

Advancing value chains for agrofood,
forestry and environment with smart tech



Boosting innovative Digitech Value chains
for Agrofood, forestry and environment



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D.1.5 - Digitech Value Chain Inspiration Framework for Agro food, Forestry and Environment



Digitech Value Chain

The “Digitech Value Chain inspiration framework for Agrofood, Forestry and Environment” identify the main transnational challenges and the technological trend affecting the Agrofood, Forestry and Environment value chains. These challenges will set the boundaries for the presentation of potential ICT-based solutions that can have a positive effect on the sectors under assessment. This activity is linked within the results produced in Work Package 1: Emergence (Figure 1).

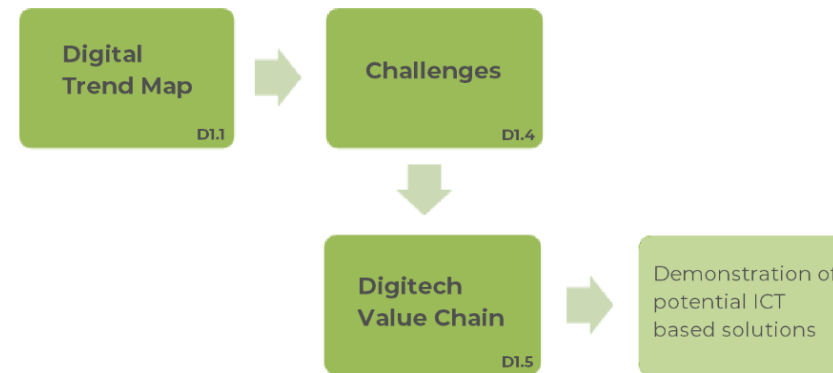


Figure 1 - Workflow WP1 Emergence

Digitech Value Chain

The “Digitech value chain inspiration framework” allows ICT SMEs to identify **agrofood market opportunities**.

The tool identifies the innovations that can be explored by the **combination of technologies within the different stages of the value chain of the agrofood, forestry and environment sector**.

In other words, the tool is an inspiration framework that gives insights to map where the investment in innovation should be implemented, in the various value chain processes, in order to meet the future challenges of the sector.

Digitech Value Chain

Value chain:



Source: FAO (2013); Best (2014); Sims, Flammini, Puri and Bracco (2015)







Technologies:



DATA ANALYTICS AND BIG DATA:

Data analytics is a combination of different methods that are meant to create new information and models from collected data. Data analytics together with both data processing and visualization has been a rapidly growing trend as it allows companies and their employees to conduct solutions that create a competitive edge from their data sources without a need of any significant coding skills or vast resources.



					
Smart Farming <ul style="list-style-type: none"> – Biomass development data – Data on fertilization status of crops – Sophisticated farm management (water, fertilizer and medications inputs data) – Weather forecasts, yield projections, and probability maps for diseases will reduce risks. 	Digital Twins <ul style="list-style-type: none"> – A digital model of the production facility or product is called a "digital twin" – Speeds up root cause investigations, optimizes processes, and more. 	Smart Labels <ul style="list-style-type: none"> – Smart labels, such as QR codes on packaging communicate information – Genetically Engineered ingredients <ul style="list-style-type: none"> – fair trade 	Social media and Track&Trace <ul style="list-style-type: none"> – Social media big data allows the an analysis of consumer confidence – Collected data allow for real-time tracking, real-time monitoring, and predictions when products leave the warehouse. 	Demand anticipation <ul style="list-style-type: none"> – A forecast is crucial to deal with volatile demand patterns (short life cycle products and perishable) – Additional data and improved predictive models allow rapid and dynamic responses. 	Resource efficient consumption <ul style="list-style-type: none"> – Display of food's environmental impact, product origin, characteristics, nutritional value, through apps or labels, give the consumer an extra variable to make purchasing decisions. – Resource-efficient consumption is crucial for the sustainability of the sector.









Adoption Considerations: The data sources are diverse and pre-processing must be done in order to have the data in the right format depending on the tasks under study. This is connected with standardization and novel interoperability mechanisms for sharing data from multi-sources.

