**UNIVERSITÀ CATTOLICA DEL SACRO CUORE**

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**Dottorato per il Sistema Agro-alimentare**

**Ph.D. in Agro-Food System**

**Cycle XXX**

**S.S.D: AGR/02, AGR/13; ING-IND/16**

# Enhance the Italian agri-food products sustainability features through a multidisciplinary approach that integrates Life Cycle Assessment analysis with other information documenting social, cultural and economic impacts of production activities on landscape and local communities

**Candidate: Pieter Ravaglia**

**Matriculation n.: 4412176**

**Academic Year 2016/2017**

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**Coordinator: Ch.mo Prof. Marco Trevisan**

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**Candidate: Pieter Ravaglia**

**Matriculation n.: 4412176**

**tutor: Prof. Ettore Capri**


**Academic Year 2016/2017**

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## List of acronyms

A: Acidification

AOC: Appellation d'Origine Contrôlée

BRC: British Retail Consortium

B2B: Business to Business

B2C: Business to Consumer

CAM: Minimum Environmental Criteria

CAP: Common Agricultural Policy

CC: Climate Change

CFP: Product Carbon Footprint

CPCC: Control Points and Compliance Criteria

DO: Denominación de Origen

DOC: Denominazione di Origine Controllata

DOCa: Denominación de Origen Calificada

DOCG: Denominazione di Origine Controllata e Garantita

EC: European Commission

EF: Freshwater eutrophication

EM: Marine eutrophication

EPD: Environmental Product Declarations

ET: Terrestrial eutrophication

FMI: Food Marketing Institute

FSC: Forest Stewardship Council

FEW: Freshwater ecotoxicity

FU: Functional Unit

GFSI: Global Food Safety Initiative

HQ: High Quality

HT-ce: Human toxicity, cancer effects

HT–nce: Human toxicity, non-cancer effects

IMELS: Italian Ministry for the Environment, Land and Sea

IR-E: Ionizing radiation ecosystems

IR-HH: Ionizing radiation human health

JRC: Joint Research Centre

LCA: Life Cycle Assessment

LCI: Life Cycle Inventory

LCIA: Life Cycle Impact Assessment

LCC: Life Cycle Costing

LCT: Life Cycle Thinking

LCSA: Life Cycle Sustainability Assessment

LU: Land Use

MF & RRD: Mineral, fossil & renewable resource depletion

MQ: Medium Quality

OD: Ozone depletion

OEF: Organisation Environmental Footprint

P1-12: Producer 1-12

PCR: Product Category Rules

PEF: Product Environmental Footprint

PEFCR: Product Environmental Footprint Category Rules

PM: Particulate Matter

POF: Photochemical ozone formation

PQ: Premium Quality

SDGs: Sustainable Development Goals

SLCA: Social Life Cycle Assessment

UAA: Utilised agricultural area

UCSC: Università Cattolica del Sacro Cuore

W1-27: Wine 1- 27

WFP: Product water footprint

WRD: Water resource depletion

# 1. Foreword

Since the 1990s, a large number of companies in the agricultural sector have decided to rely on quality, a challenge linked to certification systems, especially those of Protected Geographic Indication (PGI), Protected Designation of Origin (PDO), and Organic production. Since then, the public and private certifications linked to the concept of quality productions have been the engine of an economic revolution that has transformed the "typical product" from a niche sector to a sector that has driven agricultural innovation. This sector represent today a significant part of the European economy considered successful by the rest of the world.

The evolution of regulations at European level has favoured the development and diffusion of certified quality schemes.

New patterns of food consumption and the economic crisis are also driving businesses to a strategic repositioning on quality especially in its connotations linked to sustainability and ethics.

The strongest signals come from large-scale retailers and consumers who demand a real differentiation of production, with regard to the quality, origin of agro-food production and to their environmental and social impacts, that are becoming a major issue in public debates.

Over the past 20 years, the European system (particularly as regards Italy, France, Spain and Portugal) has gained a strong reputation making certification a subject capable of directly involving agricultural producers, manufacturers, sales channels and even consumers, who are increasingly aware of the quality and environmental impact of agro-food products (Ravaglia et al., 2018).

In particular, the environmental perception is having a predominant influence on consumer choices, also in the selection of products labelled PDO, PGI and Organic, that are conditioned by the image of protection of the territory and respect for social aspects that these brands carry with them (Aprile et al., 2012).

In this Ph.D I have dealt with the controversial issue of sustainability performance evaluation, maintaining its link to the concept of quality, in virtue of the fact that from the point of view of consumer perception and consumer behaviour, environmental performance is an attribute of quality. The protection and valorisation of the Italian agro-food production must be carried by a green innovation based on sustainability and product quality.

# 2. State of the art

## 2.1. The relevance of agriculture and food industry in Europe

The food and drink industry is the EU-28 is the biggest manufacturing sector in terms of jobs and added value (European Commission, 2017). In 2013, there were 10,8 million agricultural holdings within the EU-28. The utilised agricultural area (UAA) in the EU-28 is almost 175 million hectares (around 40,0 % of the total land area). In terms of utilised agricultural area, France and Spain have the largest share of the EU-28's agricultural land, with 15,9 % and 13,3 % respectively, while the United Kingdom and Germany have shares just under 10%. By contrast, the largest number of agricultural holdings was in Romania (3,6 million), where one third (33,5 %) of all the holdings in the EU-28 are located. Poland have the second highest share of agricultural holdings (13,2 %), some way ahead of Italy (9,3 %) and Spain (8,9 %) (Eurostat, 2015a).

In Italy the food industry is the second largest after metalworking, with a turnover of 132 billion euros in 2016 (Infomercatiesteri.it, 2017). From the last census in 2010 there were 1,620,884 active agricultural and zootechnical holdings with a total Utilised Agricultural Area (UAA) of 12.9 million hectares (ISTAT, 2014).

The environmental impact of agriculture is a relevant issue. The European Commission (EC) estimates that agriculture and animal husbandry activities emissions in the EU-28 amount to 470,6 million tons of $CO_2$ equivalent in 2012, representing 10,3 % of total greenhouse gas (GHG) emissions in the European Union (Eurostat, 2015b).

Global population is rising, continued growth of the world's population is expected at least until 2050. The projections of the 2017 UN prospect (UNDESA, 2017) indicate that there is a 95% probability that the global population will be between 8.4 and 8.7 billion in 2030, between 9.4 and 10.2 billion in 2050 and between 9.6 and 13.2 billion in 2100. To properly feed the world population in 2050 compared with the present population (7.5 billion of which more than 1 billion already underfed), the food production must be increased by 70% (Bruinsma, 2009), and if during the period to 2050, a greater proportion of cropland will be devoted to biofuels, animal feed and other non-food crop, then even greater increase of food crop production will be required to meet global demand.

The Challenge is not equally distributed throughout the world. The most vulnerable areas are in Sub-Saharan Africa and part of South Asia and Latin America, were population is growing faster, yields are low, the effect of climate change will hit harder, and infrastructure, founds and services to provide and apply currently available technology are lacking (FAO, 2011; Serdeczny et al., 2017).

Policy makers would need to address challenges of future food security. The limited amount of land that can be used to meet that growing population demand and the increasing environmental pressures on the food system, including those resulting from climate change, urgently require a behaviour change by states and civil society.

## 2.2. Origin of Sustainable Consumption

The discussion on sustainability evolved over 25 years ago, when the Brundtland Commission published their report "Our Common Future" in which it defines sustainable development as: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development, 1987).

The Earth Summit in Rio de Janeiro was followed by the World Summit on Sustainable Development in Johannesburg in 2002. Sustainable consumption and production was emphasized by the delegations participating at the World Summit as being essential for reaching sustainable development. A working definition of Sustainable Consumption was already provided at the "Oslo Symposium on Sustainable Consumption" in 1994, defining it in the following way: "Sustainable Consumption is the use of services and related products, which respond to basic needs and bring a better quality of life while minimising the use of natural resources and toxic materials as well as the emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardise the needs of future generations" (UNEP, 2010)

Another important outcome of the World Summit was the Johannesburg Plan of Implementation calling for a "10 Year Framework of Programmes" created to promote Sustainable Consumption to achieve economic development without harming the environment (UNEP, 2011).

In 2012, ten years after the World Summit in Johannesburg, the Rio+20 United Nations Conference on Sustainable Development took place in Rio de Janeiro, and it has been a cornerstone of modern sustainable development policies and has strongly influenced the direction they have taken. It has enabled a consensus between the otherwise conflicting objectives of economic growth, social equity and environmental protection by embracing the multi-dimensional concept of sustainable development. The Rio Declaration on Environment and Development, also known as "Rio Declaration", and "Agenda 21" were the major outcome documents of the Rio conference. Agenda 21 laid out specific actions for integrating and attaining social, economic and environmental objectives, including the role of major groups of stakeholders. The conference has been conceived as a landmark event in the global movement for sustainable development. As the main outcome, world leaders decided to launch a process for the development of a set of Sustainable Development Goals (SDGs), which constitute the goals of the 2030 agenda for sustainable development and have replaced the MDGs after 2015 (Eurostat, 2015c).

For many years the concept of sustainability has been used as a synonym for environmental sustainability. In the 20th century, the concept was broadened to include an economic and a social perspective. (ESCAP, 2015).

The three pillars of sustainability can be described as follows:

- **Environmental sustainability:** is a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity (Morelli, 2011).

- **Economic sustainability:** the capacity of an economic system to generate a constant and improving growth of its economic indicators. In particular, the capacity to generate incomes and employment in order to sustain the populations. Within a territorial system, economic sustainability means the capability, through the most efficient mix of resources, to produce and maintain the highest added value, in order enhance the specificity of territorial products and services (Sogesid, 2017).
- **Social sustainability:** the ability to guarantee welfare (security, health, education), equitably distributed among social classes and gender. Within a territory, Social Sustainability means the capacity of the different social actors (stakeholders), to interact efficiently, to aim towards the same goals, encouraged by the close interaction of the Institutions, at all levels (Sogesid, 2017).

