Evaluating the impact of digital technologies on future food supply chains

Implications for developed and developing markets
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

PONY EXPRESS
St. JOSEPH, MISSOURI to CALIFORNIA
in 10 days or less.

WANTED
YOUNG, SKINNY, WIRY FELLOWS
not over eighteen. Must be expert riders, willing to risk death daily.
Orphans preferred. Wages $25 per week.

APPLY, PONY EXPRESS STABLES
St. JOSEPH, MISSOURI

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*

- **Cost per journey**
  - Assumes full van load and standard basket

- **Phase 1:** Current Cost/penetration
  - **Phase 2:** Target Cost/penetration
  - **Current cost** (low population density)
  - **Target Cost** (high population density)
  - **Shared platform**

- **Fixed costs**

- **Economic to serve**

**Cost per journey**
- **HIGH**
- **LOW**

**Uneconomic**

**% Market Penetration**

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

**e.g. Increasing market penetration scenarios**

[Graph showing cost per journey and market penetration]
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

Project 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

- 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

Structure: Flagship Projects and leads

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Includes a 2-way knowledge exchange partnership by growing research capacity to address food security issues
FP5 Deliverables

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

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

- 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

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<td>Modelling impact of sowing/transplanting techniques on water balance</td>
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<td>Sustainable societal change in the usage of natural resources (Hull)</td>
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Punjab – 2/3 of districts in water distress!

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

- 2/3 (14 out of 21) of districts: usage in excess of availability
- 105 of 138 ‘blocks’ across all districts ranked ‘overexploited’; 4 ranked critical

- 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

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

Example of multiple simulation runs: distance/water use plot
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
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)
International trade – food product (supply chain adjusted)

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


non-EU partner countries importing into the EU
International trade – food product (supply chain adjusted)

e.g. BUT possible indirect trade pathways


non-EU partner countries importing into the EU
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

and Questions