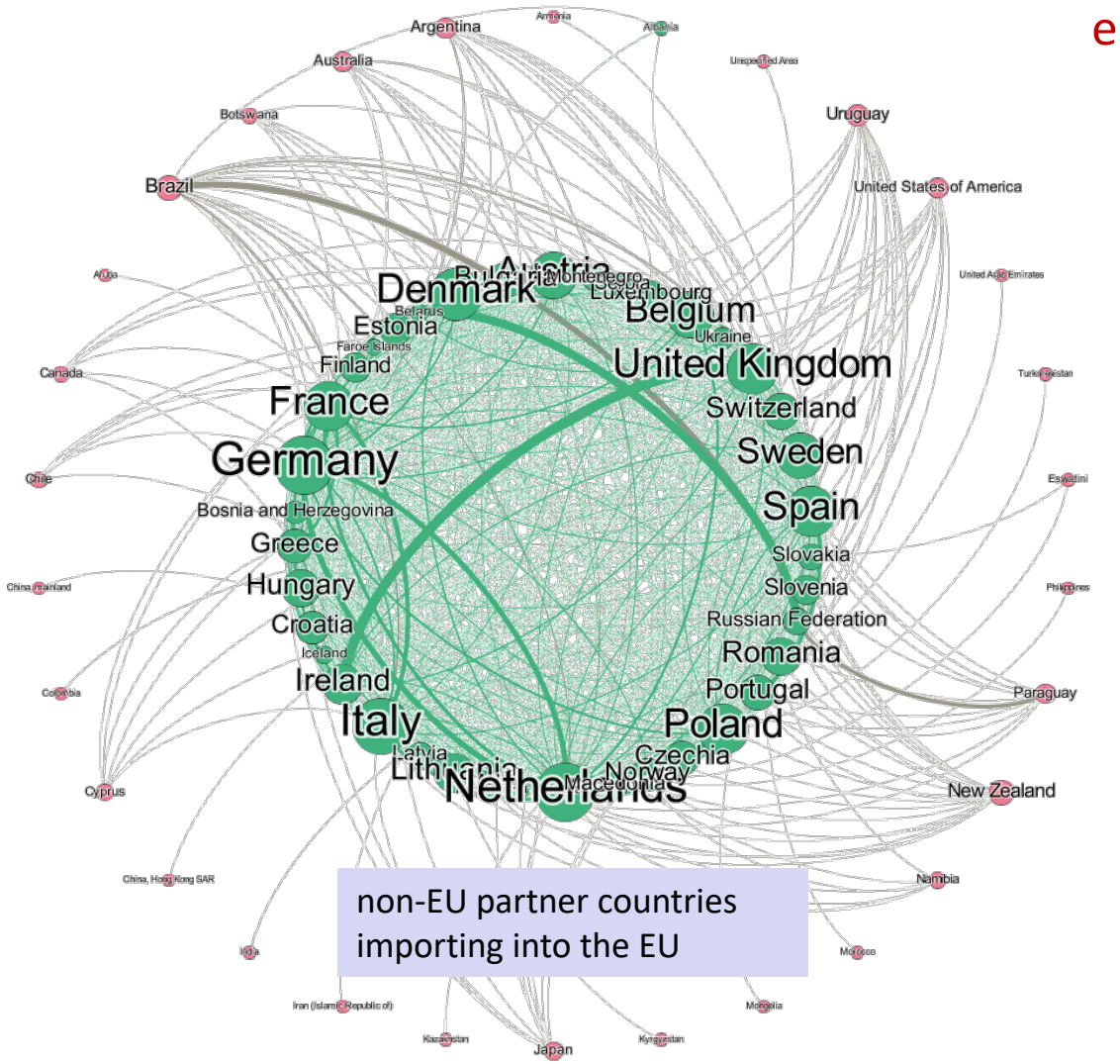
Emerging applications of inter-industry trade models:

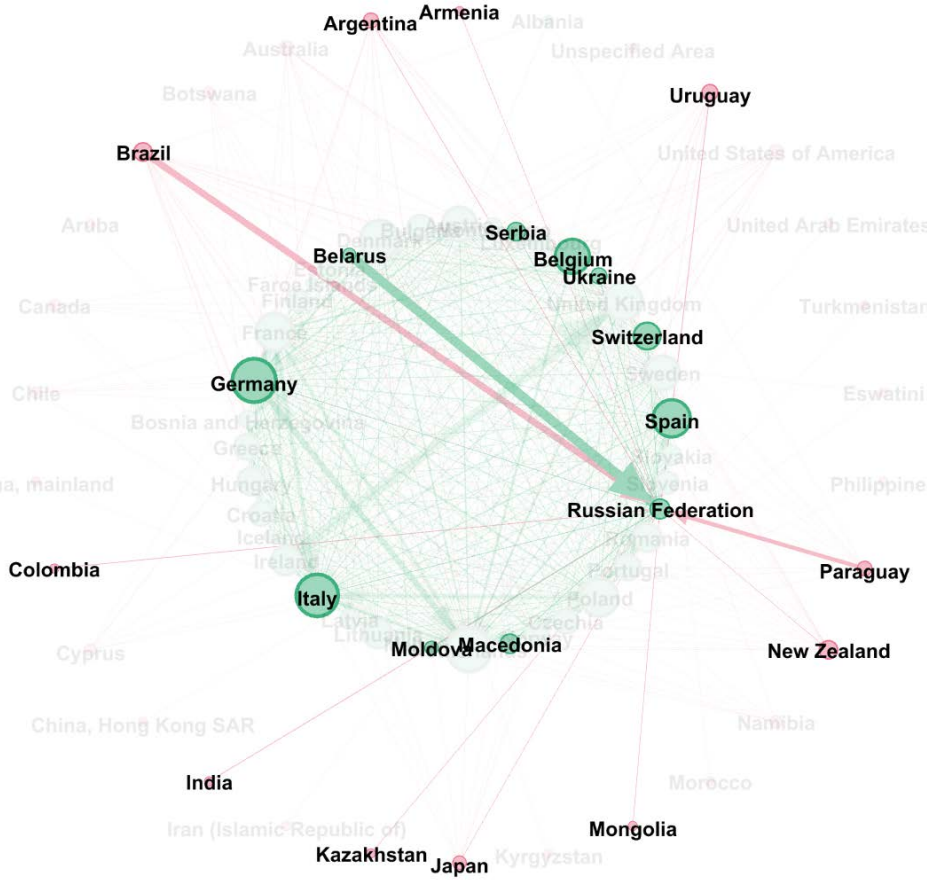
- Estimate natural resource use (e.g. water) through global trade (e.g. www.materialsflow.net)
- Evaluate the composition of foreign VA (e.g. 2018 World Investment Report, Ch I, section C.2)

Elaboration based on raw data from: www.fao.org/faostat/en/#data/TM

International trade – food product (supply chain adjusted)