In 1995 UNESCO and then the World Summit on Sustainable Development, have asked for the inclusion of **Culture** in the sustainable development model, since culture ultimately shapes what we mean by development and determines how people act in the world. This new approach addresses the relation between culture and sustainable development through dual means: firstly, the development of the cultural sector itself (i.e. heritage, creativity, cultural industries, crafts, cultural tourism); and secondly, ensuring that culture has its rightful place in all public policies, particularly those related to education, the economy, science, communication, environment, social cohesion and international cooperation.

Different authors have appealed to the use of images to increase the understanding of complex concepts, as Sustainability and his three dimensions (Lozano, 2008). One of the most used representation is a stool with three legs, by inserting the new cultural pillar the author likes to imagine it as a fundamental element where the weight of the three pillars is borne by culture, because sustainability does not exist without awareness (Figure 1).


FIGURE 1: SUSTAINABILITY BASED ON CULTURE (RAVAGLIA ET AL., 2018)

In the last decades the Environmental protection has become one of the major issues in the public debates.

The Paris COP21 Conference endorsed the principle that “climate change is an urgent and potentially irreversible threat to human societies and the planet”. It therefore requires “maximum cooperation from all countries” with a view to “speeding up the reduction of greenhouse gas emissions”.

In the recent COP23 in Bonn, which ended on 18 November 2017 and preceded the Cop24 in Katowice, the President of the European Committee of the Regions (CoR), Karl-Heinz Lambertz, stated that “Innovative approaches must be adopted at local level”, and the challenge is “to change something in people's minds and behaviour”(Regioni.it, 2017)

The General Assembly of United Nation, on the 25th September 2015, adopted the resolution 70/1 – “Transforming our world: the 2030 Agenda for Sustainable Development”. The agenda is a plan of action post-2015 to 2030, and contains seventeen Development Goals and one-hundred sixty-nine targets. The agenda was developed in universal goals and target that can involve the entire world, despite the different national realities.

The Sustainable Development Goals are (United Nations, 2015):

Goal 1. End poverty in all its forms everywhere.

Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Goal 3. Ensure healthy lives and promote well-being for all at all ages.

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.

Goal 5. Achieve gender equality and empower all women and girls.

Goal 6. Ensure availability and sustainable management of water and sanitation for all.

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all.

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

Goal 10. Reduce inequality within and among countries.

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable.

Goal 12. Ensure sustainable consumption and production patterns.

Goal 13. Take urgent action to combat climate change and its impacts.

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development.

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.

Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

The resolution encourages all member states to develop as soon as practicable, ambitious national responses to the overall implementation of the Agenda.

Quoting these words, which I completely endorse (Papa Francesco, 2015): "Worldwide, the ecological movement has made significant advances, thanks also to the efforts of many organizations of civil society. […] Environmental questions have increasingly found a place on public agendas and encouraged more far-sighted approaches. This notwithstanding, recent World Summits on the environment have not lived up to expectations because, due to lack of political will, they were unable to reach truly meaningful and effective global agreements on the environment" - I would like to introduce a document which, in an extraordinary way, has highlighted the seriousness of the damage that humans are doing to nature, in a particular historical moment in which the heads of government often deny that these problems really do exist.

The Encyclical letter "Laudato si" of the holy father on care for our common home has had an echo and a very wide diffusion. The document, contrary to the previous encyclicals, does not seem to have a specific recipient but is addressed to the whole of humanity and every one of its components, going beyond the boundaries of the Catholic Church (Cillizza, 2017).

The release of this document in the months before the Paris Agreement has contributed positively to the reaching of the final agreement. In fact, the document took a clear position precisely in view of the debate and the negotiations.

The document clearly reiterates the concept of "integral ecology" in which climate change, water and biodiversity cannot be tackled without the inclusion of the social aspect. The text identifies an ecological and social crisis that also derives from economic and technocratic domination, leading to the destruction of nature and the exploitation of people. It therefore places as necessary a cultural change and invites to an educational path so that a cultural and transversal revolution can be established.

Governments and policymakers are not the only ones responsible, the cultural revolution must also involve the choices of the individual citizen. The individual must, however, be properly informed and enabled to make a choice.

The European Commission is developing policies in this direction.

In the COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS - Roadmap to a Resource Efficient Europe (European Commission, 2011), the European Commission has set an important objective: By 2020, citizens and public authorities will be adequately encouraged to choose the most resource-efficient products and services, with correct price signals and clear environmental information. Their purchasing choices will incentivize companies to innovate and offer more efficient goods and services. Minimum environmental performance standards will be set to remove less efficient and more polluting products from the market. There will be strong consumer demand for more sustainable products and services.

In the COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL Building the Single Market for Green Products - Facilitating better information on the environmental performance of products and organisations (European Commission, 2013a) the Commission announced that: "The Roadmap to a Resource Efficient Europe" sets an ambitious target for 2020: to adequately encourage citizens and public authorities to choose the most resource-efficient products, through correct price signals and clear environmental information. It also recognizes the key role of the Internal Market in rewarding resource efficient products. This initiative "Building the Single Market for Green Products" is an important step in this direction.

This Communication sets out two shared European Environmental Footprint methodologies for measuring the environmental performance of products and organisations and a set of principles on which to base their communication. The Communication is accompanied by a Commission Recommendation encouraging Member States and the private sector to use these new approaches, as appropriate, to improve the functioning of the internal market (European Commission, 2013b).

In the COUNCIL CONCLUSIONS ON ECO-INNOVATION: ENABLING THE TRANSITION TOWARDS A CIRCULAR ECONOMY the Council of the European Union invites the Commission "to explore also the possible uses of the Product Environmental Footprint (PEF) and Organisation Environmental Footprint (OEF) for measuring and communicating environmental information, taking full account of the need to maintain the competitiveness of Member States" (Council of the European Union, 2017).

## 2.3. Quality in the agro-food sector

According to ISO (International Organization for Standardization, 2015) quality is "the totality of characteristics of an entity that bear upon its ability to satisfy stated and implied needs".

From this definition it is clear how quality is based on the figure of the consumer who, through the "product", satisfies his expectations. A human factor is intrinsic to quality assessment, which depends on the availability and knowledge of the product being consumed.

The good is seen as a "basket of attributes", however, in the case of food and agro-food products, not all characteristics are identifiable and therefore can be assessed in qualitative terms before actual consumption, and very often even after it. Following the Nelson classification (Nelson, 1970) "search good" is defined as a product for which the verification of quality is possible before the purchase of the product itself, but this verification is expensive. On the other hand, "experience good" is defined as a product for which quality is only revealed after purchase, at the time of consumption. In all those cases in which, even after its purchase, the consumer is not able to determine the quality characteristics, it is defined "Credence good" (Michael R. Darby and Edi Karni, 1973).

The attributes of a food product range from "visual" characteristics (appearance, colour, absence of external damage, etc.), "organoleptic" characteristics (bouquet, taste, etc.) and attributes that are not directly observable or verifiable by the consumer, often not even after consumption, the so called "Credence" characteristics such as product salubrity, environmental and social aspects and origin characteristics.

The consumer is more and more concerned about the attributes of "credence", quality in its broadest sense includes aspects such as health, environmental protection, animal welfare, aspects of origin and protection of the territory, and embraces in an indissoluble way the concept of sustainability.

## 2.4. Multiplication of environmental and sustainability labels

The consumer interest in sustainability performance of products is also proved by the constant growth of sustainability certification schemes. The multiplication of sustainability schemes has been observed since the 1990s (Ceci-Renaud et al., 2012; European Commission, 2013c; Gruère, 2013), Gruère observed a multiplication of the Organisation for Economic Co-operation and Development (OECD) countries total number of schemes by five (from nearly 100 in 1990 to more than 500 schemes in 2013). The food and agriculture sector, with textile, forestry and building have a dominant share of schemes.

This proliferation easily can lead to consumer confusion and frustration. Fischer and Lyon, (2014) explain that the label multiplication can impair environmental performance in general, even when consumers have access to perfect information, and that consumer confusion makes matters worse.

The proliferation of methodologies is hampering the functioning of the green products market.

To be able to fulfil high market expectations and to reduce the number of misleading or false sustainability claims, increasing the number of correct ones is important to define common international standards. Groups of products usually differ in their inherent sustainability performance so beside internationally-agreed standards also common and harmonized calculation rules have to be established within the same product group, to ensure that similar procedures are used. Unfortunately, the definition of shared and common methods can be not enough, is proved that small amounts of uncertainty about the quality of labels can create consumer confusion that reduces or eliminates the value to firms of adopting them. Label multiplication aggravates the effect of uncertainty, and as the number of labels becomes large, labelling becomes completely uninformative (Harbaugh et al., 2011). This study suggests that if one label becomes "focal" (that is, it comes to be a norm that is expected by consumers), this can alleviate the problem of multiplication. Failure to adopt the focal label is taken by consumers as a significant failing, and has a greater impact on sales than if the label were just one among many options. In fact, in a world with label uncertainty, a focal label plus multiple uncertain labels actually performs better than a single label, because firms that do not meet the standard of the focal label can still convey some information to consumers by meeting one of the others. This suggests that a government-backed label may be able to bring some order to a chaotic labelling market.

## 2.5. European consumer behaviour

Sales of PDO and PGI products and products from organic farming are growing steadily in recent years, mainly due to the fact that local and organic products may be categorized as "sustainable produced food" since they reflect two different components of sustainability: a social component related to the integration of the support of the agro-food sector with the priorities and needs of citizens and an environmental component relating to sustainable use and management of the natural resources (Vermeir and Verbeke, 2006).

