VALUMICS
Food Systems Dynamics

H2020 VALUMICS Project

# Food System Analysis: VALUMICS Case Studies and Common Challenges

**Research Findings Brief**
**August 2021**

## VALUMICS co-creation workshops

***This brief summarises findings from the VALUMICS food system thinking workshops. The objective was to; (1) create a conceptual model for a generic food system; (2) explore common challenges of food systems; and (3) select case studies for the further analysis to provide understanding of the factors influencing, sustainability, fairness, integrity and resilience of the food system***

## Selected case studies

***Wheat to bread***
***Beef cattle to steak***
***Dairy cows to milk***
***Salmon to fillets***
***Tomatoes to processed tomatoes***

## Food system analysis

A food system thinking approach was applied in co-creation workshops during the first phase of the VALUMICS project in 2017- 2018, with the objective to build a conceptual modelling framework for generic food value chains and systems. The VALUMICS project´s aim is to gain an understanding of the dynamics of food supply- and value chain systems using structural analysis, including system analysis and system dynamics and various analysis tools.
The following definitions for food value chains, food systems and sustainable food value chains have been adopted in VALUMICS:

- Food value chain is comprised of the stages of the path of the food products starting with inputs, primary production, manufacturing /processing, distribution including logistics and transportation, wholesale, and retail sectors until consumers. The viewpoint of economic value addition is emphasised.
- Food system encompasses the food value chains/networks and in addition, waste management and all the supporting and interacting activities such as administration and policies (governance), education and research, financing activities etc.
- Sustainable Food Value Chain has been defined as *"the full range of farms and firms and their successive coordinated value-adding activities that produce particular raw agricultural materials and transform them into particular products that are sold to final consumers and disposed of after use, in a manner that is profitable throughout, has broad-based benefits for society and does not permanently deplete natural resources".* (FAO 2014)[1]

## Prioritisation of VALUMICS case studies

The prioritised food system case studies encompass different food value chains at different levels; i) national, ii) European and iii) global and including animal production systems (beef and dairy, farmed salmon), plant crops targeting both food and feed inputs for the animal production systems (wheat), and wider selection of food product chains e.g. tomatoes as a vegetable source. The final selection of case studies considered existing data availability and partners' expertise based on e.g. participation in different European projects and considering the possibility of involving stakeholders and the potential to support the goals of the VALUMICS project to explore fairness, resilience, sustainability and integrity of food supply chains and systems was considered.
The VALUMICS value chain case studies and the countries where analysis and assessments are performed are the following:

1. *Wheat to bread* (Czech, Germany, France, UK)
2. *Beef cattle to steak* (UK, Germany)
3. *Dairy cows to milk* (Ireland, UK, France, Germany and Vietnam)
4. *Salmon to fillets (*Norway and export to EU*)*
5. *Tomatoes to processed tomatoes (*Italy*)*

[1] FAO (2014). Developing sustainable food value chains – Guiding principles. Rome, http://www.fao.org/3/a-i3953e.pdf

## The food system structure and material flow

***The integration of flow charts of the selected case studies revealed similarities in supply chain structures, with the input and output stocks of food raw material and products flowing through the similar stages of production, harvesting, processing, distribution, consumption and the food system waste.***

## Sustainability

***The VALUMICS analysis of food value chains, stakeholder insights and consumer behaviour studies provide policy makers and food industry actors with a range of evidence-based approaches and recommendations to drive more sustainable food production, purchasing and consumption behaviours***

## Fairness

***VALUMICS qualitative work on policy and governance provides bases for evaluating issues related to unfair trading practices e.g. power imbalances in food chains and stakeholders´ perception on fairness.***

The selected food value chain case studies serve as enablers of the overall knowledge building and development work and provide the scope of scenarios to explore the functioning of food value chains and systems using various analysis tools and modelling. The system analysis is presented in VALUMICS via sets of flow diagrams for the case studies, and when integrated the similarities in their structure becomes evident as shown in Figure 1.

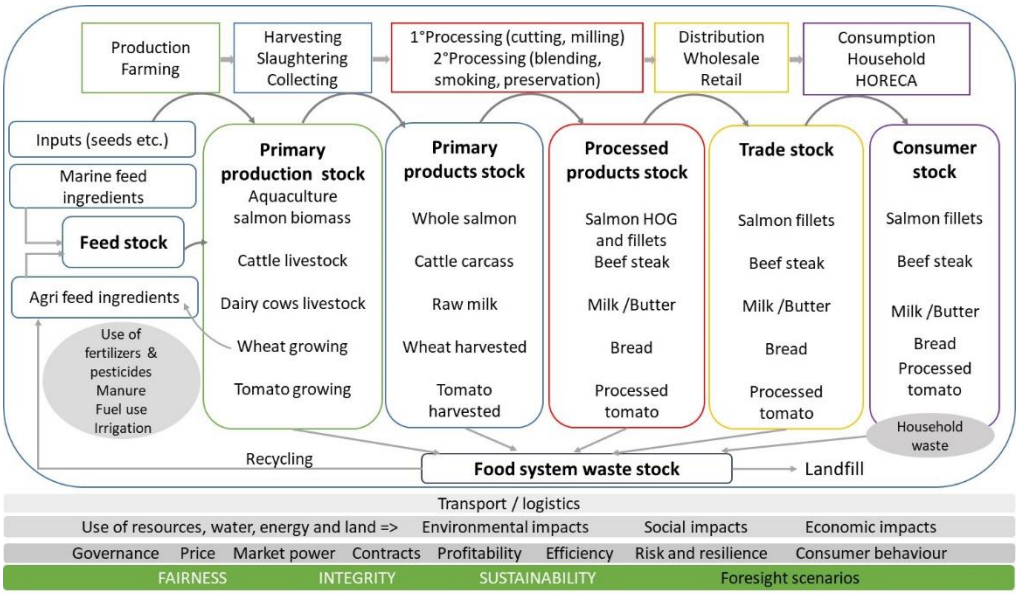


*Figure 1 An overview flowchart of the food supply chains selected as case studies in the VALUMICS project and the topics of analyses performed are highlighted in the horisontal lines at the bottom*

