



D4.2 METHODOLOGY TO ASSESS MARKET OUTLOOK AND SOCIAL IMPACT

WP 4

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EXECUTIVE SUMMARY

The IoF2020 project (<https://www.iof2020.eu/>) accelerates the uptake of Internet of Things (IoT) technologies in the European farming and food chains in view of strengthening their competitiveness and sustainability.

To achieve this, IoF2020 work is structured around five Work Packages (WPs):

- WP1, which is responsible for the successful management and coordination of the project;
- WP2, dedicated to the management of the five trials running within IoF2020;
- WP3, which guides use cases on how to leverage existing IoT technologies, approaches, methodologies and guidelines, and facilitates collaboration between use cases;
- WP4, which provides business support to the developed solutions;
- WP5 on ecosystem development.

This document has been developed within WP4. This deliverable identifies and characterises key market trends and social-economic development and develops a methodology for business impact assessment and social impact assessment in relation to the key performance indicators (KPIs) of the use cases.

Note that this document should be regarded as a living instrument, to be updated during the entire duration of the project.

Starting from desk study and in-depth analysis of the project plan, this deliverable first identifies and characterises key markets for each use case by examining the commodities and services to be generated and marketed in each use case using a template as shown in Appendix 1. For each market, the main trends and conditions are then screened and described to understand their potential impact—positive and negative—on the envisaged result of the use cases in the project. To structure the analysis, the PESTLE framework is used to identify and characterize key factors and trends. PESTLE stands for Political, Economic, Social, Technological, Legal and Environmental factors.

At this stage of the IoF2020 project (June 2017), it is important to specify KPIs according to the objectives of the use case per stakeholder and identify relevant variables and indicators that contribute to the KPIs. For a complex project like IoF2020 in which multiple stakeholders and organisations work together, it can be a daunting task to reach a clear set of objectives. It may therefore take several iterations to define and refine the final set of KPIs. Once the KPIs and related indicators are defined and specified, it is expected that the methodology as described in this deliverable can be further applied to each use case.

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1. INTRODUCTION

1.1. BACKGROUND

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This document has been developed within WP4. This deliverable identifies and characterises key market trends and social-economic development and develops a methodology for business impact assessment and social impact assessment in relation to the key performance indicators (KPIs) of the use cases.

Note that this document should be regarded as a living instrument, to be updated during the entire duration of the project.

1.2. STRUCTURE OF THE DELIVERABLE

The document is structured as follows:

Following this introduction, **Chapter 2** introduces the methodological approach to identify the markets and trends. **Chapter 3** presents the key markets identified. **Chapter 4** describes key market trends and social-economic developments per market that can have impact on the envisaged KPIs. **Chapter 5** describes and illustrates the methodology for business impact assessment and social impact assessment. **Chapter 6** ends the deliverable with concluding remarks.

2. METHODOLOGICAL APPROACH

2.1. OBJECTIVE OF THE DELIVERABLE

WP4 consists of different tasks. This deliverable is a result of Task 4.2 which is focused on the identification and quantification of future market trends and conditions and the development of a methodology for assessing their impact on today's ROI projections. The trends and conditions include regulatory and economic developments (e.g. potential ban of food speculation, cheap oil price, rising production of fuel out of bio mass), social developments (e.g. growing population, shift in eating behaviour), environmental developments (e.g. climate change, erosion, decreasing phosphate levels, less pollinators) and scientific developments (e.g. genetically enhanced plants, future disease treatments), and social innovation (e.g. changes in agrifood chain organisation due to digitalisation, power shifts).

The aim is to quantify these effects and to calculate the future value of each use case solution. The effectiveness cannot be assessed solely based on today's data, but requires projections of future developments. This market assessment will unite input from agricultural researchers, technology experts and business professionals to build a broad knowledge base upon all use cases can make

informed decisions on business models, technological features and future market niches. To ensure the information is understood and used by the use cases, WP4 has regular interactions with use cases to provide support and seek feedback.

2.2. APPROACH

The general approach to task 4.2 is visualised in Figure 1. The vision (the future the use case tries to realise), approach (methods and activities to be carried out) and key performance indicators (KPIs) are key components of the project plan. Starting from desk study and in-depth analysis of the project plan, we first aim to identify and characterise key markets for each use case by examining the commodities and services to be generated and marketed in each use case using a template as shown in Appendix 1. For each market, the main trends and conditions are then screened and described to understand their potential impact—positive and negative—on the envisaged result of the use cases in the project.

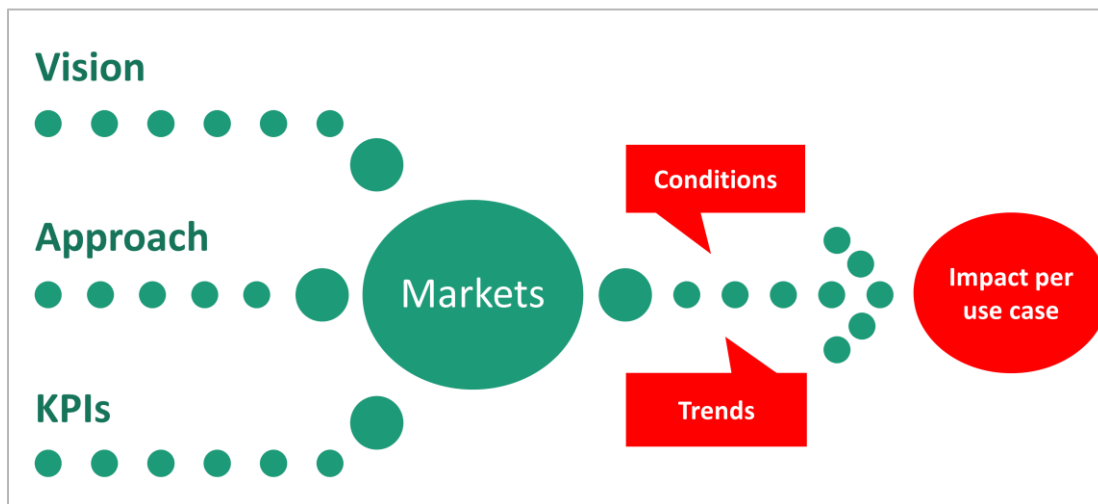


Figure 1 General approach to Task 4.2

The desk study consists of the following two activities:

- analysis of the use cases based on the description of work and interviews
- web-based search (market reports, etc.)