In particular Organic Agriculture has had and is still having an extraordinary success. Consumers prefer organic production despite the higher costs. The key to this success is linked to the ability of these products to evoke in consumers a multiplicity of "emotions". Organic products are perceived as having both attributes of "public benefit" (e.g. reduced environmental impact, animal welfare, biodiversity and protection of small and local producers) but also by attributes of "private benefit" because they are perceived as products that guarantee a healthier and "taster" diet. (Albright, 2014; OECD, 2011). Regardless of the type of benefit that the consumer is looking for, organic products are perceived as an optimal mix of quality, health and environmental protection.

This trends are reflected also by the European Commission data related to the concerns of European citizen. In 2009, according to the European Commission's barometer (European Commission, 2009a), nearly half of Europeans (47%) ranked climate change as the second most important issue, behind poverty and ahead of the global recession. The concept of "sustainable development" continues to find its way into people's minds, and not only is awareness is growing, but citizens also feel them part of the process, are increasingly sensitive to certain environmental problems, and therefore take them into account in their daily choices (Hoibian, 2012).

Various studies carried out on European consumers prove that: French citizens are widely aware of certain environmental issues (Council for Agriculture Science & technology, 1999), 93% of them agree that individual efforts can have a significant impact on environmental protection, and 78% agree that they could do more or better in their daily choices to ensure the compliance with a more sustainable development. Those most committed to the environmental cause are also the most convinced that they could still change their daily practices. But even among those who are more indifferent to environmental issues, almost seven in ten feel that they could do better or more on a daily basis to ensure sustainable development (Hoibian, 2012).

In Italy, consumers willing to pay a premium price for sustainable brands are 52%, up sharply from 44% in 2013 and 45% in 2014 (Nielsen, 2015).

In Germany TNS Emnid conducted a population-representative survey on behalf of the federation of German consumer organisations (vzbv) in January 2016. The key results of the study are that two thirds of consumers are (always) willing to buy sustainable products when shopping groceries, 63% claim to not find sufficient information on the sustainable footprint of articles and 36% have difficulties in recognizing sustainable products yet. Further, 55% criticize high prices and 44% the poor availability of sustainable food products (Verbraucherzentrale E.V. Bundesverband, 2016).

In Europe, consumers willing to pay a premium price for sustainable brands in 2015 are 51% (40% in 2014 and 37% in 2013), and at global level, the value rises to 66%, growing faster by 11 percentage points compared to 2014 and by 16 points from 2013 (Nielsen, 2015). At global level, companies committed to environmental and social sustainability registered a 4% growth in 2015 turnover, unlike those not engaged, whose turnover increased by less than 1% (Nielsen, 2015).

## 2.6. Classification of public and private certification initiatives

As mentioned above, the products are characterised by “visual”, “organoleptic” and “credence” characteristics. Some of these attributes/characteristics are “essential” and concern the fulfilment of collective interests such as trade requirements related to health and consumer information. The non-compliance with these requirements results in a ban on the product being marketed. Other attributes, instead, are “additional” and concern the guarantee of product quality principles, help to protect the reputation of companies and in some cases may form the basis for obtaining a competitive advantage.

The “essential” attributes are often regulated by the public authority, which intervenes through different regulatory models (e.g. mandatory standards, certification schemes at regional or national level), which aim to achieve optimal quality levels in order to ensure consumer protection. Outside this area where public authorities are obliged to legislate, voluntary public and private regulation fill the gap created by “additional” consumer expectations. Those regulations use the instrument of third party certification to guarantee to the consumer the respect of production standards or higher quality levels.

In 2012, the European Union issued EU Regulation n.1151 (European Parliament, 2012) “Quality package” on the quality of agricultural products, which proposes, in particular, the adoption of a common simplified and shortened registration procedure for geographical indications and traditional specialities, as well as clearer provisions on the relationship between trademarks and geographical indications, on the role of applicant associations, on the definition of “traditional speciality guaranteed” (TSG) and on the increasing demand for consumer information on “voluntary quality claims” such as the indication “Mountain Product”. The new provisions establish the rules for agricultural products and foodstuffs, but exclude from their scope the recent disciplines on geographical indications relating to wines, spirits and aromatised wines disciplined by the (EU) Regulation n. 1308/2013.

The Regulation n.1151 is linked to the Communication on the Common Agricultural Policy (CAP) towards 2020, to the priorities set out in the Europe 2020 Communication and to the guiding principles of consumer information policy.

The European Package was created to protect agro-food quality by setting standards that affect various areas: from health care to information on the characteristics of the product (labelling) and its origin. In particular, the European provisions concern the protection of products with quality characteristics deriving from the specific production area (PDO), the typical production tradition of a specific locality (PGI), and the protection of intellectual property rights. This has enabled to tune and regulate the use of quality labels, which above all in their Business to Consumer (B2C) connotations were creating confusion among consumers by threatening the transparency of information, especially as regards the credibility of claims and the transparency of schemes and the excessive increase in costs for small producers by excluding or not promoting them in market transactions.

Below is an attempt, although certainly not in an exhaustive way, to classify the initiatives for quality “protection” of product by dividing them into public and private initiatives. The classification reported here also includes all those “sustainable” or “environmental” quality initiatives that are being developed at European level and which are now unavoidably linked to the concept of quality.

A summary table of the public and private initiatives described in this chapter is provided in ANNEX V.

### 2.6.1. Public Initiatives

Public initiatives can be classified into two different sub-groups: compulsory and voluntary.

#### *2.6.1.1. Compulsory EU public initiatives*

The public authority has always been the guarantor of the food market and has tried to preserve its proper functioning. The public authority, especially in the agro-food sector, has a higher degree of “responsibility” than the other productive sectors, both in terms of costs for society and in terms of public guarantees of protection for the citizen. The intervention of the public authority is manifested through the enactment of binding rules governing production practices and, more generally, the organisation of the entire supply chain with the aim of achieving an adequate level of food quality and safety. The objective that the authority wants to achieve with this type of initiative is to guarantee the reaching of a minimum quality level, through the creation of Minimum Quality Standards. (Grazia et al., 2012) or providing correct information to the final consumer (Bureau and Valceschini, 2003).

The main mandatory public initiatives are listed here below.

### Regulation (CE) n. 396/2005 of 23 February 2005 – Plant Protection products maximum residue level

The Regulation (CE) n. 396/2005 of the European Parliament and of the Council of 23 February 2005 (European Parliament, 2005), which entered into force 1st September 2008, lays down harmonised Community provisions on maximum residue levels (MRLs). Annexes II and III of the regulation set out for the individual active substances contained in plant protection products the maximum residue levels set at Community level in/on the different food matrices listed in Annex I to that Regulation.

### Council Regulation (CEE) n. 315/93 of 8 February 1993- Contaminants in foods

Council Regulation (EEC) n. 315/93 of 8 February 1993 laying down Community procedures for contaminants in foodstuffs (Council of the European Communities, 1993) and refers to a number of regulations and circulars setting maximum levels for contaminants in foods.

### Commission Regulation (EC) n. 1881/2006 of 19 December 2006 - setting maximum levels for certain contaminants in foodstuffs

Commission Regulation (EC) n. 1881/2006 of 19 December 2006 sets maximum levels for certain contaminants (Nitrate, mycotoxins, Metals, 3-monochloro-1,2-propanediol, polycyclic aromatic hydrocarbons) in foodstuffs in order to protect public health by maintaining the levels of contaminants at toxicologically acceptable levels (European Commission, 2006). Over the years, the Regulation has been repeatedly and profoundly amended through the issuing of specific regulations (in ANNEX IV all the valid EU regulation updated to July 2017) because it appears necessary to amend the maximum levels for certain contaminants in order to take account of *Codex Alimentarius* developments.

### Regulation (EU) n. 1169/2011 of the European Parliament and of the Council of 25 October 2011 – provision food information to consumers

Regulation (EU) n. 1169/2011 on the provision of food information to consumers entered into application on 13 December 2014. The obligation to provide nutrition information will apply from 13 December 2016. Mandatory labelling includes the list of ingredients; net quantity; date of minimum durability; special conditions for keeping or use; and the name of the manufacturer, packager, or a vendor established in the Community. It is noteworthy, though, that provenance must only be indicated when the omission of such information might mislead the consumer; in most cases it is not required to indicate the origin of products (The European Parliment and the Council of the European Union, 2011).

### *2.6.1.2. Voluntary EU public initiatives*

Public authorities also defined voluntary standards. In these cases, the aim of public intervention is to protect the final consumer as regards the correspondence of the product with respect to certain requirements on which companies base their qualitative differentiation and which therefore aim to ensure the transparency of the prescribed requirements in such a way as to ensure that the quality level is maintained in the long term. (Grazia et al., 2012).

Consumers are no longer only interested in "organoleptic" attributes, but are increasingly looking for attributes defined above as "credence", such as social, ethical and information related to the production techniques of agro-food products, their provenance, the correct remuneration of agricultural producers, respect for the environment and the correct management of natural resources.

Regulation (EU) n. 1151/2012 of the European Parliament and of the Council of 21 November 2012 on agricultural product and food quality schemes is the new reference text of the European Union framework on food Quality Systems (QS) (European Parliament, 2012). It repealed the previous legislation on designations of origin, geographical indications and traditional specialities guaranteed. The implementing regulations of Commission Regulation (EU) n. 1151/2012 are Commission Delegated Regulation (EU) n. 664/2014 of 18 December 2013 and Commission Implementing Regulation (EU) n. 668/2014 of 13 June 2014.

The QS concerned by this legislation are those which identify, at European level, the names of products with specific qualities linked to a geographical area (PDO and PGI), or the names of products obtained by traditional methods or raw materials (Traditional Specialty Guaranteed - TSG - which are not geographical indications). This identification is carried out following the completion of the procedures and in compliance with the conditions laid down in these regulations, through registration of the name. The name registration is intended to protect its use: only products that comply with the product specification may be marketed under the registered name. Conversely, all producers who comply with the specification may use the registered name. The virtuous consequences of such a system are the fair gain for producers (they are protected against unfair competition from those who could use the registered name to sell a product of lower quality and lower commercial value) and clear information for consumers (they are given the opportunity to know what they buy because they are assured that the product purchased is obtained in accordance with certain rules contained in the product specification).