# Sustainability, Fairness, Integrity and Resilience and the VALUMICS case studies

The selected case studies are relevant to better understand the functioning of the food system and the main challenges that need to be addressed to improve sustainability, integrity, resilience and fairness of European food chains.

***Sustainability***: The food system is responsible for environmental impacts including climate change, biodiversity loss, use of water and waste generation. The VALUMICS analyses include assessment of environmental and social dimension of food chains by life cycle assessment and the influence of transportation and logistics of selected food chains. Considering the socio-economic impacts, the profitability and competitiveness of the enterprises constituting food value chains are also key elements to ensure employment and livelihoods. Structural changes through mergers and acquisitions are common trends in food value chains at all stages, although most prominent in food processing and retail, and these influence bargaining position of upstream actors. Therefore, VALUMICS research focus is on analysis of governance and food chain organisations, market power, price formation and price transmission, persistence of supply chain relations, assessment of economies of scale and technical innovations, and finally statistical analysis of agribusiness profitability. Moreover, the insights on stakeholder perceptions and consumer behaviour provides understanding of the dynamics of the functioning of food supply chains and systems.

***Fairness***: Food value chains are characterised by industrial food manufacturing segments dominated by large corporations, often international ones, that are deemed to put a pressure on farmers. For example, milk producers, have been hit by a continuous decrease in milk prices at farm gate and an increase price volatility. The issue of unfair trading practices and trade contracts is thus a key topic in milk / dairy chains as well as other food chains.

The market power of the retailers has been increasing and in many countries the specification for e.g., meat cutting and packing are managed and driven by the retailers. This affects selection of breeds, animal welfare and other rearing parameters stipulated within increasingly integrated supply chains involving specialised large processors and packers. In Germany, France and UK the top five beef/veal companies in these countries have more than 50% market share. This impacts on competitiveness of different actors along the value chain and issues of unfair trading practices may arise. The work in VALUMICS pays special attention to fairness in the case

study work, while acknowledging the proposal of the Council of the EU for fairer relations in the agro-food sector between small farmers and processors, and their larger trading partners[2], which has now been adopted as EU Directive on Unfair Trading Practices[3]. Furthermore, the focus of the VALUMICS modelling work is on simulations to assess fairness in terms of fair value distribution among actors in the food value chains.

## Integrity

***Labels and authenticity of food is directly linked to transparency of data which VALUMICS depends on for empirical analysis.***
***The transparency of market data for FVC in the EU is still not ensured for consumers and further work is needed to align different sectors´ data management policies, to facilitate research and informed choices of safe and sustainable foods.***

***Integrity***: An important part of the integrity of food value chains is food authenticity which has become a key issue in relation to food fraud and responsibility, and consequently the enforcement of EU food standards and labelling regulations. Until recent years, drinking milk for example, was mainly considered as an undifferentiated product and the issue of authenticity was not so important. The increased level of competition has led to various attempts to segment the final markets through labels (free GMO milk in Germany, grass-fed milk in France and the Netherlands). However, there is complexity in labelling as evidenced for example in the commercial connections in the tomato value chain e.g., start global, go local and become global again. Companies can use foreign tomatoes and tomato by-products, process them in Italy, and then resell in other intra-European and extra-European countries. Tomato products must be labelled to communicate the origin of production site, or if different, of the packaging site. This is aimed at giving to the agro-food companies a competitive advantage and providing a more efficient protection of consumer health.

Another aspect of food integrity is the availability of data for empirical analysis. In this respect transparency of food market data and information availability continues to be seen as competition issue by the FVC actors. The reluctance to make data accessible has impacted the research in VALUMICS. Example is the higher level of transparency in the Norwegian salmon case study compared to agricultural case studies which has resulted in a number of studies in VALUMICS being focused on salmon food value chain. The EU Transparency and sustainability of the EU risk assessment in the food chain regulation[4] that came into force in March 2021 covers the reliability, objectivity and independence of studies used by European food Safety Authority (EFSA). However, the transparency of market data for FVC is not ensured for the consumers and further work is needed to align different sectors data management policies to facilitate research and informed choices of safe, sustainable foods taking all aspects into consideration for understanding the dynamics of the food system.