The interviews are carried out in different forms in combination with activities carried out in other tasks within WP4 to obtain feedback on the following:

- Semi-structured interview (or online feedback) with trial leaders + relevant actors
- Verification of key products and services;
- Verification of key (intended) markets (geographical locations, size, etc.)
- Commodities
- Services
- IoT solutions
- competitors & collaborators
- Verification of trends and developments

To structure the analysis, we use the PESTLE framework to identify and characterize key factors and trends. PESTLE stands for Political, Economic, Social, Technological, Legal and Environmental

factors¹. Depending on the research contexts, the interpretation of these factors can vary. Table 1 explains how these dimensions are interpreted in this task and how they may influence different KPIs.

Table 1 Key dimensions to analyse market outlook and impact of the PESTLE framework

Impact dimension	Explanation
Political	The political dimension is about how and to what degree a government intervenes in the economy. Political factors include government policy (e.g. tax policy, foreign trade), political stability or instability in domestic and overseas markets. Political factors can influence economic and social outcomes of the project.
Economic	The economic dimension consider factors influencing the demand, supply of the product or service. Economic factors include inflation rate, interest rates, foreign exchange rates, economic growth patterns etc.
Social	The social dimension concerns the social environment of the business market. Social factors such as cultural trends, demographics, population analytics.
Technological	The technological dimension considers the current state and developments in technology that may affect the operations of the industry and the market favourably or unfavourably.
Legal	Legal factors include - health and safety, equal opportunities, advertising standards, consumer rights and laws, product labelling and product safety.
Environmental	Factors from the surrounding environment, including but not limited to climate, weather, geographical location.

Figure 2 visualises how trends and factors from different dimensions are used in the analysis, i.e., to identify potential impact on the envisaged KPIs. Although theoretically all factors would have impact on the outcome of the project, for the purpose of the project, it is important to focus on the KPIs that can be measured within the confines of the project. The choice of KPIs for each use case depends on the specific target of objective the use intends to achieve. Based on the objectives, the KPIs can be classified into economic, environmental and social KPIs. As an illustration, a number of well-known KPIs are shown in Figure 3. Detailed KPIs per use case and their measurements are described in Deliverable 4.1 (results of task T4.1) of the IoF2020 project.

¹ More information on the PESTLE analysis can be found at: <https://www.cipd.co.uk/knowledge/strategy/organisational-development/pestle-analysis-factsheet>

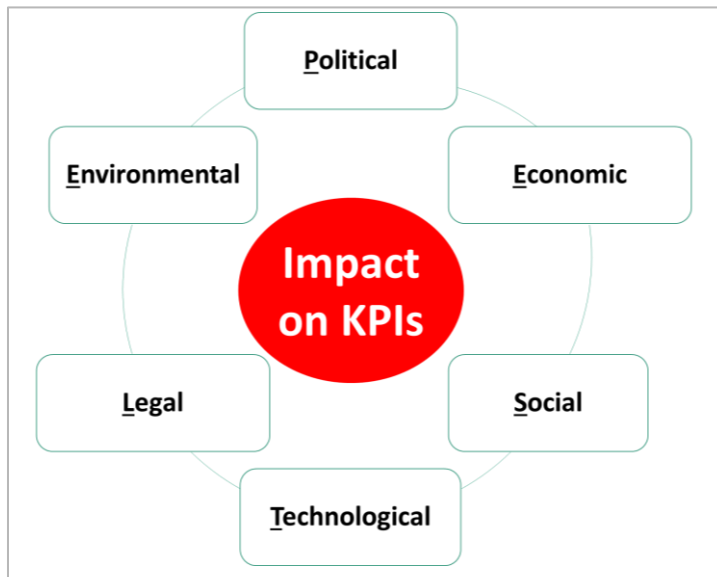


Figure 2 The PESTLE framework for analysing impact

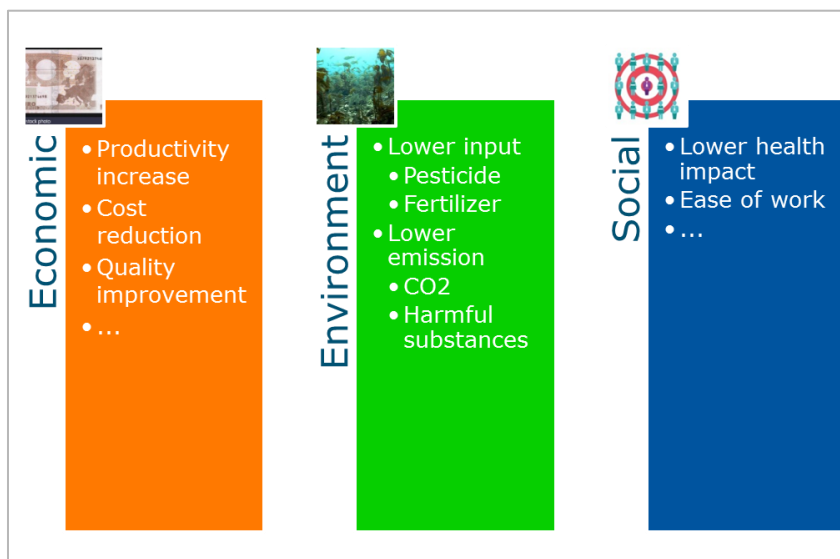


Figure 3 Different categories of KPIs.