The three types of QS mentioned above are briefly described here below.

**Protected Designation of Origin –PDO** - identifies products that are produced, processed and prepared in a specific geographical area, using the recognised know-how of local producers and ingredients from the region concerned. These are products whose characteristics are linked to their geographical origin. They must adhere to a precise set of specifications and may bear the PDO logo below.

**Protected Geographical Indication –PGI** - identifies products whose quality or reputation is linked to the place or region where it is produced, processed or prepared, although the ingredients used need not necessarily come from that geographical area. All PGI products must also adhere to a precise set of specifications and may bear the logo below.

**Traditional Speciality Guaranteed – TSG**- identifies products of a traditional character, either in the composition or means of production, without a specific link to a particular geographical area.

The intensity of the link with the geographical location varies according to whether PDO, PGI or TSG. For PDO products, an essential or exclusive link between the quality or characteristics of the product and the geographical area of reference is required. All stages of production take place in the area and all raw materials come from the area. There is a direct and exhaustive identification between the area and product. For PGI the link with the territory can be modulated in a less stringent way. It is only required that a given quality or reputation or other characteristics of the product are attributable to its geographical origin. Only one stage of production must necessarily take place in the geographical area and the raw materials may also come from outside the area. As a rule, the Commission accepts PGI's specifications which provide for the use of raw materials exclusively from the geographical area. However, if there is no obligation to use the raw materials originating in the area. The origin of the raw materials must be left free in accordance with the principle of free movement of goods, unless a restriction on the origin (outside the area) of the raw materials can be justified by the need to maintain the link between the product and the territory geographical indications (PDO and PGI) can therefore be defined as particular intellectual property rights, since they are not owned by a person or body but by a territory. The heart of the regulation is in the protection of the name. It is the name that is protected and not the product. The product whose name is protected may be imitated. Therefore, it is not protected as a product. But, if imitated, it cannot be marketed under the protected name. Moreover, the rule also applies to non-comparable products where the use of the registered name is intended to exploit the reputation of the protected name. The protection is extended to the use of PDO and PGI as ingredients. The second rule of the protection regime is to protect the name against any misuse, imitation or evocation, even if the true origin of the goods or services is indicated or if the protected name is a translation or accompanied by expressions such as «style», «type», «method», «in the manner», «imitation» or similar. The third rule provides for residual protection against any other false or misleading indication as to the source, origin, nature or essential quality of the product used on the packaging, in advertising material or other documents. This rule is intended to affect cases where the label or packaging contains particulars, signs or any other visual device intended to manipulate the consumer's perception of the origin, origin, nature or quality of the product despite the fact that the name under which the product is sold complies with the first and second protection rules.

Despite efforts at Community level to protect local production, EU regulations are very often not enough as there is still a flourishing trend and the uncontrolled marketing of “similar” products, with considerable economic damage to individual consortia (Fondazione Qualivita, 2017). The “similar” products that are sold both in Italy and abroad on the shelves alongside PDO products with names and images on the packaging that somehow evoke the PDO productions (e.g. Gran Grattuggiato, GranMix etc. made up of a mix of grated cheeses and do not contain Grana Padano cheese inside them) mislead less careful consumers. For years the various consortia have been complaining about the need to protect the most valuable productions with more specific rules that avoid the confusion of the consumer with stricter requirements as regards images on products and positioning on shelves in supermarkets, but for the moment the actions taken have not been successful.

Up to a few years ago, the EU classified wine quality into two categories: Quality Wine Produced in a Specific Region (QWPSR) and Table Wine. These classifications were replaced in 2013 with Regulation (EU) n. 1308/2013 which specify that wines with characteristics attributable to a specific region can be registered under the European Union's quality logos “Protected Designation of Origin” and “Protected Geographical Indication”. But they still maintain the specific national quality categories which correspond to PDO and PGI.

The most significant for PDO are:

- France: AOC (Appellation d'Origine Contrôlée);
- Italy: DOC (Denominazione di Origine Controllata) and DOCG (Denominazione di Origine Controllata e Garantita);
- Spain: DO (Denominación de Origen) and DOCa (Denominación de Origen Calificada);
- Portugal: IPR (Indicação de Proveniência Regulamentada) and DOC (Denominacão de Origem Controlada);
- Germany: QbA (Qualitätswein bestimmter Anbaugebiete) and 'Prädikatswein' (formerly known as 'QmP' or Qualitätswein mit Prädikat);
- Austria: Qualitätswein and Prädikatswein, including DAC (Districtus Austriae Controllatus).

The Most Significant for PGI are:

- France: VDP (Vin de Pays);
- Italy: IGT (Indicazione Geografica Tipica);
- Spain: VT (Vino de la Tierra);
- Portugal: VR (Vinho Regional);
- Germany: Landwein;

- Austria: Landwein.

### Organic agriculture

The QS of the European Commission also include production from organic farming.

Organic agriculture, sometimes called biological or ecological agriculture, combines traditional conservation-minded farming methods with modern farming technologies. It emphasizes rotating crops, managing pests naturally, diversifying crops and livestock, and improving the soil with compost additions and animal and green manures. Organic farmers use modern equipment, improved crop varieties, soil and water conservation practices, and the latest innovations in feeding and handling livestock. Organic farming systems range from strict closed-cycle systems that go beyond organic certification guidelines by limiting external inputs as much as possible to more standard systems that simply follow organic certification guidelines (Reganold and Wachter, 2016).

In Europe, the production of products from organic farming is regulated by Council Regulation (EC) No 834/2007. In other countries, organic standards are formulated and overseen by the government. The United States, Canada and Japan have, like the EU, comprehensive organic legislation, and the term "organic" can be used only by certified producers. In other countries, government guidelines may not exist, and certification is handled by non-profit organizations and private companies. Internationally, negotiations are underway and some agreements are already in place, to harmonize certification between countries and facilitating international trade. The International Federation of Organic Agriculture Movements (IFOAM) is also working on harmonization.

The EU regulation protects the denominations "biological" and "organic", sets production rules and standards, and defines the procedures of control and inspection. Organic farming relies on a number of objectives and principles, as well as common practices designed to minimize the human impact on the environment, while ensuring the agricultural system operates as naturally as possible.

Typical organic farming practices include (European Commission, 2018a):

- wide crop rotation as a prerequisite for an efficient use of on-site resources;
- very strict limits on chemical synthetic pesticide and synthetic fertiliser use, livestock antibiotics, food additives and processing aids and other inputs;
- absolute prohibition of the use of genetically modified organisms;
- taking advantage of on-site resources, such as livestock manure for fertiliser or feed produced on the farm;
- choosing plant and animal species that are resistant to disease and adapted to local conditions;
- raising livestock in free-range, open-air systems and providing them with organic feed;
- using animal husbandry practices appropriate to different livestock species.

### Quality terms

In addition to these quality regimes at EU level, there are other optional schemes recognised by the European Commission within the EU Regulation n. 1151/2012 and the implementing and delegated regulations, defined as "Quality terms".

### *Mountain product*

In order to use this term, the products' raw materials and the animal feed used must come essentially from mountain areas, while for processed products, production should generally take place in such areas.

Created to enhance the value of mountain products grown or produced in less-favoured areas, it is particularly suitable for products of animal origin and honey.

### *Product of EU's outermost regions*

Outermost regions (French Overseas Departments -Guadeloupe, French Guiana, Réunion and Martinique- and the Azores, Madeira and the Canary Islands) face difficulties relative to regions in mainland Europe from their remoteness and insularity, including difficult geographical and meteorological conditions. With a view to ensuring greater awareness and consumption of quality agricultural products, whether natural or processed, which are specific to these outermost regions, a graphic symbol (logo) was introduced in 2006 (Figure 2). The regulation sets out specific measures in the agricultural sector to remedy the difficulties caused by the specific situation facing the Union's outermost regions.

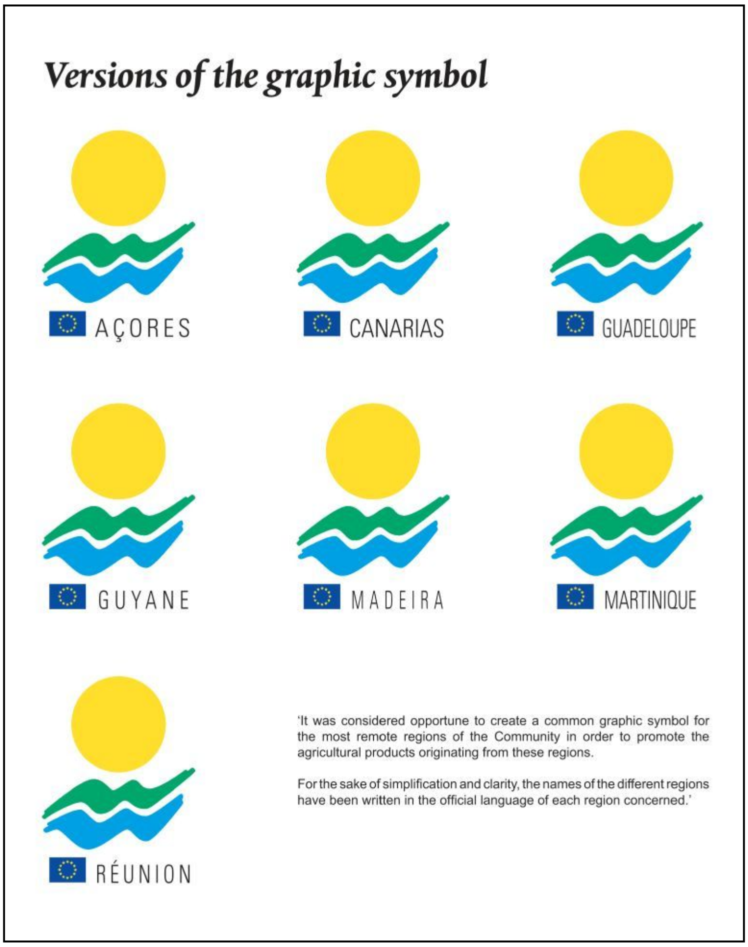



FIGURE 2: OUTERMOST REGIONS LOGOS

## The Product Environmental Footprint (PEF) of the European Commission

The European Commission has launched, on an experimental basis, a European programme called "Single Market for Green Products Initiative", to develop a shared European methodology on the environmental footprint of products called Product Environmental Footprint (PEF), in order to contrast the proliferation of environmental impact assessment methodologies (European Commission, 2013b). The testing of the methodology, defined by the Commission Recommendation 2013/179/EU, started in 2013 and will end in 2018 allowing companies to calculate and communicate the environmental footprint of products in a fair and comparable way. The experimentation process involves twenty-five product categories, eleven of which are linked to the agro-food chain (wine, animal feed, pasta, bottled water, olive oil, red meat, saltwater fish, animal feed for the livestock chain, beer, coffee, dairy sector). Unfortunately, the number of Italian, Spanish, Portuguese and Greek companies that participated in this experimental phase was very small. In those few sectors in which they were involved, there was a strong commitment to enhancing the value of local and quality products.