Blockchain takes in Big Data is more secure, as the data can not be forged or falsified. In the agriculture domain, smart contracts together with automated payments; agricultural insurance, green bonds, and traceability could be the game-changer.

ROBOTICS:

The recent focus of the agri-robotics community has been to identify applications where the automation of repetitive tasks is more efficient or effective than a traditional human or large machine approach. One advantage of modern robotics is their ability to be built using low-cost, lightweight and smart components. Due to their prevalence in consumer electronics, such as mobile phones, gaming consoles and mobile computing, high quality cameras and embedded processors can be built in to many platforms at very low cost.



					
From Milk Robots to automated harvesting <ul style="list-style-type: none"> – Milk Robots are widely adopted – Unmanned tractors – Fruit and vegetable harvesting robots – Satellites and drones provide remote sensing for mapping and monitoring. – Crop spraying drones function autonomously at a fraction of the cost 	Additive manufacturing <ul style="list-style-type: none"> – 3D printing has been limited to inorganic ingredients – Opportunities for mass customization. 	Cobotics <ul style="list-style-type: none"> – Human-robot collaboration (Cobotics) – Automation of intra-logistics, from in-field transportation to packhouse to warehouse operations – Sensing and image interpretation for analysis and manipulation of complex food products. 	SideWalk Robots <p>To deal with last-mile logistics in urban environment, "Sidewalk delivery robots", are already employed to deliver in some cities</p>	Automated fulfillment centers <p>E-grocery is transformed by automating fulfillment centers that reduce prices and waiting times.</p>	3D Printers in the kitchen & Domotics <p>Some entrepreneurs are working on bypassing the manufacturing process by bringing the 3D printer to the kitchen.</p>









Adoption Considerations: A robot can use 90% less herbicide, making it 30% cheaper than traditional treatments. A fleet of these robots could easily replace human farm labor down the road. Fruit picking robots, driverless tractor/sprayers, and sheep shearing robots are designed to replace human labor. Robots can be used for other horticultural tasks such as pruning, weeding, spraying and monitoring. As well as in livestock applications such as automatic milking, washing and castrating. They can also be used to automate manual tasks, such as weed or bracken spraying, where the use of tractors and other manned vehicles is too dangerous for the operators. Automated Guided Vehicles can increase the precision of agricultural operations. For example, autonomous tractors with intelligent agricultural tools, can reduce soil compaction and reduce the overdosage of nitrogen and herbicides.

SENSORS

The sensor technology evolution is generating cheaper sensors for several relevant agronomic parameters. These sensor attached to IoT solutions, Robots, agricultural machinery will feed advanced Farm Management Intelligent Systems with relevant data to obtain accurate prescriptions maps, which will allow a more ecofriendly and precision agriculture/forestry.



					
Robotics Integration <ul style="list-style-type: none"> - The integration of sensor systems within autonomous robotic systems offers the significant potential for new measurements that would otherwise be unobtainable - Embedded sensors on equipment (tractor, UAV, ULM or plane) 	'Plug-n-play' <ul style="list-style-type: none"> - Plug and Play applications are available, with improved and cheaper sensor technologies also being used for data collection - Sensors for food safety detection, quality monitoring, process default monitoring. 	Sense and Sort <ul style="list-style-type: none"> - Sensor technologies available to address government regulation concerns, product quality and the traditional weight and size factors - Sensor systems can sense and sort fruits (dried or fresh), nuts, vegetables and processed food (fresh, dried or frozen) 	Food 4.0 <ul style="list-style-type: none"> - Potential for the increased use of sensors, software and automation - Development of more sustainable food supply chains from <i>farm-to-factory-to-fork</i> - use of sensors and modeling to better understand where and why food waste occurs - use of wireless sensors in refrigerated vehicles 	Dynamic pricing & storage monitoring <ul style="list-style-type: none"> - Through sensors and electronic food labels prices can decrease as the sell-by date is approaching - Opportunities for dynamic pricing. 	More information <ul style="list-style-type: none"> - Retailers could use sensors to gain information on paths customers take through the store, what shelves or ads they linger at and when they prefer to be in a specific area - shopping experience and shopper preferences









Adoption Considerations: The sensor technology evolution is generating cheaper sensors for several relevant agronomic parameters, such as NPK quantification, soil moisture, soil temperature, rainfall, wind, sunlight, chlorophyll concentration Index, leaf wetness, air temperature, etc.; which allows better decisions with an expected impact on the efficient use of the resources.