## Resilience

***VALUMICS work includes the development of a framework for risk and resilience in food value chains and applies the global salmon value chain as a case study to develop a hybrid simulation model***

***Resilience:*** The increase in the globalization of food value chains and interconnectedness among supply chain partners have led to higher dependency and increased complexity of relations between the firms in the supply chain. Firms have in recent years been focused on generating high levels of efficiency through lean operations during stable business conditions, but at the same time they have become highly vulnerable to disruption risks. VALUMICS has adapted the definition of resilience considering food supply chain system: "*Capacity over time of a food system and its units at multiple levels to provide sufficient, appropriate and accessible food to all, in the face of various and even unforeseen disturbances*''[5].
Disruptions often derive from upstream suppliers due to production problems, that may be caused by natural disasters, quality defects, or financial reasons which influence downstream partners and trade. While not foreseen at the outset of the VALUMICS project, the COVID-19 pandemic has significantly disrupted food supply chains, for example the raw material shortage due to plant closures or shortage of workers; transportation disruption impacted firms who are dependent on airfreight capacity in passenger aircraft, with a knock-on impact on the price and availability of commercial cargo plane capacity. Shift in consumer demand due to lockdown of HoReCa has resulted in more demand at the retailers, for food being consumed at home. In addition, the reduction in consumer disposable income may lead to purchasing of cheaper items, such as cheaper cuts of meat as well as more demand of frozen or canned products with longer shelf life etc. VALUMICS work on risk and resilience aims at enabling value chain actors to develop appropriate resilience strategies by utilising a simulation model for process optimisation.

[2] Press Release 538/18, 01/10/2018. Better protection for farmers against unfair trading practices: Council agrees its negotiating position. Visited on Internet 16/10/2018; https://www.consilium.europa.eu/en/press/press-releases/2018/10/01/better-protection-for-farmers-against-unfair-trading-practices-council-agrees-its-negotiating-position/
[3] On 17 April 2019, Directive (EU) 2019/633 on unfair trading practices in business-to-business relationships in the agricultural and food supply chain was adopted
[4] Transparency and sustainability of the EU risk assessment in the food chain, European Commission
[5] Tendall, D.M., Joerin, J., Kopainsky, B., Edwards, P., Shreck, A., Le, Q.B., Krütli, P., Grant, M. and Six, J., 2015. Food system resilience: defining the concept. Global Food Security, 6, pp.17-23. https://doi.org/10.1016/j.gfs.2015.08.001

# VALUMICS Case studies: Characteristics and scope

## WHEAT TO BREAD

### Wheat production in Europe

***Wheat accounts for about 50 % of total cereal production in Europe. The main wheat producers are France, Germany, UK and Poland***

### Competition

***The value chain is highly industrialised and characterised by high competition***

### Challenges

***The volume and quality of production is significantly influenced by weather conditions/climate changes***

### Wheat to bread

***The countries targeted for analysis are the Czech Republic, Germany, France and UK.***

**Characteristic of the value/supply chain:**

- ✓ Wheat dominates the cereal production in EU. Moreover, world wheat production creates over one third of world cereal production.
- ✓ Primary production: has a form of intensive farming.
- ✓ Milling industry: The production process is characterised by transformation of large volumes to reach economies of scale (i.e. saving in costs gained by higher quantity of production) and profitability (typically, small margin business). Moreover, the flour millers sell most of their flours B2B to downstream manufactures[6]. The production has typically high efficiency and productivity.
- ✓ Bakery and delivery system: is highly industrialized. The market is characterized by high competition and product innovations.
- ✓ Supply chain: is demand driven. That is, the demands of the bakers shape the varieties of wheat grown for the chain by the farmers to meet the end product specifications i.e. higher protein content in the harvested wheat grain (Smith and Barling, 2014) [7]. Moreover, there are strong links between the industrial baking sector and the agriculture and milling industries with many of the large bakers being owned by key agricultural or milling concerns.[8]

**Challenges**

- ✓ Cereals represent major part of the crop production with the largest share on arable land and consequently associated with various environmental challenges
- ✓ The production is characterized by high production and market risks coming from unpredictable weather conditions/climate changes and considerable market volatility.
- ✓ CAP plays important role in securing stable supply of wheat and in preventing crisis situations.
- ✓ Stagnating yields on one side and increasing population on other side ask for efficiency and productivity improvements.
- ✓ First-generation agri-ethanol generates new competition for land between energy and food suppliers.

**Case Study Specification**

The case study will focus on wheat to bread value/supply chain, from wheat production to bread consumption. The research work is on material flows and governance analysis, economic studies on food chain organisations, market power, price formation and price transmission, persistency of supply chain relations, assessment of economies of scale and, technical innovations and furthermore statistical analysis of agribusiness profitability. A special focus in France is on future scenarios and transition pathways.

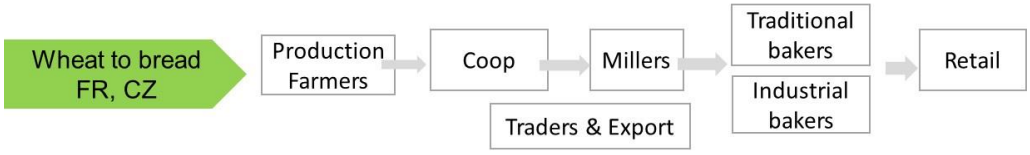


*Figure 2 Key actors in the wheat to bread chain*

[6] European flour millers (2018)

[7] Smith J and Barling D (2014) Glamur project UK wheat to bread supply chain case study. City University London http://glamur.eu/wp-content/uploads/2015/04/glamur-wp3-uk-bread-3-cases.pdf (Accessed 28 October 2018)

[8] https://www.fob.uk.com/about-the-bread-industry/industry-facts/european-bread-market/ (Accessed 23 October 2018)

# DAIRY COWS TO MILK (AND BUTTER)

## Production

***Dairy sector in Europe produces approximately 150 million tons of raw milk, out of which nearly 15 % is exported under different forms (depending on the year considered)***

## Challenges

***Policy interventions /end of quota system 2015***

***Volatile prices - influenced by world market (milk powder and butter)***

***Competition across Europe – lower production cost – environmental challenges***

## Dairy cows to milk

***The dairy cow to fresh milk and butter chains are relevant to reflect on the main issues that need to be addressed to improve the integrity, sustainability and fairness of European food chains***

***The countries to be studied for the fresh milk product value chain are France, Germany, UK, Ireland and complementary analysis in Vietnam***

### Characteristic of the value chain

The dairy chain illustrates the complexity of European food chains and allows to address connections and interdependences between scales and chains. The dairy value chain is part of a structuring sub-sector of the European agri-food sector, with a total production of raw milk amounting to 150 million tons, out of which nearly 15 % is exported under different forms (depending on the year considered).