#### EU Ecolabel – label of ecological quality

With Regulation (EC) n. 66/2010, the European Union has established a voluntary participatory ecological labelling scheme to promote and make recognisable products with a reduced environmental impact to consumers throughout their life-cycle, to provide consumers with accurate, non-deceptive and scientifically based information on the environmental impact of products.

Until now, this trademark has expressly excluded its referability to agricultural products and foodstuffs, but Ecolabel is reported here because in the current version of the regulation (that replace the regulation n. 880/92) there is a reference to the possible extension to food and feed covered by organic farming.

### *2.6.1.3. Voluntary National Initiatives*

At EU level, different types of quality systems (QS) have been set up to recognise and identify quality production through European/national labels. These labels must be audited and certified by specially authorised independent third parties.

The QS recognised at community level, so as reported before, cover designations of origin (PDO and PGI), organic production. Member States have the possibility to recognise other QS at national level, provided that they ensure quality characteristics that add value to the final product, such as special production techniques, quality criteria that are well above the commercial minimums for the final product, covering issues such as animal welfare, public health or environmental protection. These QS must be open to all agricultural producers, and must provide production regulations that are binding, transparent to stakeholders and capable of ensuring complete traceability in the production chain.

#### Label Rouge (FRANCE)

The Label Rouge is a French national sign of quality assurance as defined by Law n. 2006-11 of the 5th January 2006, which refers to products which by their terms of production or manufacture have a higher level of quality compared to other similar products usually marketed.

Quality, in this case, refers to all the properties and characteristics of a product that give it its ability to satisfy explicit or implicit needs.

In addition to the sensory characteristics and their perception, of the Label Rouge product by the consumer, the superior quality is based on:

- production conditions, which differ from the conditions of production of usually marketed similar products;
- product image in terms of its conditions of production;
- elements of the presentation or service.

Products which may benefit from a Label Rouge are food and non-food items as well as non-processed agricultural products (i.e. flowers).

The Label Rouge is open to all products, regardless of their geographical origin (including outside the European Union).

At all stages of its production and its development, the Label Rouge product must meet the requirements defined in the specifications, validated by the Institut national de l'origine et de la qualité (INAO) and approved by a ministerial order published in the Official Journal of the French Republic.

The monitoring of compliance with these requirements and product traceability is ensured by an independent certification body on the basis of a monitoring plan approved by the INAO.

Monitoring of maintenance over time of the high food quality is ensured by performing regular sensory analysis and organoleptic tests that compare the Label Rouge product with the current product.

A commodity or Label Rouge product may benefit simultaneously from a protected geographical indication or a traditional speciality guaranteed, but not an original (PDO). (INAO, 2018)

### SQNPI – Sistema di Qualità Nazionale per la Produzione Integrata (ITALY)

The Italian Government Law n. 4 of the 3rd February 2011, "Disposizioni in materia di etichettatura e di qualità dei prodotti alimentari" in art. 2, subsections 3 - 9 establishes the National Integrated Production Quality System (hereinafter referred to as SQNPI). The SQNPI quality system is active since January 2016 and is applicable to all crop production.

The SQNPI provides for the adoption of the regional integrated production specifications (approved by the Ministry of Agricultural and Forestry Policy). Integrated production is defined as a system of agro-food production that uses all means of production and defends agricultural production from adversity, aimed at minimising the use of synthetic chemicals and rationalising fertilization in compliance with ecological, economic and toxicological principles. In practice, it is a system of traceability of production to demonstrate that certified products come from farms which apply the above regional specifications. Companies can join SQNPI either individually or in an associated form (e. g. producer consortia, cooperatives or associations).

The integrated production according to the SQNPI allows on one hand to comply with the legal obligations regarding integrated pest management (National Action Plan) and on the other hand to respond to the pressing market demands of the national and international large-scale retail trade, which is increasingly aware about cultivation methods.

SQNPI, it is a quality system recognised in accordance with Community rules, allows both individual and associated information farms to have access to public financing measures under the rural development plans.

### Haute valeur environnementale HVE certification (FRANCE)

The haute valeur environnementale (High Environmental Value - HVE) certification comes from the Grenelle Environment law. This environmental certification, which appeared in February 2012, is a voluntary approach accessible to all the sectors concerned by four themes: biodiversity, fertilization management, phytosanitary strategy and water resource management.

The HVE certification is established according to a progressive certification logic taking into account the totality of farms. Environmental certification is controlled by third party bodies that are both independent and approved by the Ministry of Agriculture. This type of certification corresponds to the characterization of farms with high environmental performance. The HVE certification cycle is three years. Those who have received certification benefit from less pressure from Common Agriculture Policy (CAP) controls and a financial incentive.

This program is similar to the Italian SQNPI, and have the same objective. Add to the European regulation of Integrated Pest Management some stringent compliance about environmental sustainability of high quality farm production.

### VIVA Sustainability and Culture (ITALY)

This certification has not already been recognized has quality system following the European rules, because focused only on the wine industry in Italy, but has important innovative aspect.

The VIVA project promoted by the Italian Ministry for the Environment Land and Sea (IMELS) since 2011 aims to improve the sustainability performance of the wine sector, through the analysis of four indicators: Air, Water, Territory and Vineyard. The scheme uses for the Air indicator the carbon footprint analysis with an LCA approach, while for the Water indicator uses an innovative methodology that integrates the Water Footprint Network with an innovative method for grey water (Lamastra et al., 2014). In addition to these first two indicators, which concern environmental sustainability, the programme presents two indicators specific for the wine sector: Territory (social, cultural and economic sustainability) and Vineyard (environmental and social sustainability understood as health of consumers and workers in the agricultural sector) (Lamastra et al., 2016; MATTM, 2016).

The programme imposes as a condition of access compliance with a series of mandatory minimum criteria linked to the wine sector, both as regards social aspects (e.g. transparency regarding seasonal employment contracts; training of workers; safety in the field and cellar) and aspects of protection and financing of territorial relaunch activities (the limits are integrated in the Territory indicator).

The certification has a duration of 2 years and at each renewal the company must commit itself to improve its environmental performance through the definition of energy efficiency strategies and environmental impact reduction in the short, medium and long term in order to undertake a path of continuous improvement.

An inter-ministerial agreement has recently been signed between the IMELS and the Ministry of Agricultural Policy to coordinate the efforts of the VIVA and SQNPI projects (Viticolturasostenibile.org, 2017).

### Italian Environmental Footprint Assessment National Programme

The IMELS is committed to supporting, through programs in collaboration with public administrations and national companies, the promotion and dissemination of sustainable production and consumption models that include the reduction of greenhouse gas emissions, the main causes of climate change.

The IMELS in 2011, has lead off an intensive program on the environmental footprint of goods/services/organizations, that represents today, a good practice of public-private cooperation, with the involvement of more than 200 actors, among companies, municipalities and universities (MATTM, 2017a).

The initiative aims at the promotion of the companies' voluntary commitment for the evaluation of the environmental performances and for the reduction of the GHG emissions.

The project aims at identifying the companies' procedures of carbon management and at supporting the use of low-carbon content technologies and good practices in the manufacturing processes. This work represents:

- an environmental driver but also a competitive tool for the whole system of Italian companies, that nowadays takes into account the importance of the "eco-friendly" requisites of products on the market;
- an incentive to rethink the production and supply system cycles;
- an opportunity to create a new awareness for users, to encourage increasingly responsible choices and good practices.

### Made Green in Italy

(Italian Law 221/2015)"*Disposizioni in materia ambientale per promuovere misure di green economy e per il contenimento dell'uso eccessivo di risorse naturali*" (Provisions on environmental issues to promote green economy measures and for the containment of excessive use of natural resources), in the art. 21, foresee the establishment of a national scheme for the assessment and communication of the environmental footprint of products, called "*Made Green in Italy*", based on the PEF methodology promoted by the European Commission (MATTM, 2017b).

A Ministerial decree n. 56 of march 2018 approved the Made Green in Italy Voluntary Scheme (MATTM, 2018).

The Made Green in Italy (MGI) is a voluntary scheme aimed at promoting the adoption of innovative production technologies and regulations, able to guarantee the improvement of product performance and, in particular, the reduction of environmental impacts that products have during their life cycle[...]. In particular, the programme aims to strengthen the image, appeal and communicative impact that distinguishes Italian productions, associating aspects of environmental quality, also in compliance with social sustainability requirements. In addition to strengthening the environmental qualification of agricultural products, priority should be given to the definition of production parameters that are sustainable from an environmental and landscape quality point of view.