IoT Internet of Things

Interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications. This is achieved by seamless large-scale sensing, data analytics and information representation using cutting edge ubiquitous sensing and cloud computing

Gubbi, Buyya, Marusic and Palaniswami (2013)



					
Internet of (Living) Things <ul style="list-style-type: none"> - The IoT will collect data on humidity, temperature, soil moisture, among others - Cattle can be tracked by wearable sensors forming the Internet of Living Things (IoLT), or by 3D cameras measuring individual animal behavior and weight. 	Optimization <ul style="list-style-type: none"> - An IoT network throughout processing and manufacturing environments optimizes maintenance, quality and minimizes waste. 	Smart Packaging <ul style="list-style-type: none"> Active packaging changes its condition to extend shelf life or improve the condition of the food <ul style="list-style-type: none"> - Intelligent packaging communicates based on its ability to detect, sense and record changes. 	Crowdsourcing & Transport <ul style="list-style-type: none"> - IoT within logistics can measure the temperature conditions on a product level, instead of ambient conditions on a pallet level <ul style="list-style-type: none"> - Ability to make adjustments in real-time, food waste is minimized and food quality improved. 	Proximity campaigns <ul style="list-style-type: none"> - Smartphones in combination with electronic beacons provide new information to retail stores - These beacons spread throughout the store allow proximity marketing and customer behavior analysis. 	Reviews and Likes <ul style="list-style-type: none"> - Aggregation of customer experiences in shared advisory websites - Customer decision support (pre- and after-sales)









Adoption Considerations: IoT will play an essential role on intelligent and precision agriculture/forestry, namely to collect data more accurately and allow a precision control on the field, to reduce water and energy costs and improve operations efficiency. IoT can innovate and interconnect irrigation systems, crop data collection, climate conditions monitoring, greenhouse automation, Crop management, Cattle monitoring and management, operations monitoring and control, transport management systems and end-to-end farm management systems. IoT depends on Lora, Sigfox, Wifi, 4G, 5G networks and, as other solutions, their implementation still suffers from traditional challenges such as a lack of or poor infrastructure, failures of interoperability, and other technological issues.

DECISION SUPPORT SYSTEMS

Systems thought and designed to provide support to decision-makers, giving them access to a wide range of data and facilitating the use of procedures, operations, and models in an easy and flexible way; allowing managers to virtually change parameters and observe the implications in the final results.

Branco, Gonçalves, Martins and Cota (2015)