The development of an impact assessment methodology consists of the following steps:

- developing impact logic
- choice of indicators
- data and information needed
- quantification

3. KEY MARKETS

To understand market outlook, a logical step is first to identify the key markets for the use cases in IoF2020. IoF2020 runs 5 trials with 19 use cases in 14 EU countries. From the perspective of the end



users, each use case may concern different commodities, services and IoT components. In this deliverable we focus on markets for commodities. The market for IoT products is addressed by other work packages (WP3).

To identify the key markets, we start by identifying the commodities and services from the perspective of the partners involved in the use case and then identify the key markets for major commodities and services.

The basic information on the commodities and geographic scope can be found in Appendix 1.

The key markets identified for the use cases in IoF2020 are shown in Table 2. Note that several use cases may share the same market as they concern the same commodities or services.

Table 2 Key markets for IoF2020 use cases

Trial	Market	Use cases	Remarks
Arable	European consumption potatoes (mass production)	1.1 Within-field management zoning	Could be sold to global potato market
	European cereal crops (conventional)	1.2 Precision crop management	Could be sold to global cereals market
	East and Central Europe Soy beans (Austria, Serbia, Romania, Ukraine), Italy	1.3 Soya Protein management	Could be sold to global cereals market
	Farm machinery	1.4 Farm Machine interoperability	Cross over Europe (Denmark lead country)
Dairy	European dairy market (mass production)	2.1 Grazing Cow Monitor 2.2 Happy Cow 2.3 Silent Herdsman 2.4 Remote milk quality	Could be sold to global market
Fruit	Fresh table grapes chain (organic)	3.1 Fresh table grapes	Table grapes (integrated, organic)
	Wine	3.2 Big wine optimization	Grapes and wine (conventional and organic)
	Olive oil	3.3 Automated olive chain	Olive oil or fruit (conventional and organic)
	Multi fruits	3.4 Intelligent fruit logistics	multi fruits and vegetables
Vegetables	Leafy vegetable for convenience food	3.4 Intelligent fruit logistics 4.1 City farming leafy vegetables	
	Greenhouse vegetables	4.2 Chain-integrated greenhouse production	
	European organic vegetables (field vegetables)	4.3 Added value weeding data	

	European Organic grapes/wine	4.4 Enhanced quality certification system	
Meat	European Meat market (pork and poultry)	5.1 Pig farm management; 5.2 Poultry chain management 5.3 Meat transparency and traceability	

4. KEY MARKET TRENDS AND SOCIO-ECONOMIC DEVELOPMENT

In this section we present key market trends and socio-economic developments and highlight their potential impact on the envisaged KPIs. When presenting the trends and factors we focus on the following:

- General trend as known in the global agrifood section and trends within the EU
- Key market trends per use case (+ local aspects)

For each trial, we summarize the key trends and factors for the key markets in a table using the PESTLE structure. When relevant, more explanation is provided in the corresponding paragraph.

4.1. ARABLE

Table 3 Key factors and trends relevant to the KPIs

Factors/ Trends	PESTLE: Major Trends and Factors					
	Political	Economic	Social	Technical	Legal	Environment
1	Changes to the Common Agricultural Policy (CAP)	Increasing EU cereal demand and soybean imports	The sensitivity to ecological agriculture (Organic Farming)	Increasing mechanisation and digitalisation	New energy efficiency legislation	More attention for soil quality and soil use
2	Attention to agriculture's influence on climate change	Low cereal prices				Demand for improved fresh water management in Africa and EU neighbouring countries
3	Product-specific subsidies	Decreasing cultivation of rapeseed				

In the following paragraphs, we provide some explanation and additional information on the trends and factors along the five dimensions:

The political dimension:

The political dimension is strongly influenced by the Common Agricultural Policy (CAP) that has gradually removed product-specific subsidies for cereals, oilseeds, protein crops and rice.

Governments need to improve the economic efficiency and environmental effectiveness of policies that seek to improve water resource use efficiency and reduce water pollution from agricultural systems²

Agriculture is one of the few sectors that can both contribute to mitigation and sequestration of carbon emissions and accounting for agriculture's carbon footprint is necessary, particularly if agriculture is included in greenhouse gas reduction commitments.

EU support for arable crops, which used to be provided through a complex system of market measures, has been simplified. Farmers no longer receive subsidies according to what or how much they produce; payments are fully decoupled. The direct payment system allows them to switch to different crops or types of production in response to market developments.

The economic dimension

The European Union is one of the world's biggest cereals producers and an important cereals trader. Changes to the Common Agricultural Policy (CAP) have gradually removed product-specific subsidies for cereals, oilseeds, protein crops and rice.