With this initiative, the Legislator intends to take an important step to highlight how Italian products can be considered not only of high quality, but also "green" products and undertakes to define for each specific product category analysed, a series of criteria and indicators that will optimally characterize the specific critical aspects of the sector examined from a 360° sustainability point of view.

### 2.6.2. Classification of private initiatives

Public regulations often limit themselves to prescribing "result limits" by defining basic parameters or prescribing the mandatory nature of a control system, and are accompanied by private standards of quality and food safety. Private initiatives are mostly undertaken by large organised retail outlets, or by large processing industries which, through the adoption of these standards, implement a system of control over the supply chain, minimising the possibility of exposure to image risk.

Private initiatives are therefore "more stringent" than public regulation, as they are able to be more "specific", focusing on the critical aspects of the sector analysed, also intervening in the single sector, defining conditions of effectiveness, specific requirements and surveillance measures, acting directly on the process.

Increasingly, they also include social and environmental requirements on their suppliers.

Private quality assurance initiatives can be classified on the basis of their intention to signal quality commitment directly to the consumer or not. The standards with a Business to Business (B2B) perspective.

#### 2.6.2.1. *Standard with a Business to Business (B2B) perspective*

The following described standards are used exclusively for B2B communication, with the aim to access certain foreign markets or to commercialise their products in certain large retail chains.

**The Global GAP standard**

The GLOBAL G.A.P. certificate, also known as the Integrated Farm Assurance standard (IFA), covers good agricultural practices for agriculture, aquaculture, livestock and horticulture production. It also covers additional aspects of the food production and supply chain such as chain of custody and compound feed manufacturing.

The IFA standard was revised through an extensive stakeholder involvement and consultation process and IFA standard V5 was published in July 2015 with one-year conversion period. This means that the IFA standard V5 became obligatory in 2016.

The GLOBALG.A.P. IFA standard V5 is built on a system of modules that enables producers to get certified for several sub-scopes in one audit. It consists of:

- general regulations: these map out the criteria for successful Control Points and Compliance Criteria (CPCC) implementation as well as set guidelines for the verification and the regulation of the standard;
- Control Points and Compliance Criteria (CPCC): these clearly define the requirements for achieving the quality standard required by GLOBALG.A.P.

The CPCC are also modular-based consisting of:

- the all farm base module: this is the foundation of all standards, and consists of all the requirements that all producers must first comply with to gain certification;
- the scope module: This defines clear criteria based on the different food production sectors. GLOBALG.A.P. covers 3 scopes crops, livestock and aquaculture;
- the sub-scope module: these CPCC cover all the requirements for a particular product or different aspect of the food production and supply chain.

To get certified, producers must comply with all the CPCC relevant for their sub-scope. (GlobalGap, 2018)

**The British Retail Consortium (BRC) global standard**

The BRC global standards is a private, for profit, membership-based association. It represents the whole range of retailers for the UK retail industry, from the large department stores through to independents. Over the past thirteen years, BRC has developed the BRC global standards, a suite of four industry-leading technical standards that specify production, packaging, storage and distribution requirements to guarantee safe food and consumer products. Originally developed in response to the needs of UK members of the British retail consortium, the standards have gained usage world-wide and are specified by retailers and branded manufacturers in the EU, North America and elsewhere.

### International Featured Standard - IFS 6.1 food

The IFS Food Standard is a GFSI (Global Food Safety Initiative) recognized standard for auditing food manufacturers. The focus is on food safety and the quality of processes and products. It concerns food processing companies and companies that pack loose food products.

IFS Food applies when products are "processed" or when there is a hazard for product contamination during primary packing. The Standard is important for all food manufacturers, especially for those producing private labels, as it contains many requirements related to the compliance with customer specifications.

The Standard supports the production and marketing departments in their efforts for brand safety and quality. IFS Food has been developed with full and active involvement of certification bodies, retailers, food industry and food service companies. (IFS, 2018)

### ISO 22000 - Food safety management

The International Organization for Standardization (ISO) developed the food safety management system certification: ISO 22000. ISO and its member countries used the quality management system approach, and tailored it to apply to food safety, incorporating the widely used and proven Hazard Analysis and Critical Control Points (HACCP) principles and good manufacturing principles. The standard has requirements for food safety management systems processes and procedures, and requires that the organization implement prerequisite programs and HACCP.

Unlike some of the other food safety management systems certification programs (for example FSSC 22000 and SQF) the ISO 22000 does not have specific requirements for PRerequisite Programs (PRPs), but requires that the organization identifies and implements the appropriate programs. This makes it more flexible, and food organizations of any type can implement and be certified to ISO 22000.

Food processors and manufacturers can use the ISO technical specification ISO/TS 22002-1 to develop their PRPs. It outlines the requirements for PRPs that are applicable to these organizations (22000-tool, 2018).

This ISO is now under revision and the updated version will be released at the end of this year.

### Safe Food Quality institute – SQF code

The SQF code was redesigned in 2012 for use by all sectors of the food industry from primary production to transport and distribution. It replaced the SQF 2000 code edition 6 and the SQF 1000 code edition 5.

The SQF code is a process and product certification standard. It is a HACCP based food safety and quality management system that utilizes the National Advisory Committee on Microbiological Criteria for Food (NACMCF) and the *Codex Alimentarius* Commission HACCP principles and guidelines, and is intended to support industry or company branded product and to offer benefits to suppliers and their customers. Products produced and manufactured under the SQF code certification retain a high degree of acceptance in global markets.

First developed in Australia in 1994, the SQF program has been owned and managed by the Food Marketing Institute (FMI) since 2003, and was recognized (at level 2) in 2004 by the Global Food Safety Initiative (GFSI) as a standard that meets its benchmark requirements. The SQF code level 3 exceeds the requirements of the GFSI benchmark documents.

The main feature of the SQF code is its emphasis on the systematic application of HACCP for control of food quality hazards as well as food safety. The implementation of an SQF management system addresses a buyer's food safety and quality requirements and provides the solution for businesses supplying local and global food markets.

Certification of an SQF system by a certification body licensed by the Safe Quality Food Institute (SQFI) is not a statement that the certification body guarantees the safety of a supplier's food or service, or meets all food safety regulations at all times. However, it is an assurance that the supplier's food safety plans have been implemented in accordance with the HACCP method and applicable regulatory requirements and that they have been verified and determined effective to manage food safety. It is also a statement of the supplier's commitment to(SQF / Food Marketing Institute (Hrsg.), 2014):

- produce safe, quality food;
- comply with the requirements of the SQF Code; and
- comply with applicable food legislation.

#### 2.6.2.2. *Standard with a Business to Consumer (B2C) perspective*

These standards are used by companies mainly but not exclusively for B2C communication, but in many cases are also useful to provide additional indications to retailers in B2B relationships.

##### ISO 14040:2006 - Environmental management -- Life cycle assessment -- Principles and framework

This standard describes the principles and framework for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements.

ISO 14040:2006 covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies. It does not describe the LCA technique in detail, nor does it specify methodologies for the individual phases of the LCA. The intended application of LCA or LCI results is considered during definition of the goal and scope, but the application itself is outside the scope of this International Standard, therefore LCA study can be use in B2C and B2B communication also through the adhesion to specific ISO 14020 Environmental Labeling standards.

### ISO 14044:2006 - Environmental management -- Life cycle assessment -- Requirements and guidelines

ISO 14044:2006 specifies requirements and provides guidelines for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, relationship between the LCA phases, and conditions for use of value choices and optional elements. ISO 14044:2006 covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies.

### ISO 14067:2018 - Greenhouse gases -- Carbon footprint of products -- Requirements and guidelines for quantification

This document specifies principles, requirements and guidelines for the quantification and reporting of the carbon footprint of a product (CFP), consistently with the International Standards on life cycle assessment (ISO 14040 and ISO 14044). In particular requirements and guidelines for the quantification of a partial CFP are also specified. This document is applicable to CFP studies. This document addresses only a single impact category: climate change. Carbon offsetting and communication of CFP or partial CFP information are outside the scope of this document.

### ISO 14046:2014 - Water footprint -- Principles, requirements and guidelines

ISO 14046:2014 specifies principles, requirements and guidelines for conducting and reporting a water footprint assessment as a stand-alone assessment, or as part of a more comprehensive environmental assessment of products, processes and organizations. The assessment is based on life cycle assessment (LCA) method.

Only air and soil emissions that impact water quality are included in the assessment, and not all air and soil emissions are included. Whereas reporting is within the scope of ISO 14046:2014, communication of water footprint results, for example in the form of labels or declarations, is outside the scope of ISO 14046:2014.

### Guidelines for Social Life Cycle Assessment of Products

This guideline is the first international voluntary guidance document to assess social impacts along the life cycle of products. It provides an analysis and description of the current practice of social Life Cycle Assessment (S-LCA) as well as a methodology and suggests social impact categories linked to key stakeholder’s groups such as workers, consumers and local communities. The guideline helps decision makers to better understand and track the implications of the consumption and production of products over their life cycle in terms of impacts on the quality of work and life of people in both developed and developing economies (SETAC/UNEP, 2009).

### Life Cycle Costing (LCC)

Life cycle costing (LCC) is used to evaluate the cost directly covered by one or more actors throughout a product life cycle. Currently available standards refer to buildings, but several scientific studies also r also report applications in agri-food sector (Falcone et al., 2016; Schmidt Rivera et al., 2014; Settanni et al., 2010).

### ISO 14020 family of Environmental Labelling

#### *Environmental labels and declarations – Type I - ISO 14024:2001*

This International Standard establishes the principles and procedures for developing Type I environmental labelling programmes, including the selection of product categories, product environmental criteria and product function characteristics; and for assessing and demonstrating compliance. The standard also establishes the certification procedures for awarding the label. Type I environmental labelling refers to the multi-criteria, life-cycle seals of approval, commonly known as "ecolabelling". ISO 14024 provides the requirements for operating an ecolabelling scheme, like the Nordic Swan or the Japanese Eco-Mark.