The sector has a variety of systems and chains at different levels, e.g. (1) at local / national scale, grazing vs confinement systems (Germany vs. Ireland/UK or Intensive *vs* extensive systems in French Britany); (2) short vs. long supply chains (e.g. local production and consumption *vs* local production and international consumption or raw milk to processed dairy ingredient to processed consumer food).

From the raw milk 97% of all milk produced in the EU is produced by cattle, and 92% of the milk produced is delivered to dairies. Foreign trade in raw milk is of negligible magnitude. About 20% of the raw milk is processed into fresh drinking milk and an additional 10% into other fresh milk products. The remaining 70% are processed into manufactured dairy commodities (cheese, milk powder, butter, and whey as by product) which are traded globally.

### Challenges

- ✓ The dairy sector has been highly regulated over years through a quota system, whose termination at the end of the year 2015 has had important impacts on the organization of the whole chain. More generally, the milk chain has been a matter of policy interventions from upstream to downstream for more than six decades. For example, during the 1940s', the modernization of dairy systems upstream has been accompanied by a system of public promotion / incentives for milk consumption downstream to ensure an uptake of the increase of the production.
- ✓ The fresh milk market, while being mainly a local or a national one, is highly influenced by the world market, especially since the end of the quota system in the EU: price for raw milk at farm gate has become more and more volatile and is based on world market for milk powder and butter and does not depend anymore upon the level of local / national demand. Milk producers across Europe (especially in Denmark, Ireland, France and the Netherlands) are engaged in a fierce competition between each other's that force them to lower production costs, often at the expense of their level of environmental sustainability.

### Case Study Specification

The dairy case study will focus on the fresh milk as a consumer product and for the LCA work the butter product is defined as a sub case study in Ireland. The analysis is on material flows, life cycle assessment, governance and economics, modelling to optimise logistics and simulation of decisions linked to supply flows and assessment of fairness in terms of market power and price. Furthermore, studies to consumer behaviour, future scenarios and transition pathways are included.

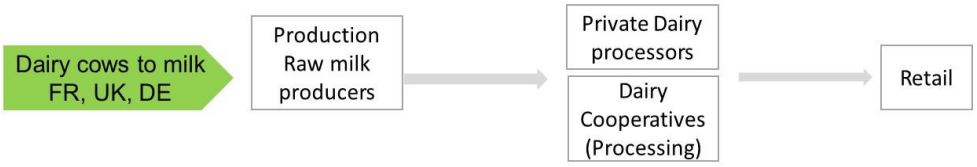


*Figure 3 Key actors/ activities in the Dairy cows to milk chain*

# BEEF CATTLE TO STEAK

## Production

***Main beef producing countries in EU are Germany, France, UK and Italy***

### Characteristic of the value chain

The majority of the bovine meat production is concentrated in few countries, and the annual output is about 800 thousand tons of bovine meat. The standing animal stock above 2 years old is about 44 million animals and about 8.5 million animals are slaughtered annually.

In EU 3.6 million farms are in the cattle sector and this accounts for 17% of all farms in EU and rear half of the livestock units and contribute 33% of the agricultural gross production value using one third of EU agricultural land – employing 25%of the agricultural labour force. The biggest producing countries are respectively Germany, France, UK and Italy.

The farm types involved in the meat sector are:

- ✓ Specialist cattle — rearing and fattening ("specialist fattening"),
- ✓ Cattle — dairying, rearing and fattening combined ("dairying and meat"),
- ✓ Mixed livestock, mainly grazing livestock ("mixed livestock") and
- ✓ Field crops — grazing livestock combined ("crops and cattle")

## Challenges

- ***Pressure from environmental groups***
- ***Changed consumption patterns***
- ***CAP subsidies influence the drivers in the beef market sector***

### Challenges

The EU cattle sector has been undergoing reshaping in recent years and concentration of market power has become increasingly vested in the retail sector. The consumption of beef and dairy products has reduced in Europe as consumers' lifestyles are changing and also the CAP direct payments to farmers have changed the drivers in the beef market sector. Overall cattle farm incomes in EU are dependent on the CAP support, 49% in dairy and 100% in the bovine meat sector [16].

Pressure from environmental concern groups[9] are likely to further impact policies and motivate consumption patterns that in short- and longer term will lead to reduced meat production from conventional systems.

The consumption of meat products has been driven by the increase in white meat (poultry and pig meat) and declining or stagnant red meat consumption. The importance of bovine farming in EU, especially in more rural areas is a core factor in pursuing this case study, and with consideration of continued use of grass/range lands that would not be appropriate for another crop production. The cattle can during their life cycle eat grass and feeds that cannot be directly consumed by humans, i.e. cattle can utilise farmlands that otherwise would not be used to produce foods directly.