The economic dimension has several prominent trends:

- EU cereal demand could increase by 6 % by 2026 (EU Outlook conference)
- Low cereal prices were driven by abundant world supply and stocks (European Commission, https://ec.europa.eu/agriculture/cereals_en)
- Global Wheat Use for Food Shows Strong Growth, while Use for Seed and Ethanol Purposes Increases Marginally³ (Rabobank)
- the cultivation of rapeseed decreasing and soybean imports increasing (EU Outlook Conference)
- the dietary pattern in the developing countries will further shift towards the more costly vegetable oils and animal proteins at the expense of cereals (EC)

The social dimension

- the sensitivity to ecological agriculture (Organic Farming) among farmers and citizens

The technological dimension

- moderate increase in protein crop production
- arable farm equipment for Europe as a whole sales decreased 2%, but stable demand is expected for 2017 (OEM)
- Russia and the Ukraine, significant growth rates, in sales of field sprayers and precision seed drills. (OEM)

² OECD: <http://www.oecd.org/tad/sustainable-agriculture/water-use-in-agriculture.htm>

³ Rabobank: https://research.rabobank.com/far/en/sectors/grains-oilseeds/global_wheat_demand_article_2.html

- The overall aim is greater user-friendliness and efficiency

The legal dimension

- the biggest driver post-2020 is the strong reduction in overall petrol and diesel use following new energy efficiency legislation

4.2. DAIRY

Table 4 Key factors and trends relevant to the market outlook and impact of markets for the dairy cases

Factors/ Trends	PESTLE: Major Trends and Factors					
	Political	Economic	Social	Technical	Legal	Environment
1	Changes to the Common Agricultural Policy	World demand to expand, especially in Africa and Asia; Moderate increase in demand expected	Concerns for animal welfare, bio-diversity, and public health	Increasing digitalisation and automation		Concerns for GHG emission, bio-diversity and other environmental constrains
2	Existing WTO commitments and Only ratified Free Trade Agreements (FTA) and Russian import ban until end 2017	Volatility in markets				

The political dimension

- The CAP reform process has opted for gradual market orientation
- After a production quota environment, market fundamentals will be the main drivers of EU supply developments
- Trade assumptions :Existing WTO commitments and Only ratified Free Trade Agreements (FTA) and Russian import ban until end 2017
- Ex-ante risk management and Natural disaster aid (mostly ex-post)
- The CAP has chosen to directly support farm income

The economic dimension

- During the next decade, global and EU production growth is expected to be more moderate, driven by a sustained increase in world demand
- Therefore, the rise in EU milk production in the next decade is expected to be moderate and lower than in recent years.
- World demand to expand, especially in Africa and Asia
- The EU to become first world exporter, just in front of New Zealand

- A moderate production increase in the EU
- Environmental constraints to limit production expansion
- Volatility is to be expected

The legal dimension

- total emissions are expected to decrease in the next decade
- The dairy and beef sector for GHG emissions and the pork sector for ammonia are the ones most concerned by such issues
- Nutrient surplus: Stability at EU level, but N surplus in some regions

The environmental dimension

- Emissions (greenhouse gas (GHG))
- Nutrient surplus (N, P) in the EU countries with intensive livestock production.

4.3. FRUIT TRIAL

Table 5 Key factors and trends relevant to the market outlook and impact of markets for the fruit trial

Factors/ Trends	PESTLE: Major Trends and Factors					
	Political	Economic	Social	Technical	Legal	Environment
1	Uncertainty in some markets: Russia (boycott) and UK ('Brexit')	Growing retailer competition is an opportunity (Rabobank, 2016)	Across EU different consumer appreciation of traceability	Increasing digitalisation and automation in fruit chains	EU/NL : regulations for emission reduction	Drought weather conditions due to climate change
2		Retailers strengthening supply chain to improve traceability (Rabobank, 2016)	Decline in EU domestic market for fruit, wine, olive oil (EUC, 2016)		EU: labelling regulations, including origin labelling	Low olive oil production in Greece and Italy, among others due to olive fly (DG AGRI, 2017)
3		Trade important to balance markets in fruit, wine, and olive oil (EUC, 2016)	Value adding key issue (EUC, 2016)		future: carbon mitigation constraints	
		Main olive oil producers: Spain, Italy and Greece (TyR, 2016); Production in Spain and Portugal still	Growing demand wine in Asia and America (EUC, 2016)			

		growing (EUC, 2016)				
		Fluctuating production levels olive oil, low stock high prices (DG Agri, 2017)	Wine trends: Fresh / easy wines (in particular sparkling), trade in bulk, segment of premium classical (EUC, 2016)			

More background information on the commodity markets and trends:

Table olives

Olive

World table olive **production** for 2016/17 is forecast at 2 736 500 tonnes⁴. If this tonnage is confirmed, it would be a record figure, up by 3% or 86 500 t from the season before. This increase is driven by good harvests in certain IOC member countries, such as Egypt, which expects to produce 500 000 t (+ 6%), Turkey 433 000 t (+9%), Greece 234 000 t (+23%), Algeria with 234 000 (no change), and Iran 75 500 (+10%). However, the production of the world leader (Spain) is set to decrease by 16%. The other countries will have similar or lower production levels compared to the previous crop year.

Consumption is forecast to increase by 5%, following the trend in production. It should be noted that world consumption of table olives over the last three campaigns has increased constantly with an average yearly increase of 4%. **Imports** in table olives in the first ten months of the 2015/16 crop year (October 2015 – July 2016)⁵ in the six markets that appear in the table below presented an increase of 4% in Australia and 3% in Canada compared with the same period the previous year. However, imports decreased by 9% in Brazil, by 4% in the United States and by 3% in Russia.

EU data for the first nine months of 2015/16 (October 2015 – June 2016) present a 2% year-on-year increase in intra-EU acquisitions and of 3% in extra-EU acquisitions.

Olive oil / olives

The **production** of olive oil is low in 2016/17, 13% below last 5 year average, together with low stock levels resulted in high prices and reduced availability of oil⁶. Production is also fluctuating. Producer prices increasing since 2011/2. Also consumer prices increasing, though they stayed high after a rise in 2003/4, while producer prices dropped. Esp. low production in Greece and Italy, among others, due

⁴ MARKET NEWSLETTER No 108 – September 2016, Source: International Olive Council page 1

⁵ https://ec.europa.eu/agriculture/sites/agriculture/files/markets-and-prices/short-term-outlook/pdf/2017-03_en.pdf

⁶ <http://www.internationaloliveoil.org/estaticos/view/132-world-table-olive-figures>

to olive fly. Also (outside EU) in Tunisia drought effected harvest. Only Turkish production increased. Consumption in the EU decreasing. Despite lower availability and higher prices, EU exports were 3% above the last five-year average in the last quarter of 2016. Exports to Japan and China. Low but increasing quantities are imported.