The principles of this standard include the following stipulations:

- environmental labelling programmes should be voluntary;
- compliance with environmental and other relevant legislation is required;
- the whole product life cycle must be taken into consideration when setting product environmental criteria, e.g. extraction of resources, manufacturing, distribution, use and disposal relating to relevant cross-media environmental indicators. Any departure from this comprehensive approach or selective use of restricted environmental issues has to be justified;
- product environmental criteria need to be established to differentiate environmentally preferable products from others in the product category when these differences are significant;

#### *Environmental labels and declarations - Type II - ISO 14021:2016*

ISO 14021:2016 is the International Standard that deals with so-called self-declared claims. It states that the overall goal of environmental labels and declarations is, through the communication of verifiable, accurate information that is not misleading, to encourage the demand for, and supply of, products which cause less stress on the environment, thereby stimulating the potential for market-driven, continual environmental improvement.

ISO 14021 addresses the issue that if a claim is made, how can it be made in a way which is meaningful and useful to a consumer. The objectives of ISO 14021 are stated to be the harmonization of the use of self-declared environmental claims with the following anticipated benefits:

- accurate and verifiable environmental claims that are not misleading;
- increased potential for market forces to stimulate environmental improvements;
- prevention or minimization of unwarranted claims;
- reduction in marketplace confusion;
- facilitation of international trade;
- increased opportunity for consumers to make more informed choices.

There are three key elements to ISO 14021 concerning requirements for claims. These give the basic rules for the making of environmental claims.

- use of symbols. This deals with the fact that many claims for products are made not just with the use of text, but also by the use of pictures, symbols or logos;
- evaluation and claim verification requirements. Essentially this requires that claims must be verified before they are made, and that this information must be available on request to any person;
- specific requirements for selected claims. This recognizes that some claims are used more frequently than others (e.g. recyclable or biodegradable), and provides for specific requirements in the use of such claims.

The basic requirements for all claims are that they shall be:

- accurate and not misleading;
- substantiated and verified;
- unlikely to result in misinterpretation.

Italian government with the legislative decree n° 50 of April 18, 2016 has enhanced the value of Type II declarations in the minimum environmental criteria (CAM in Italy) for green public procurement.

If, on the one hand, this decree opens up a new horizon for the use and diffusion of environmental declarations, on the other hand, it opens up a problem linked to the impossibility and non-existence, at present, of a certification and accreditation system according to ISO 14021, which currently regulates self-declared environmental declarations. In the following years the Italian Accreditation Board - ACCREDIA will have to deal with this legislative evolution by defining rules or guidelines, at least national ones, for the certification or verification of Type II environmental statements.

### *Environmental labels and declarations – Type III - ISO 14025:2010*

ISO 14025 establishes principles and specifies procedures for issuing quantified environmental information about products, based on life-cycle data referred to as environmental declarations. A Type III environmental declaration can be described as: quantified environmental data for a product with pre-set categories of parameters based on the ISO 14040 series of standards, but not excluding additional environmental information.

Type III environmental declarations present the environmental performance of a product to enable objective comparisons between products fulfilling the same function.

Such declarations:

- are based on independently verified Life-Cycle Assessment (LCA) data, Life-Cycle Inventory analysis (LCI) data, converted LCI data to reflect the Life-Cycle Impact Assessment (LCIA) of a product or information modules in accordance with the ISO 14040 series of standards and, where relevant, additional environmental information;

- are developed using predetermined parameters;
- are subject to the administration of a programme operator, such as a company or a group of companies, industrial sector or trade association, public authorities or agencies, or an independent scientific body or other organization.

The output is known as the declaration which has the objective to communicate environmental performance within clearly defined and classified product categories and service types. The system approach covers separate products and services, as well as complete or partial assortments of products and services. A Type III environmental declaration is designed to meet various information needs within the supply chain and for end products in both the private and public sectors, as well as for more general purposes in information activities and marketing.

*The International Environmental Product Declaration System*

The International EPD System is a programme that provides Environmental Product Declarations (EPDs) in accordance with ISO 14025 and ISO/TS 14067 standards; it helps and supports companies in communicating the environmental performance of their products in a credible and comprehensible way (International EPD System, 2017a). The programme, with technical secretariat located in Sweden, has an international focus. The EPD of Italian agro-food products are about 125 in the International EPD System database (International EPD System, 2017b).

# 3. Sustainability Initiatives involving the Italian wine industry

## 3.1. Italian sustainability protocols for wine

Italy is the world's largest producer of wine, with a production of 39.3 mhl, followed by France with 36.7 mhl, Spain with 33.5 mhl, the world's fourth largest producer of wine are the United States with 23.3 mhl. Australia, Argentina, South Africa, Chile and Germany follow, with 13.9 mhl, 11.8 mhl, 10.8 mhl, 9.5 mhl and 8.1 mhl, respectively (International Organisation of Vine and Wine, 2017).

The wine sector is one of the mainstays of Italian agricultural and food export and production, due to its economic value and product quality. Viticulture has historically had a widespread penetration in Italy and the wine sector is appreciated as one of the most identified elements of our “culture” and landscape.

At the same time Vineyards have a massive environmental relevance because of the distribution and geographical concentration, such as the wine-growing areas of Piedmont, Tuscany, Friuli Venezia Giulia, Veneto and Sicily. In these areas the vineyards have an important environmental weight for the possible contamination of surface and deep waters linked to the use of plant protection products and fertilizers, for the erosion of the soil linked to agricultural labor, for the potential emissions of greenhouse gases and for the effects on the conservation of biological diversity (MATTM, 2016).

Despite the fact that the majority of publications on the subject of wine sustainability refer to minor wine producer countries (Briamonte, 2013; New Zealand Wine, 2018; sustainablewinegrowing, 2018; Wine of South Africa, 2018)**,** in recent years, the number of publications linked to the Italian reality has increased. This is due in part certainly to the growing pressure both at institutional level and from final consumers, but in particular is linked to the growing development of sustainable initiatives at the Italian level. Starting from 2010, in Italy the number of Sustainability initiatives linked to wine is relevantly increased (Santini et al., 2013).

Corbo et al. (2014) published an exhaustive review listing ten initiatives (some already mentioned above) including organic wine:

- **i.** **Tergeo:** Initiatives of the UIV – Unione Italiana Vini, an Italian wine trade association with the Objective to support the environmental, social and economic sustainability in the Italian Wine sector. The program provides a "platform" aiming to collect sustainability tool and initiatives validated with a scientific process.
- **ii.** **Magis:** A sustainability program developed by Bayer CropScience in cooperation with the university of Milan. The program aims to promote sustainability in viticulture minimizing the environmental impact in the vineyard through high precision technique in viticulture to reduce pesticide and fertilizers use, with a third part validation.
- **iii.** **SOStain:** A sustainability programme promoted by the Observatory for productivity and efficient use of resources in agriculture – OPERA. The project is focussed on Sicilian Viticulture with a strong focus on the territory and it promotes through a pathway of continuous improvement the assessment with different indicators of Social, environmental and economic sustainability in the wine production chain.
- **iv.** **VIVA Sustainability and Culture**: Already mentioned and better described in chapter (3.3).
- **v.** **ECO-Provine:** European Project funded with the CIP-Ecoinovation framework. The objective was to promote the sustainability in the wine sector with the use of LCA methodology. Some social and economic aspect are taken into account and also a Life Cycle Costing is methodology is proposed. One of the project deliverable was a PCR for wine product that was used in this work as one of the reference documents analysed for the publication of the VIVA -AIR Indicator assessment guideline.
- **vi.** **Ita.Ca/Gea.Vite:** Two sustainability initiatives promoted by Studio Sata, an agronomic consultancy firm that have proposed a Carbon footprint calculator (Ita.Ca), and a program to assess efficiency in the wineries.

vii. **Vino Libero:** A programme initiated by an Italian wine entrepreneur, who started with his products and then involved other Wineries. The program promotes the production of wine from grape cultivated free of chemical fertilizers, herbicides and with low sulphite in the wine production.

viii. **New Green Revolution:** Project developed for a precise region "Montefalco Sagrantino" that have created a protocol for social, economic and environmental sustainability. They use an improved version of Gea.Vite and they have developed a new machinery which allows the use of an anti-drift for the recovery of pesticides in hill area.

ix. **Organic Wine:** Already mentioned and described before (2.6.1.2)

x. **Natural Wines:** Wine produced with organic or biodynamic grape, hand-picked with no sugar or added yeast or bacteria in the production phase. The use of sulphite is strictly limited and no heavy manipulation are permitted.

The paper has highlighted some important similarities among the described programs reporting also the problem of overlapping and confusion for wine companies and consumers due to the high number of existing initiatives in Italy. In the paper conclusions a question is asked to the different programme operator: Will it be possible to "merge" the different elements of the programs in order to create a single, uniform framework to spread sustainability in the Italian wine sector, at the same time promoting scientific consistency, clarity and transparency towards wineries and consumers? The question that comes to my mind when I read this conclusion was: can one methodological approach evaluate all the pillars of sustainability? A search for an answer to these questions can perhaps be foreseen in the development of the Environmental Footprint methodology at European level and in its transposition at Italian level initially with the VIVA project and perhaps now with the Made Green in Italy.

## 3.2. Relevant studies in the wine sector with a Life Cycle approach

In addition to the above described and more structured initiatives, scientific studies on carbon, water footprint and Life Cycle Assessment conducted in the Italian wine sector have a certain relevance.