e.g. No direct trade between Russian Federation and Poland





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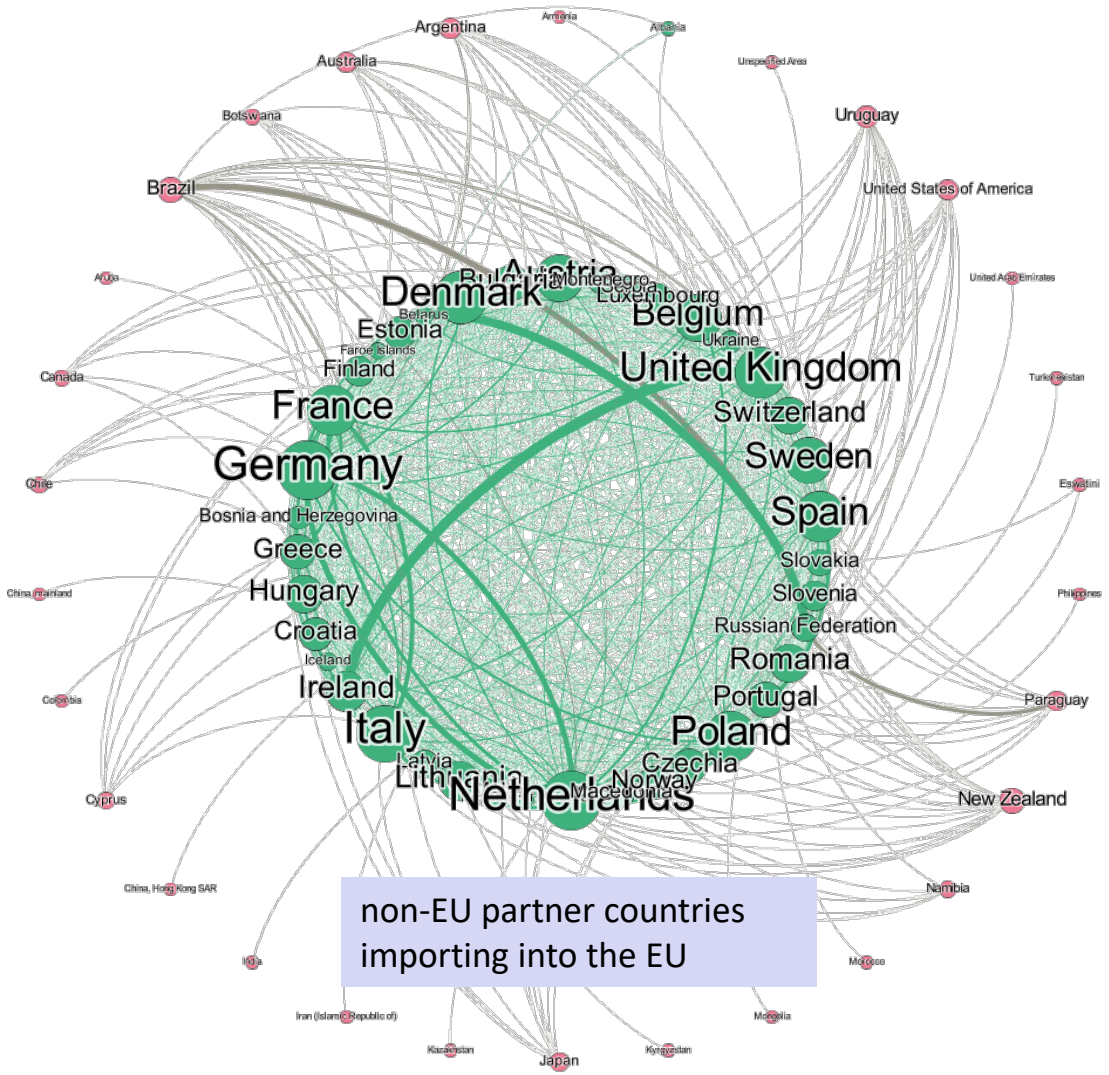
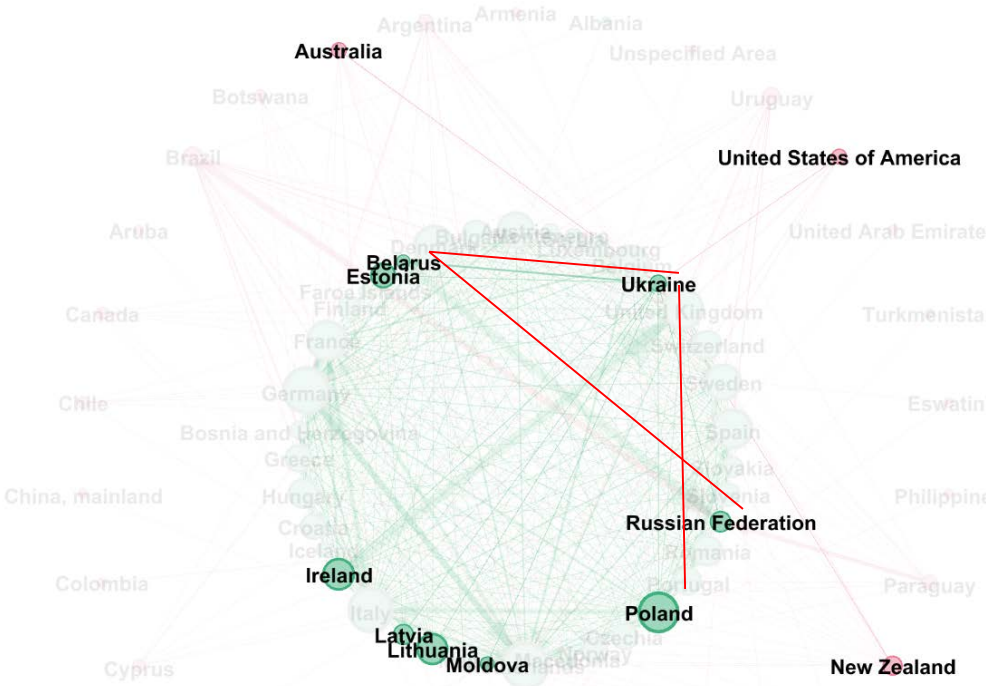