In EU the bovine meat consumption has not changed much in recent years and average bovine meat consumption is about 11 kg per capita, or 17% of total average meat consumption. The EU is a net importer of bovine meat for its consumption.

## Beef to steak

***The countries targeted for analysis are Germany and UK***

### Case Study Specification

The case study will focus on bovine meat production, from farm to beef steak as a product. The research work is on governance, economic analysis and consumer insights.


*Figure 4 Key actors/ activities in the Beef to steak chain*

[9] Buckwell, A., and Nadeu, E. (2018). What is the Safe Operating Space for EU Livestock? RISE Foundation, Brussels.

## ATLANTIC SALMON TO FILLETS

### Production

***About 70% of the world's salmon production is farmed. Main producing countries are Norway, Chile, Scotland and Canada and the top four largest salmon producers are Norwegian enterprises.***

### Technical innovation to mitigate challenges

***Development of closed farming systems and novel feed using alternative feed sources (e.g. microalgae, seaweed, microbial cultures or insects)***

### Export to EU

***Majority of salmon produced in Norway is exported as commodity to avoid tariffs of value-added products within EU***

### Salmon to fillets

***The countries targeted for analysis are Norway and export to France and Poland. Included are stakeholder interviews in Norway, Scotland and in Iceland***

**Characteristic of the value chain**

The salmon aquaculture industry has been one of the fastest growing food producing sector in recent years. The Norwegian salmon supply chain represents a global food system which sources feed ingredients from crops and marine systems worldwide and supplies products to various markets including Europe, Asia and America. Thus, salmon feed and subsequently the salmon product are associated with a wide range of environmental impacts on many ecosystems and with other social and environmental conflicts.

- ✓ The farming of salmon is based on smolt production in freshwater in a land-based hatchery and grow out in sea cages with a total life cycle length of 24-40 months[10]
- ✓ The chain is driven by the producers and characterised by strategic horizontal collaboration and vertical integration. The large aquaculture producers have driven the technical innovations, which has ensured their market competitiveness
- ✓ The primary processing includes slaughtering, gutting, filleting, chilling and packaging and by-products such as guts, heads, tailbones and other fractions from slaughtering are further processed into fish oil and fish meal. Secondary processing is mainly outside of Norway (e.g. France and Poland).

**Challenges**

- ✓ Salmon aquaculture is heavily influenced by political decisions in terms of regulation of where farm sites and slaughter plants are located and legislation regarding feeds and medication (antibiotic use)[11].
- ✓ The aquaculture sector has invested in research to mitigate environmental impacts. The focus is on biological uncertainties, farming technologies and feed (e.g. feed utilization, optimizing the feed conversion ratio and novel). ingredients The share of vegetable ingredients has increased and a corresponding reduction in the share of marine ingredients has reduced the impact on marine ecosystems, per unit of salmon produced, but shifted environmental burdens to terrestrial ecosystems
- ✓ Governmental monitoring and legal requirements ensure that aquaculture farms report on biological challenges (e.g. occurrences of lice, escapees, the use of medication and water quality and sediment monitoring).
- ✓ There is an increasing awareness of transparency and consensus that monitoring data should be accessible in the public domain to enhance the integrity and help building an image of responsibility for the sector.

**Case Study Specification**

The scope of the case study is salmon aquaculture supply chain in Norway from farming and processing into HOG (head on gutted) products and export to EU for further processing into fillets and distribution to markets. The analysis is on material flows, decision making, life cycle assessment, governance and economics. Modelling work is on optimised logistics and simulation of decisions linked to supply flows and assessment of fairness in terms of market power and price. Furthermore, consumer behaviour insights and development of future scenarios include a study on transition pathways.

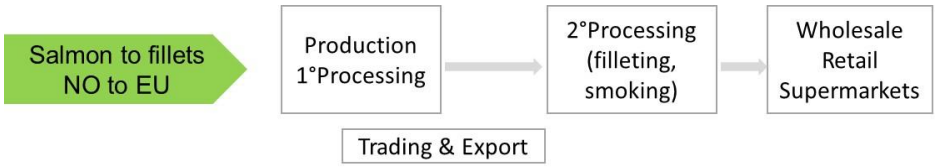


*Figure 5 Key actors/ activities in the salmon to fillets chain*

[10] Salmon Farming Industry Handbook 2017. http://hugin.info/209/R/2103281/797821.pdf

[11] Ziegler et al., (2012). The Carbon Footprint of Norwegian Seafood Products on the Global Seafood Market. Journal of Industrial Ecology, 17 (1): 103 - 116.

# TOMATO TO PROCESSED TOMATOES

## Production

***Italy is the largest tomato producing country in Europe and in Northern Italy there is a localized production district, including companies of production, processing, cooperatives and private processing***

## Price negotiations and setting of reference price

***The price can vary according to quality parameters specified in the Framework Contract agreed by all the companies of the district. One of the parameters is the level of "BRIX" of the tomato. Another parameter is the "percentage of major and minor defects".***

## Tomato to processed tomato

***The scope of the analysis on Northern Italy Emilia Romagna region and specifically focuses on the role of PO and IBO to mitigate power imbalance and fairer outcomes for farmers***

### Characteristic of the value chain

The tomato chain is an example of a fruit and vegetables produce from South European/Mediterranean agricultural goods, that completes the set of food products analysed by VALUMICS.

- ✓ The value chain organization includes a tomato Interbranch Organization (IBO) with a role to establish actions in favour of tomato food chain functioning, such as the creation of an emergency fund for farms. Tomato value chain has specific chain governance relationships including the Producer Organizations[12] and the IBO, an umbrella organization, which includes tomato producers and processors in Northern Italy.
- ✓ It is a localized production district, including several types of companies.