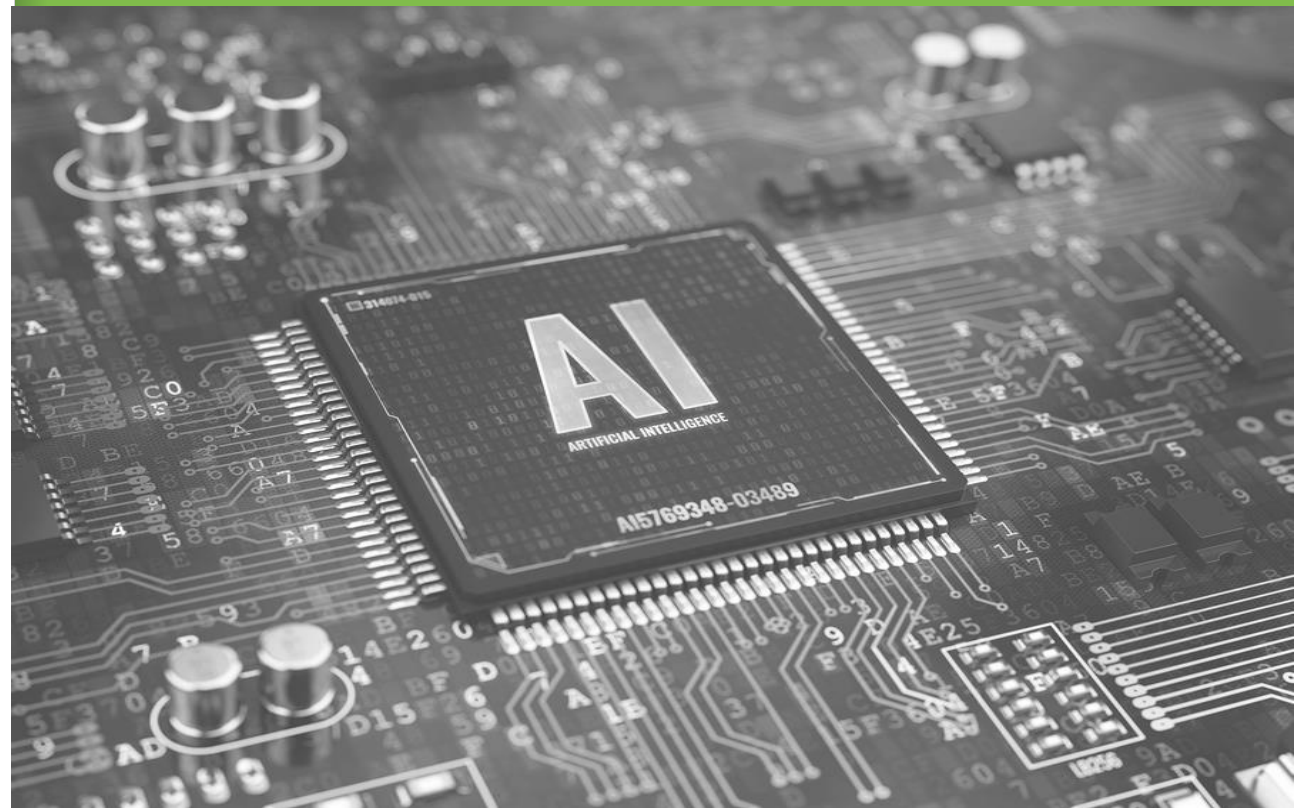
					
Farm support <ul style="list-style-type: none"> - N-fertilisation in annual crops and irrigation scheduling are the more relevant activities in agriculture - Help farmers for farm-specific agro-expert decisions to increase the crop yield 	Predictive Maintenance <ul style="list-style-type: none"> - Analysis of what has happened in the past on the farm, as well as what currently is happening and is going to happen - Post-harvest management - Information on opportunities for profit in down commodity prices 	Real-time data <ul style="list-style-type: none"> - Intelligent analysis and reporting of exchanged data to enable early warning and advanced forecasting: real-time virtualization; logistics connectivity and logistics intelligence - Smart refrigeration 	Inventory map <ul style="list-style-type: none"> - Real-time insights and visibility into inventory even along the supply lines, along with delivery route optimizations 	Workforce efficiency <ul style="list-style-type: none"> - Real-time shop-floor data helps in better collaboration and synergy between departments; thereby greatly improving workforce efficiency. 	Personalised nutrition <ul style="list-style-type: none"> - Nutrition monitoring and personalised advice by using smartphones - connected sensors, wearables like smartwatches, equipment at home (e.g. refrigerators, weighing machines) and outdoor equipment (e.g. in canteens, restaurants, supermarkets, fitness clubs)



Adoption Considerations: DSS should provide valuable information to support decision-making concerning the management of the resources available such as water, machinery, workers. The plans and schedules for performing operations along the value chain are often displayed in the form of user-friendly interfaces. Dashboards and other monitoring features enable remote follow-up of operations execution when integrated with IoT. DSS implies the design and implementation of information systems that can integrate machine learning, predictive analytics, big data and optimization approaches as back-office tools.

ARTIFICIAL INTELLIGENCE (AI) & MACHINE LEARNING (ML)

Artificial Intelligence (AI) is a field of computer science that deals with intelligent machines. Machine learning and deep learning are two of the most commonly used algorithms in the field of AI. These models learn from data and are used to make predictions. The objective is to come up with the most suitable solution to any problem. Today, machine learning models are being developed to deal with the complexity and variety of data in the food industry.