non-EU partner countries importing into the EU

e.g. BUT possible indirect trade pathways



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Concluding summary:

Evaluating the impact of digital technologies on future food supply chains

Developed markets: Rapid growth of e-Commerce

- Consumer benefits of convenience and speed but is this unchecked consumerism environmentally sustainable? ***Integrate a sustainable dimension!***
- Do digital platforms provide new opportunities to connect consumers with their local retailers and farmers offering personalisation, a more informed shopping basket and less waste? ***Are Digital platforms with consumer involvement and appropriate governance an answer?***

Developing markets: Sustainable economic development

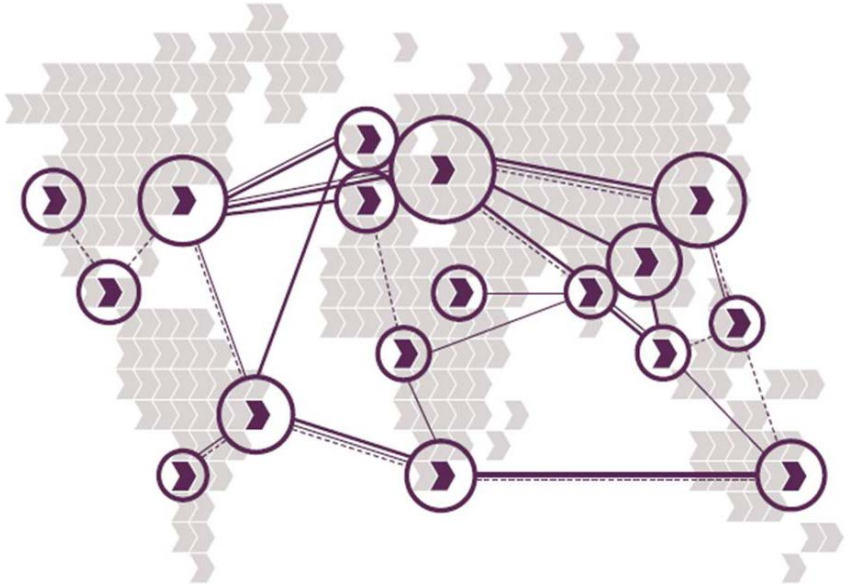
- Building attractive markets for farmers without compromising available resources; **Informed crop–land allocation**
- Technology solutions e.g. through precision agriculture ***Is more technology the solution?***

Understanding international flows to ensure authenticity and quality

- Complexity of international trade is challenging traceability and provenance **Can we use digital technologies to avoid fraudulent activity?**

Acknowledgements

Dr Ettore Settanni
Dr Naoum Tsolakis



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and Questions