The tomatoes are mainly transformed into the following types of products: i) Canned tomatoes (Whole tomatoes, sliced, smashed, purée); ii) Tomato sauce, such as ketchup and similar; iii) Ingredient product for other food products (e.g., pizza, soup, ready-to-eat products, etc.)

**Challenges: Price negotiation in the supply chain**

- *Between processing industry and retailers:* The processors negotiate only a small part of their products (15%) with the retailers through reverse auctions. Interviewees sustain that the auction system influences the price setting strategy also beyond the auction system itself, and leads to low prices, especially in consideration of the quality characteristics of the tomato product produced.

- *Between production and processing industry:* Processed tomato is produced on a contractual basis. Tomato production and commercial relationships within the IBO are regulated by general rules. These are set within a Framework Contract and specific contract-by-contract conditions set in detailed Supply/Delivery contracts between producers and processors, and between producers and self-processing cooperatives (e.g. no pesticide residues or chemical ingredients, Brix level, consistency, flaws, etc.).

**Recycling of the waste in the processing stage:** Water: 70% of the water utilized in the depuration process of the tomato is recycled and utilized again in the first phase to transport the fresh to-be-processed tomatoes in the processing line. The parts of the tomatoes not utilized in the final product are recycled in agriculture, biogas or fodder.

**The processing stage includes several steps:** Thanks to the geographical proximity of the chain actors, the tomato is harvested and sent directly to the processing plant, without intermediate storage. The transport of the harvested tomato from producer to processor is carried out mainly on trucks organized/provided mostly by specialized logistics and transportation companies. The harvested tomato is delivered to the processing industry within few hours after harvest, and undergo a quality check within four hours of the agreed delivery time.

### Case Study Specification

The tomato case study focuses on the Italian production and processing of tomatoes into canned products and distribution to consumer market. Analysis includes governance and studies on food chain organisations, market power, price formation, persistency of supply chain relations, assessment of economies of scale and technical innovations. Furthermore, studies on consumer behaviour are included.

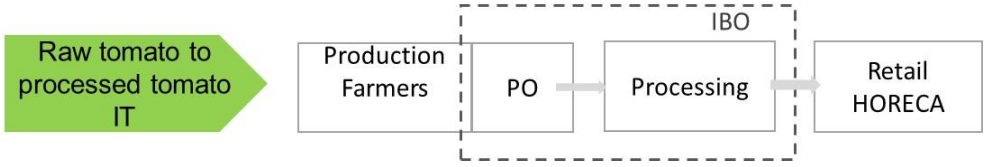


*Figure 6 Key actors/ activities in the raw tomato to processed tomato chain*

[12] PO recognized and regulated by the EU as part of the European Common Agricultural Policy (CAP) Reg. EU 1234/2007, Reg 1308/2013

## Interconnections through use of feed

***The dairy chain is linked to the beef chain through the production systems, while the wheat chain is linked as feed component for the livestock. Moreover, the imports of soy and use of wheat for feed for farmed salmon links those systems that are dependent on feed***

## Governance and externalities

***To improve the fairness, resilience and longer-term sustainability, the governance of the food system, actors' behaviours and various externalities shaping the different food sectors as part of the food system must be considered holistically***

## Environmental challenges

***The environmental challenges of the food system include the use of water for agricultural irrigation, degradation of land and contribution to global greenhouse gas emissions through e.g. use of fuel, pesticides and fertilisers, and livestock manure. Agriculture through intensive farming is a primary cause of biodiversity loss***

# Interconnections of VALUMICS case studies

There are important common challenges and interconnections between the VALUMICS case studies. For example, the production of milk, and more generally the functioning of the whole dairy chain, relates to the functioning of at least three other major food or commodity chains. The first two are protein crops and cereals, that play an important role for feeding dairy cows and other livestock under the form of compound feed, depending on whether it is an intensive or extensive system. The beef case study is linked to the dairy case study in terms of the dynamic linkages between these two production systems, also, the case study on wheat is inherently linked due to the feed components used for the livestock. Amongst the different environmental issues of livestock, are those related to manure management and enteric fermentation in farmed animals (livestock) and eutrophication in aquaculture as well as water pollution, feeding strategies, and deforestation embodied in e.g. soy imports[13] for feed. These are all common upstream challenges of beef and dairy value chains as well as farmed salmon. The efficiency of the feeding and farming systems is of key importance to minimize environmental impacts. Furthermore, food loss and waste through processing, storage and transportation contribute to downstream environmental challenges which are common for all food value chains, in particular for distant markets.

# Challenges of food systems

Agro-food systems have been successful in feeding a growing number of people but are pushing planetary boundaries in terms of greenhouse gas emissions, biodiversity loss, freshwater use, and both nitrogen and phosphorous cycles, risking expensive, potentially irreversible environmental change[14]. The global food system, which includes all actors and sectors involved in producing, distributing, retailing, and consuming food, is thus at the centre to mitigate the challenges facing the planet. Numerous studies using Life Cycle Assessment (LCA) have shown that the primary production and intensive farming is causing the main environmental burden in the whole life cycle of animal and aquaculture products. This is contributed by e.g., the use of fertilisers and pesticides in the production of feed components through growing of crops and by fuel use in fisheries while sourcing marine feed ingredients. The use of fuel during transport can also contribute considerable climate change impacts of exported products in distant markets.