					
Farmer's Virtual Assistant Farmers can use AI to determine: <ul style="list-style-type: none"> - the optimal date to sow crops, - precisely allocate resources such as water and fertilizer, - identify crop diseases for swifter treatment, and detect and destroy weeds - integrating informal and qualitative data (temporal series, practices, neighborhood information) 	Forecasting <ul style="list-style-type: none"> - Forecast the year ahead by using historical production data, long-term weather forecasts, genetically modified seed information, and commodity pricing predictions, among other inputs - More accurate forecasting to managing pricing and inventory 	Packaging – more & less <ul style="list-style-type: none"> - The packaging is less important for attracting new buyers - But at the same time, shoppers still want a good packaging experience with products - for themselves and for any photos they might post on social media. 	Optimize Supply chain for food delivery <ul style="list-style-type: none"> - Virtual Assistants and Chatbox to respond to inquiries - Cargo Sensors, AI systems can be used to detect risks in trade shipping lanes due to weather conditions 	Virtual Retail Showroom System <ul style="list-style-type: none"> - Virtual walk through a representative merchandised store and pick items for checkout 	Consumer AI <ul style="list-style-type: none"> - Machine learning and predictive algorithms to model consumer flavor preferences - Predict how well they will respond to new tastes



Adoption Considerations: ML can be used in many tasks related to agriculture since data can be collected. These data can be images, data from sensors, data obtained from soil analysis, from meteorological stations, from productivity cards, measures collected in plant breeding projects, among others. These data can be used to generate production predictions or potential hydric predictions, to detect plagues, to recommend treatments given the place and the time, among several other tasks.







Digital Marketplaces and Platforms

Digital Marketplaces and Platforms are flourishing today thanks to the advances made in Artificial Intelligence, machine learning, real-time personalization and the scale and speed of the latest generation of cloud platforms. Today's digital marketplaces are capitalizing on these technologies to create trusted, virtual trading platforms.

Marketplaces have become platforms [that enhance] product and service models and experiences between what sellers offer and what buyers demand.

[Forbes](#) and [Diginomica](#)



					
Agri-Platforms As more producers come in reach of online marketplaces, farmers have the opportunity to save significantly on inputs.	Cooperative platforms Cooperative working methods are increasingly digital. Using platforms to share data, to meet digitally and to co-create through ideation platforms.	End-to-end real-time platform - End-to-end real-time supply chain management software for centralized inventory management e supplier and site performance monitoring.	Aggregators The outsourcing of delivery to aggregator platforms has become very accessible by reduced capacity problems and minimized uncertainty.	E-Commerce Market access for smallholders through E-commerce is a revolutionary change, removing middleman and information asymmetry	Sharing initiatives - Platforms are contributing to sustainable consumption patterns by minimizing waste and enhancing social connections - Consumers participate in agriculture, community gardens or consumer-to-consumer meal sharing.



Challenges: Apart from providing market prices to users, ability to post bids and offers, e-marketplaces systems consist of a matchmaking feature to match user's bids and offers for commodities. Providing such information to users contributes to improved negotiation power (e.g., farmers' increase their power to negotiate with intermediaries, based on their ability to understand pricing in multiple markets); sophisticated marketing plans based on price information; access to better and variety markets; reduced logistics and transportation costs.

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FAO, 2013. *Climate smart agriculture – Sourcebook*, Food and Agriculture Organization of the United Nations

Sims, R., Flammini, M., Puri, M., Bracco, S., (2015). *Opportunities for agri-food chains to become energy-smart. Food and Agriculture Organization of the United Nations (FAO) and POWERING AGRICULTURE: An Energy Grand Challenge for Development (PAEGC).*

Links:

<https://diginomica.com/are-digital-marketplaces-the-future-of-retail>

<https://www.forbes.com/sites/louiscolumnbus/2018/10/21/predicting-the-future-of-digital-marketplaces/#5846370f1d0e>