The International Olive Oil Council has announced its forecast of olive oil world production⁷, setting an expectation of 2,918,000 tons for the new 2016/2017 campaign, which is approximately 7% less compared to the previous season. Regarding the Spanish harvest, it will be similar to last year and it is expected to have a total production of 1,380,000 tons in Spain.

With no change, the main producing countries of the new campaign are still Spain, Italy and Greece. The estimation for Italy would be 330,000 tons, which means a decrease of 30%, and 260,000 tons for Greece. As the largest producing country, we forecast that Spain will have a share of 47% of the global production.

After a very hot and dry summer, which are not the optimal conditions for the olive oil harvest, the positive news came the second week of October, that is to say that the last rains brought calm to the main producing areas of Andalusia. Jaen will be the largest producing province with more than 540,000 tons, and our region, Andalusia will represent a 38% of the total world production, which is twice as much as the sum of productions of Italy and Greece.

In summary, olive oil production increase in Portugal and Spain, little increase in the rest of EU. Consumption in EU countries is stable, slightly decreasing. There is more net export. Traceability of olive oil is an important issue due to potential fraud (Hou, 2011).

Table grapes

International trade in table grapes has expanded tremendously over the last few decades, with out-of-season fresh produce now being traded and consumed globally (Seccia et al., 2015). However, grape consumption is not only on the rise in these traditional markets⁸; there is clearly growing interest in this fruit in Southeast Asian markets. Thailand, Hong Kong, Malaysia, South Korea, Vietnam and Taiwan are increasingly showing preference for grapes. (China, India and Russia, despite being traditional grape consumers, are now considered potential markets for the largest exporters as well, given their growing demand for grapes, which still leaves ample room for expansion, and economic and social forecasts for these three large markets.

Grapes/ wine

In general, wine consumption is gradually decreasing in the EU, but growing in Asia and America. Trends in wine consumption include the following:

- Fresh / easy wines (in particular sparkling)
- Trade in bulk
- Segment of premium classical
- Growth in Asia / America

4.4. VEGETABLES

Table 6 Key factors and trends relevant to the market outlook and impact of markets for the vegetable cases

Nr.	PESTLE: Major Trends and Factors
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⁷ <http://www.torresyribelles.com/en/2016-2017-olive-oil-production-forecast/>

⁸ <http://www.prospectiva2020.com/sites/default/files/report/files/re - grapes - jan 2015.pdf>

	Political	Economic	Social	Technical	Legal	Environment
1	Uncertainty in some markets: Russia (boycott) and UK (Brexit)	Increasing value chain integration (production and logistics)	Consumers are increasingly critical about the quality, sustainability and traceability of food	Increasing digitalisation and automation in vegetable production chains	Increasing legal requirements for food safety, quality and transparency	Potential shortages of fresh water supply
2		Retailers strengthening supply chain to improve traceability (Rabobank, 2016)	Public awareness for the health effect of different farming methods		Food integrity receives attention due to fraud and food scares	Runoff of pesticide and other chemicals in the environment
3			Increasing awareness to city farming, local to local			

4.5. MEAT

Table 7 Key factors and trends relevant to the market outlook and impact of markets for the meat trial

Nr.	PESTLE: Major Trends and Factors					
	Political	Economic	Social	Technical	Legal	Environment
1	Uncertainty in some markets: Russia (boycott) and UK (Brexit)	Meat market is supply driven, prices will be under pressure in 2017 (Rabobank, 2016)	Slowing down per capita consumption of pork in the EU (growth is less than 1%, DG Agri, 2017)	2005-2025 15 to 20% reduction of GHG is possible (technology and practice fixes), (FAO, 2015)	EU: Animal welfare regulations (for poultry and pig production)	Climate change especially extreme conditions may affect the livestock sector (FAO, 2015)
2		Growing retailer competition is an opportunity (Rabobank, 2016)	Slowing down population growth in western countries		EU/NL : regulations for emission reduction	

3		Retailers strengthening supply chain to improve traceability (Rabobank, 2016)	Global demand will rise with 70% (website FAO) in 2050, and wil reach over 35 kg/c in 2025 (OECD/FAO, 2016)		EU: labelling regulations, including origin labelling	
4		Higher cost to comply with present and future legal demands for environment and animal health (OECD/FAO, 2016)	Meat demand stems from middle classes in Asia, Latin Amerika and Middle East (OECD/FAO, 2016)			
5		Increasing imports of poultry and beef by China (Rabobank, 2016), but imports of pork stabilise (Rabobank, 2016) or drop (DG Agri, 2017)	Consumer (western) concerns about animal health and welfare (Rabobank, 2016), Links between meat consumption and cancer (OECD/FAO, 2016)			

The social dimension

- Concern about livestock as source of GHG, it contributes to human-induced GHG emissions for 14.5% and is a large user of natural resources (FAO website)
- Resistance to antibiotics (existing problem not mentioned in outlook reports)
- Across EU different appreciation of boar taint (Martínez et al., 2016) and traceability (Dopico et al., 2016)

5. METHODOLOGY FOR IMPACT ASSESSMENT

Identifying the factors and trends is the first step towards impact assessment. For IoF2020 we interpret the impact as the influence of these factors and trends on the expected KPIs. Impact assessment typically consists of the following steps:

- Developing impact logic: explain why and how do the trends and factors influence the KPIs
- Choosing indicators: identify indicators underlying the KPIs that will be influenced by the trends or factors
- Collecting data and information needed
- Quantifying the impact on KPIs.