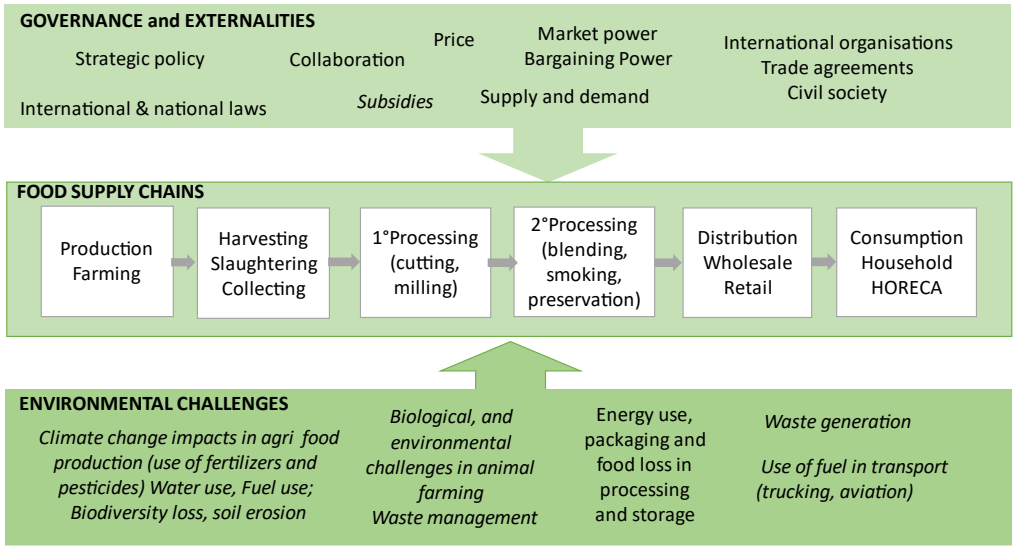


Figure 7 *Environmental challenges, governance and externalities influencing the functioning of the food system*

[13] Although it must be acknowledged that pigs and poultry consume a much higher share of all protein crops consumed in Europe (58 % for pig and poultry *vs* 8 % for dairy cows), that are imported from e.g. Latin America to the EU.

[14] Rockström et al., (2009) "Planetary Boundaries: Exploring the Safe Operating Space for Humanity." https://www.ecologyandsociety.org/vol14/iss2/art32/)

It has also been emphasised that open, efficient, and *fair-trading systems* should be encouraged, and countries should reduce trade distortions by reducing high *import tariffs* and eliminating *export bans* and restrictions in order to expand secure an equal access to markets for food and agriculture. The challenges of the global food system are also reflected by rising *anti-globalism, especially trade protectionism*, which is influencing the free flow of goods needed to ensure food security and nutritional products, particularly for nutritious and sustainably sourced foods[15].

## CAP and subsidies

***The farm support policies in developed countries often insulate producers from market price and can lead to overproduction and depressed global prices. Countries have been reluctant to give up farm subsidies and multi-country agreements on reforming domestic support have not been reached***

The Common Agricultural Policy (CAP) support of the EU through direct payments and market measures under the first pillar and rural development measures under the second pillar have been debated. However, challenges in the meat and dairy sector are of such nature that specific support measures, especially for the dairy sector, have been introduced. These include the 2012 milk package to improve bargaining of dairy farmers in the milk supply chain and the 2015 aid package targeting the beef meat and dairy sectors through, among others, aid for private storage and promotion[16]. In a global context, in terms of farm support policies, low-income farmers lose when they compete against subsidized production and the developing countries may face increased malnutrition, food insecurity, and adverse consequences for rural development[15]. Further, while the discussion on reducing meat production and consumption in response to the severe environmental challenges, the analysis of the EU cattle sector in recent years, has highlighted its economic importance, productivity, and prospects for further increases in bovine meat and milk. The analysis emphasise that further consideration of impacts are needed in terms of*: public policies, - both at national and EU level – such as environmental restrictions and the abolition of the milk quota system in April 2015; price developments at world, EU and national levels; problems of profitability in the sector; changing demand both in terms of quantity and quality; increased competition in the EU due to the progressive opening of the market through international trade agreements; a changing geopolitical context; the international economic situation; and the consequences of climate change.* " [16]

## Policy support needed for radical changes

- ***Sustainable production***
- ***Reduce food loss & waste***
- ***Diet changes***
- ***Exploit knowledge and emerging technologies***
- ***Fair trading systems***
- ***Level playing field***

The need for a radical change in the global food system is widely acknowledged, where changes in production and emerging technologies are seen as an opportunity for food systems. Major food system can thus contribute to the UN´s Sustainable Development Goals (SDGs)[17] by increasing sustainable production efficiencies (more food with less impact), reducing food waste and loss, and shifting diets in particular shifting towards plant-based diets[15]. Furthermore, to support radical changes in the food system it has been highlighted that "polices must encourage structural change in farming to bring about a better balance, structure, location and de-concentration of livestock and better integration of crop and animal production, as well as resource efficiency improvements and reduction of leakage and waste"[18].

It should be noted that during the later phases of the VALUMICS project the Green Deal[19] and the Farm2Fork strategy [20,21] have been launched with ambitious aims to tackle the challenges of the European food system and motivate transition to sustainable food system. The work in VALUMICS provides evidence on the functioning of selected food value chains through stakeholder insights, policy oversight, governance analysis, mapping of information and material flows, economic analysis, life cycle assessment, consumer behaviour studies and modelling work aimed at optimising logistic and simulation modelling of processes and actors' decision, as tools to explore the impact of interventions aimed at enhancing fairness, resilience and sustainability in future scenarios.