Developing impact logic through KPIs

To identify the path through which the factors and trends influence the KPIs, it is relevant to look at the variables underlying the KPIs that are described in Deliverable 4.1. Impact pathway can then be identified along the construction of KPIs through the indicators. The general approach is illustrated in Figure 4 in which KPIs like profitability and competitiveness of the stakeholder are influenced by the quality and quantity of different inputs and outputs as well as prices in the market. As each use case may have different KPIs in different categories, the specific input, output and processes as well as the market and social environment must be specified per use case.

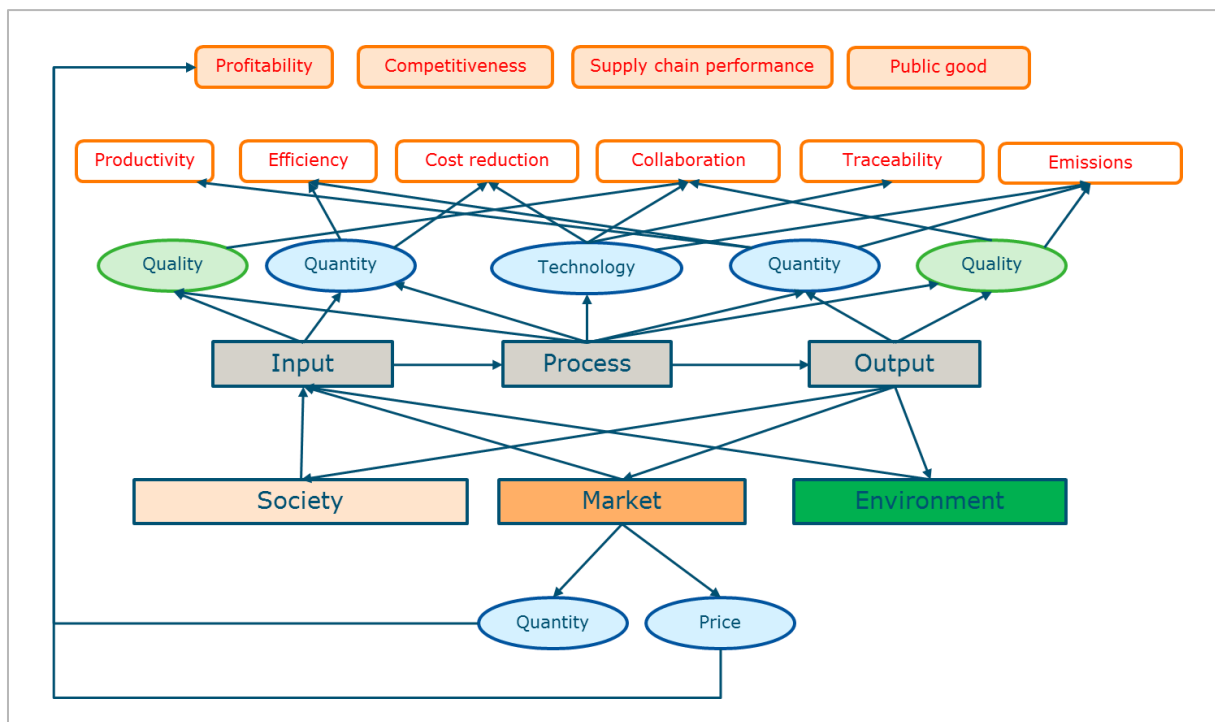


Figure 4 Impact paths to KPIs.

Choosing indicators and assess impact

For each KPI, the impact of the factors and trends can be assessed through the indicators underlying the KPI. To illustrate this, indicate the potential impact for the trials in the following tables as follows:

- (++) potentially very favourable effect
- (+) potentially favourable effect
- (+/-) uncertainty with regard to the impact
- (-) potentially negative influence
- (- -) potentially very negative impact

Brief explanation is added to the signs. Note that some cells in the table are left blank as no direct impact is foreseen at this stage of the project. The tables should however be regularly revisited and adapted to the use case when preferred to take into account latest developments in the five dimensions of the PESTLE framework.

Arable trial

Table 8 Potential impact of key factors and trends on the KPIs in the arable trial

KPI dimensions	PESTLE factors and trends and potential impact on KPIs					
	Political	Economic	Social	Technical	Legal	Environmental
Economic indicators						
Reduction of input/labour/resources/pesticide	(+) Policy on improving use water resource/reduce pollution)		(+) Public awareness of ecological agriculture			(++) More attention for soil quality and soil use
Yield increase crops		(++) Product specific subsidies				
improve production system efficiency				(+) The overall aim is greater user-friendliness and efficiency		
Quality improvement crops		+ (Protein crops recently experienced a strong revival)				

Environmental indicators						
Reduction use nitrogen, fuel, pesticide, water		(++) (Improved fresh water management will be a pre-requisite for stabilising food security and economic development in Africa and EU neighbouring countries)			(+) New energy efficiency legislation	(++) (Improve use water resource/reduce pollution)
Reduction minerals and CO2 emission	(+) accounting agricultural carbon footprint included in greenhouse gas reduction commitments					
Social impact indicators						
Ease of work		Increase time use efficiency	(+/-) Aging population and high rate of unemployment in some EU countries			

Table 9 Key factors and trends relevant to the market outlook and impact of markets for the dairy cases

KPI dimensions	PESTLE factors and trends and potential impact on KPIs					
	Political	Economic	Social	Technical	Legal	Environmental
Economic indicators						
Productivity increase		(+) The rise in EU milk production in the next decade is expected to be moderate and lower than in recent years				
Transparent monitored production system		Environmental constraints to limit production expansion +				+ (Total emissions are expected to decrease in the next decade)
Environmental indicators						
Lower input	(+)				(+)	(+)
Lower leaching						(+) Helps addressing environmental problems and the image of the value chain
Social impact indicators						
Ease of work for farmers			(+/-) Aging population and high rate of unemployment in some EU countries			

Table 10 Key factors and trends relevant to the market outlook and impact of markets for the fruit trail

KPIs	Indicators	PESTLE factors and trends and potential impact on KPIs					
		Political	Economic	Social	Technical	Legal	Environment
Economic	Economic Indicators						
	Productivity increase		(+) Productivity gains needed to offset legal requirements, increase farmers income and for bulky markets			(--) Increasing legal requirements for environment	(+) need for pest control
	Higher yields		(++) Especially in the table grapes, and table olives for global market				
Quality improvement	Improved product characteristics			(++) Demand for premium products/diversification			
	Information improvement		(++) Opportunity to strengthen relations with retailers through information (source, way of production)	(+) Diversified opportunity across Europe to create value added for consumers based on traceability;			
				(+) Information to guarantee product quality			

Environmental KPI's	Environmental indicators						
Reduced waste/ lower emissions/ lower input levels						(++) Increasing legal demands	(+) need for water reduction
Social impact KPI's	Social impact indicators						
Reduced public health risk (workers, reduced residues)				(+) Sector that is not-harmful for public health is a licence to produce (probably not a value added)			
Better jobs (knowledge based)				(+) new job opportunities			
Improved consumer /customer satisfaction (trust)				(+) Diversified opportunity across Europe to create value added for consumers based on traceability			

Table 11 Key factors and trends relevant to the market outlook and impact of markets for the vegetable cases

KPI dimensions	PESTLE factors and trends and potential impact on KPIs					
	Political	Economic	Social	Technical	Legal	Environmental
Economic indicators						
Productivity increase/ cost reduction	(+) Productivity gains needed to offset legal requirements			(--) Increasing legal requirements for	(+) Need for pest control	Productivity increase/ cost reduction

	nts, increase farmers income and for bulky markets			environ ment		
Environmental indicators						
Reduced waste/ lower emissions/ lower input levels				(++) Increasin g legal demands	(+) need for water reductio n	Reduced waste/ lower emissions/ lower input levels
Social impact indicators						

Table 12 Key factors and trends relevant to the market outlook and impact of markets for the meat cases

KPI dimensions		PESTLE factors and trends and potential impact on KPIs					
		Politi cal	Economic	Social	Techn ical	Legal	Environm ental
Economic indicators							
KPIs	Indicato rs						
Productivity increase	Milk produc tion		(+) The rise in EU milk productio n in the next decade is expected to be moderate and lower				

			than in recent years				
Transparent monitored production system			(+) Environmental constraints to limit production expansion				(+) Total emissions are expected to decrease in the next decade
Environmental indicators							
Reduced waste/ lower emissions/ lower input levels						(++) Increasing legal demands	(+) Need for reduction in water use
Social impact indicators							
Reduced public health risk (workers, reduced residues)				(+) Sector that is not-harmful for public health is a licence to produce (probably not a value added)			
Better jobs (knowledge based)				(+) new job opportunities			
Improved consumer /customer satisfaction (trust)			(+) Diversified opportun				

			ity across Europe to create value added for consumers based on traceability				
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6. CONCLUDING REMARKS

Key Performance Indicators (KPI) measure the performance of an organization relative to its objectives (Shahin and Mahbod, 2007). When specifying the KPIs, it is a good practice to clearly define the objectives of each stakeholder and the use case and ensure the KPIs are measurable and justifiable.

At this stage of the IoF2020 project (June 2017), it is important to specify KPIs according to the objectives of the use case per stakeholder and identify relevant variables and indicators that contribute to the KPIs. For a complex project like IoF2020 in which multiple stakeholders and organisations work together, it can be a daunting task to reach a clear set of objectives. It may therefore take several iterations to define and refine the final set of KPIs. Once the KPIs and related indicators are defined and specified, it is expected that the methodology as described in this deliverable can be further applied to each use case.

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APPENDIX 1: KEY PRODUCTS AND SERVICES OF THE USE CASE

Trial	Use Case No	Title	Main commodity of the case	End-user market	
			Commodity that is sold in the market of the case, as main income source for the farm	Geographic scope (of the case)	Relevant market for the partner
T1 Arable	1.1.	Within-field management zoning	Potato in common (mass production)	North West Central Europe (Netherlands, Belgium, Germany)	Global potato market
	1.2	Precision crop management	Cereal crops(conventional)	France	Global cereal market
	1.3	Soya Protein management	Protein production: Soy-bean	East and Central Europe (Austria, Serbia, Romania, Ukraine), Italy	Global soy-bean market
	1.4	Farm Machine interoperability	Machines Farm equipment	Cross over Europe (Denmark lead country)	Global Farm Machine interoperability market
T2 Dairy	2.1	Grazing Cow Monitor	Dairy/Meat (mass production)	BE/NL at start, FR, UK/IR with open call	Global dairy/meat market
	2.2	Happy Cow	Dairy/Meat (mass production)	NL/BE, DE/PL at start UK/IR with open call	Global dairy/meat market
	2.3	Silent Herdsman	Dairy/Meat (mass production)	UK/IR, BE/NL at start DE/PL with open call	Global dairy/meat market
	2.4	Remote milk quality	Dairy/Meat (mass production)	NL/BE, DE at start >> with open call	Global dairy/meat market
T3 Fruit	3.1	Fresh table grapes chain	Table grapes (integrated, organic)	IT (organic); Greece (integrated)	IT: EU, Middle East, Far East; Greece: UK, NL, DE