[15] Glauber, Joseph W. 2018. Developed country policies: Domestic farm policy reform and global food security. In 2018 Global food policy report. Chapter 7. Pp. 54-61. Washington, DC: International Food Policy Research Institute (IFPRI). https://doi.org/10.2499/9780896292970_07
[16] Ihle, R., Dries, L., Jongeneel, R., Venus, T., Wesseler, J. (2017). Research for Agri Committee – The EU Cattle Sector: Challenges and Opportunities – Milk and Meat. Dictorate-General for Internal Policies, Policy Department B: Structural and Cohesion Policies, Agriculture and Rural Development. doi:10.2861/85585 http://www.europarl.europa.eu/supporting-analyses
[17] https://www.un.org/sustainabledevelopment/sustainable-development-goals/
[18] Buckwell, A. and Nadeu, E. 2018. What is the Safe Operating Space for EU Livestock? RISE Foundation, Brussels
[19] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
[20] https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en
[21] https://ec.europa.eu/food/farm2fork/sustainable-food-processing-wholesale-retail-hospitality-and-food-services/code-conduct_en

## Key sources for further information

This brief presents an overview of the VALUMICS project phases and findings from co-creation workshops in the first year of the project where all VALUMICS partners contributed. Common challenges of food systems and the selected case study specifications are highlighted.

To discuss the research presented in this brief, please contact Gudrun Olafsdotttir, University of Iceland, email: go@hi.is

Further information on different VALUMICS case studies´ analyses, please contact respective case study leaders:

**Wheat to bread:** *Case study leaders*: Lukas Cechura, CZU, Czech Republic, Contact: *cechura@pef.czu.cz* and Pierre-Marie Aubert, IDDRI France Contact: pierremarie.aubert@iddri.org
*Participating partners*: IAMO, UH, UNEW, Norway/ SINTEF

**Dairy cows to milk (butter):** *Case study leader:* Pierre-Marie Aubert, IDDRI, Contact: pierremarie.aubert@iddri.org
*Participating partners:* IAMO, UH, CZU, UCD, SINTEF, UEH

**Beef cattle to steak**: *Case study leader:* Sigurður G Bogason, University of Iceland. Contact: sigboga@hi.is
*Participating partners*: UH, IAMO, SINTEF

**Atlantic salmon to fillets**: *Case study leaders*: Maitri Thakur, SINTEF Ocean, Norway Contact: maitri.thakur@sintef.no
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**Tomato to processed tomatoes:** *Case study leaders*: Antonella Samoggia, UNIBO Contact: antonella.samoggia@unibo.it and Gianandrea Esposito ART-ER, Contact: gianandrea.esposito@art-er.it,
*Participating partners*: SINTEF, IAMO, CZU, UH, UEH, FIAB, UCD, UNEW

**Cross cutting analysis of consumer behaviours linked to VALUMICS case study products in partner countries:** *WP Leader:* Mariana Nicolau CSCP, Contact: mariana.nicolau@scp-centre.org
*Participating partners*: CSCP (DE), UNIBO (IT), UNEW (UK), IDDRI (FR), UoI (IS), MM (IS), CZU (CZ), UEH (VN), CAU (CN), REWE (AT)

**Deliverable reports**

Ólafsdottir, A.H., Sverdrup, H.U., Gudbrandsdóttir, I.Y., Ólafsdóttir, G., Bogason S.G. (2018). Summary report for all first year's WP2 workshops The VALUMICS project "Understanding Food Value Chains and Network Dynamics" funded by EU Horizon 2020 G.A. No 727243. **Deliverable D2.3**, University of Iceland, Reykjavik, 19 pages.

Olafsdottir G., Gudbrandsdottir I. Y., Bogason S. (2018) Integration report for qualitative model and initial designs for the qualitative model delivered to WP7. The VALUMICS project "Understanding Food Value Chains and Network Dynamics" funded by EU Horizon 2020 G.A. No 727243. **Deliverable D2.5**, University of Iceland, Reykjavik, 40 pages.

**Published scientific papers and conference proceedings based on the VALUMICS food system analysis:**

Olafsdottir, A.H., Gudbrandsdottir, I.Y., Sverdrup, H.U., Bogason, S. G., Olafsdottir, G., Stefansson, G. (2018). System Dynamics Modelling and System Analysis Applied in Complex Research Projects - the Case of VALUMICS. Int. J. Food System Dynamics 9 (5), 2018, 409-418 DOI: http://dx.doi.org/10.18461/ijfsd.v9i5.953

Gudbrandsdottir, I.Y. Olafsdottir, G. Bogason, S.G. (2019). Modelling food supply networks. Aquaculture Europe, Vol. 44(1), pp. 32-36. Available at: https://valumics.eu/wp-content/uploads/2019/10/AE-vol44-1-VALUMICS.pdf

Gudbrandsdottir I.Y., Olafsdottir A.H., Sverdrup, H.U., Olafsdottir, G., Bogason, S.G. Stefansson, G. (2018) Modelling of integrated supply-, value- and decision chains within food systems. Proceedings in System Dynamics and Innovation in Food Networks 2018, p. 341-348, DOI: http://dx.doi.org/10.18461/pfsd.2018.1827



## H2020 VALUMICS – Understanding Food Value Chains and Network Dynamics

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