	3.2	Big wine optimization	Grapes and wine (conventional and organic)	France (conventional, grapes and wine); Italy (organic, wine), but partner not yet specified	FR: global market
	3.3	Automated olive chain	Olive oil or fruit (conventional and organic)	Spain (conventional); Greece (organic)	Spain: global market?; Greece:?
	3.4	Intelligent fruit logistics	multi fruits and vegetables	Germany and the Netherlands?	National, Europe
T4 Veggies	4.1	City farming leafy vegetables	Leafy vegetables for convenience food (lettuce)	NL, metropolises	other metropolises
	4.2	Chain-integrated greenhouse production	Greenhouse vegetables	Mediterranean	The Netherlands, France, Italy, Greece, Morocco or Turkey.
	4.3	Added value weeding data	Organic vegetables (field vegetables)	NL, DE, AT	Global, arable farming and open field horticulture
	4.4	Enhanced quality certification system	Organic grapes/wine	Italy	Global
T5 Meat	5.1	Pig farm management	Finishing pigs	Belgium and the Netherlands	European, world market
	5.2	Poultry chain management	Poultry	Spain	Spain, Portugal, France, Germany
	5.3	Meat transparency and traceability	Pork	Belgium and the Netherlands	European, world market



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APPENDIX 2: KEY IOT COMPONENTS PER USE CASES AND MATURITY LEVEL

Trial	Use Case No	Title	IoT devices	IoT software/Integration	IoT application/Service	Maturity level of IoT	Target maturity level
T1 Arable	1.1	Within-field management zoning	30 sensors for soil moisture, weather stations, Veris soil scanner, machine control, yield sensors, indoor climate, crop quality, 3 GEO-localization units	Lora Network, 365 Farmnet, Zoner, Crop-R and Akkerweb platforms, Cloudfarm FMIS	Weather forecast service, Akkerweb agro-eco algorithms; GIS, zoning and T&T modules	5/6	8
	1.2	Precision crop management	Soil, crop and climate and yield sensors; Accurate GNSS; Fertilizer, irrigation and harvest machines	Arvalis platform; 365 Farmnet and interaction with other platforms; FMIS	Weather forecast service, Arvalis agro-eco algorithms	5	7
	1.3	Soya Protein management	48 Soil, crop, climate and quality sensors; Accurate GNSS; Weed control and fertilizer use machines; Crop quality sensor	Platform 365 Farmnet, FMIS	Weather forecast; Agronomic models of extension services	6	9



	1.4	Farm Machine interoperability	Soil and yield sensors on 2 tractors, 2 soil tillage implements and on 1 combine; 11 stations for precipitation, humidity, air and soil temperature, soil moisture and weather	365 Farmnet, ThingWorx IoT platforms	Soil-plant-atmospheric algorithms; Weather forecast; GIS and zoning tool; Traffic optimization modules	4	7
T2 Dairy	2.1	Grazing Cow monitor	GPS-tracker stickntrack (IoT device), BLE tags (IoT device)	UNB (Sigfox; LoRa is also possible)	Location integration of object cow	6	8
	2.2	Happy Cow	Sensor Device Base Station Device, Cloud Platform	oData + FiWare Analytics for cloud based support system for using cow centric behavioural data.	IoT approach combined with advanced big data and machine learning technologies	6	8
	2.3	Silent Herdsman	Sustainable Society New Economic Models IT as an Utility	Collar based cloud based analytics	Network of sensors, cloud, management support for chain	6	8
	2.4	Remote milk quality	Automated milk quality data exchange for remote calibration	Infrared IoT sensors for milk quality in food factory	Connect milk quality in factory to farm processes by remote validation and calibration	6	8
T3 Fruit	3.1	Fresh table grapes chain	IoT network adapted to the complete supply chain of table grapes from field to fork, benchmarking platform	Integrated Farm Management Information System(FMIS), Pest and disease control management system(PDCMS),	Decision support tool for irrigation management, intelligent water application system, real time alert system for pest and disease incidence	6	8



	3.2	Big wine optimization	sensor device, local internet network, multi sensor/actuator node?, collect data gateway, cloud framework	management software,	Pest management, selective harvesting, wine cellar monitoring, remote quality assessment	6	8
	3.3	Automated olive chain	sensors, on-board computers, LoRA devices	IoT platform (web portal), WSN platform	Farm management, ERP system	6	9
	3.4	Intelligent fruit logistics	Sensors, RFID tags, connectivity devices (Bluetooth, Wifi, etc.)	IoT cloud platform (M&A)	Transparency and traceability system	4-5	7-8
T4 Veggies	4.1	City farming leafy vegetables	sensors, microcomputers, microcontrollers	Data platform, communication standards	software, dashboards, automatic lighting	5-6	8-9
	4.2	Chain-integrated greenhouse production	sensors, computers, server, camera	Data model, platform	decision support system (DSS)	5/6	8
	4.3	Added value weeding data	weeding machine, sensor, camera	machine software, control system	IoT software, algorithms	5	8
	4.4	Enhanced quality certification system	environmental sensors, GPS sensors	IoT data platform	IoT data analytics	3	6
T5 Meat	5.1	Pig farm management	RFID tags, sensors	Platform, data analytics	Early warning, dashboard	6	8
	5.2	Poultry chain management	Sensor, adapter, network	Platform, data analytics	Predictive analytics	6	8
	5.3	Meat transparency and traceability	Sensors, network devices	EPCIS (GS1, ISO)	Farm management, electronic message, traceability	6	8