Wine and grape for wine production has been one of the most studied food products with an LCA approach. Only referred to the Italian market six publications have made inventory data available and were used for comparison with the average inventory data (paragraph 5.1.4). Three study have a special focus on the agricultural phase (Bartocci et al., 2017; Bosco et al., 2011; Falcone et al., 2016), and Bosco et al. (2011) and Falcone et al. (2016) had also a special focus on the vineyard planting phase (Unfortunately for this phase it was not possible to make a comparison). Fusi et al., (2014) performed an LCA for the assessment of the environmental impacts of a Vermentino white wine produced in Sardinia and exported all over the world. Bonamente et al., (2016) made a publication about the application of CF and WF on a red wine that participated in the VIVA pilot project. Other studies, like the one made by Ardente et al., (2006), used a cradle to gate approach, considering the distribution but not the waste disposal stage. Another study considered the waste disposal but not the distribution (Iannone et al., 2016). Arzoumanidis et al., (2014) addressed the application of LCA studies on wine through the use of simplified LCA tools and was a starting point for the final reflections on the use of tools in PEF.

These studies have contributed to increasing the competence of technicians and the dissemination of these methodologies in the national wine and food sector.

In addition to these initiatives, I think it would be useful to report the experience of the International EPD System (already described above), which over the years, with the contribution of Unioncamere and ENEA (for still wine) and INNOVI and Lavola (for sparkling wine) has developed two PCRs for the wine sector:

1. PCR International EPD System – UN CPC 24211 – Sparkling wine of fresh grapes (International EPD System, 2014).
2. PCR International EPD System – UN CPC 24212 – Wine of fresh Grapes, except sparkling wine (International EPD System, 2010).

PCRs have been underused, the only wine analysed in those year was an Italian Wine Grasparossa Righi of Consorzio Interprovinciale Vini s.c.agr. (CIV, 2008), and there are no EPDs of wine products valid for now (International EPD System, 2017a), but PCRs have been a valuable reference for the creation of the VIVA -AIR Indicator Assessment Guideline and were used in many cases as reference for the application of CF studies using the ISO/TS 14067:2013 (Bonamente et al., 2016; Bosco et al., 2011; Rinaldi et al., 2016).

Research related to Life cycle thinking in recent years has shifted to the assessment of social and economic sustainability performance through the application of Social Life Cycle Assessment and Life Cycle Costing (Guinée et al., 2011). Some studies apply these approaches in the wine-growing sectors (Arcese et al., 2017; Falcone et al., 2016; Settanni et al., 2010) and have provided the basis on which I have developed hypotheses on the future of wine sustainability certification.

## 3.3. The IMELS "VIVA Sustainability and Culture" initiative

Wine is one of the Italian products that most evokes the quality and beauty of our country whenever it is consumed, in Italy and especially abroad.

Italian producers have been able to grasp and promote wine as a symbolic product of "made in Italy" and it is no coincidence that in 2016 Italy was the world's leading producer of wine with a production of 39.3 Million hl (International Organisation of Vine and Wine, 2017). Today wine is at the top of exports and represents the third agro-food sector in terms of turnover (Federalimentare, 2014).

This is the result of techniques and skills honed over the years and the passion of Italian producers who have managed to enhance the native grape varieties, selecting grapes that enhance the characteristics of the different climates and soils of our country. Through these competences that we can define as "historical", an original capacity of adaptation of viticulture to climatic variability has been developed in our country, allowing both the preservation and expansion of the productive capacity and the protection of vast agricultural areas from the risk of marginality and degradation. Wine production is today one of the best identified components of our "culture" of management and protection of the rural environment and the agricultural landscape, associated with product safety and consumer health.

Today, a large part of Italian wineries has adopted, in vineyards and cellars, criteria and techniques of sustainable production mainly due to the pursuit of objectives of quality and protection of the territory, investing in a correct and combined use of the available tools. At the same time, also through the project "VIVA – Sustainability and Culture" promoted by the IMELS, concrete initiatives have been started to measure, monitor and improve the environmental performance of wineries and wines, leveraging on the integrated use of four specific indicators that help producers to become aware of the real influence of their activities on the climate, on the management of the vineyard and on the agricultural landscape.

Italy is characterized by the presence of numerous wineries with a great diversification in terms of size, geographical and production characteristics. These companies are rather attentive to sustainability, but have a reduced or limited ability to communicate with the end consumer. The promotion activity carried out by a single company is, in this sense, very limited; the wine producer who intends to grow following a model of sustainable development today faces the following challenges:

1) pursue an integrated approach, taking into account not only the environmental but also the social and economic aspects;
2) develop analysis on a robust scientific basis;
3) find an efficient way to communicate their commitment to the final consumer.

Some important experiences were already active at regional or local level (e.g. SOStain; New Green Revolution), but it was necessary to create something relevant at national level. It was necessary to have a project that could be used by all companies regardless of geographical location, product type and size.

To meet these needs, the VIVA pilot project "Sustainability and Culture" was launched in 2011.

The project was born from the collaboration between the IMELS, and two university research centres:

- OPERA - Observatory for productivity and efficient use of resources in agriculture.
- AGROINNOVA - Centre of Competence for the innovation in the agro-environmental field.

with the involvement of nine pilot wineries chosen on the basis of geographical and product criteria.

This extraordinary collaboration has allowed the research centres and the IMELS, under the scientific supervision of prof. Ettore Capri, to carry out a detailed analysis of the Italian context through discussion groups and continuous experimentation on the field with the involved companies. A methodology was therefore developed for the assessment of the four pillars of sustainability (environmental, economic, social and cultural), which allows, through the analysis of four indicators AIR ( carbon footprint of product and inventory of company emissions), WATER ( water footprint), VINEYARD ( agronomic management of the vineyard) and TERRITORY (consequences of company activities on the territory and its landscape, cultural commitment), an assessment of the performance of sustainability in wine companies.

The project can be applied to all Italian wineries, whether they have the agricultural production of grapes under their control, or to social wineries or consortia that do not produce the grapes themselves, but buy them from external suppliers.

Indicators are a very useful tool for both businesses and consumers. Companies can use it to measure and improve the environmental performance of their activities through the optimal use of resources; the consumer, thanks to a simple and transparent system, can verify the actual commitment of the company in the environmental and socio-economic field through a product sustainability label.

### 3.3.1. The VIVA Project Indicators

#### *3.3.1.1. AIR – Product Carbon footprint and Organization Green House Gas inventory*

The AIR indicator expresses the impact that the production of a specific product and/or all company activities have on climate change.

<u>The product carbon footprint (CFP):</u> this is an analysis carried out using a life cycle approach, referring to a 0.75 litre bottle of wine.

The life cycle of a wine bottle comprises four main phases: vineyard management; transformation of grapes into wine and subsequent bottling; distribution of the bottles to the final consumer; and refrigeration and disposal of the glass. These phases are called respectively vineyard, cellar, distribution and consumption.

The analysis carried out gives the possibility to the producer and the consumer to understand which processes included in the life cycle of a product have the greatest influence on climate change, giving the producer the possibility to improve them and allowing the consumer to make his purchases in a more conscious way.

<u>Greenhouse gases Inventory (GHGI):</u> it is an analysis referring to the company carried out through the elaboration of an inventory of climate-altering emissions. This type of analysis expresses the total emissions generated by the company's activities and allows manufacturers to understand the areas of intervention in order to reduce the impact on climate.

The logic of the AIR indicator is therefore based on the combination of quantification and communication. Climate impact can be an effective communication tool, whose credibility is based on the fact that it has been calculated on the basis of internationally recognised standards:

- ISO TS 14067 for CFP indicator;
- ISO 14064-1 for the GHGI indicator

The research team, under the scientific supervision of prof. Ettore Capri, on the basis of the experimentation carried out in the nine pilot companies, has drawn up guidelines on the minimum criteria to be adopted in terms of data quality and the boundaries of the analysis, and has also developed a communication system structured in such a way as to be easily comprehensible to the consumer who can access it, through QR code, or from the website directly from the label on the bottle or from the company's information documents.

#### *3.3.1.2. WATER – Water footprint*

The issues related to the use and waste of water have been of primary importance for years for national agri-food companies and in particular for wine producers (Ene et al., 2013; Herath et al., 2013; OECD, 2017).

A rational and sustainable use of water translates, both in an economic benefit for companies that reduce production costs, and in an environmental and social benefit due to the greater availability of water resources and reduced pollution of the same.

A winery must therefore apply calculation tools that allow it to acquire a greater awareness of the actual volume of water consumed. A group of researchers from the Università Cattolica del Sacro Cuore, supervised by prof. Capri, on the basis of what was already elaborated by Hoekstra et al. in 2011 developed a specific indicator for calculating the Water Footprint for the vineyard and cellar. This indicator can be used both at district level and therefore at company level, and for a specific product. The indicator considers direct consumption linked exclusively to cellar and vineyard activities.

The indicator, as well as the main standard (Hoekstra et al., 2011), divides the water consumed into three different categories:

<u>GREEN Water:</u> refers to the volumes of water evapotranspired by the vine during its annual production cycle. Green water has a very high variability due to the climatic and territorial conditions of the place of cultivation and the year analysed, but is a useful tool to understand whether the production area chosen is actually suitable for the cultivation of the vine. The plant mainly uses rainwater for its growth and development, and therefore in essence the GREEN water consumption is “positive”, as it is the water that was actually used for plant growth and grape production.

<u>BLUE Water:</u> refers to the volume of fresh water taken from the surface or underground water bodies for the irrigation of the vineyard (where applicable), or directly from the aqueduct or for the sanitization and cleaning of machinery and used for the production and bottling of wine. This water is therefore the water actually used by the company and is accountable through the monitoring of actual consumption.

GREY Water: indicates the level of pollution due to the activity carried out in the field and in the cellar expressed in terms of volume of fresh water necessary to dilute the water of the contaminated water body to ensure that it returns to a specific level of legal and eco-toxicological contamination.

For this specific indicator, the OPERA Research Centre has developed a model which, on the basis of the plant protection product applied by the company, calculates the expected contamination in water bodies by drift, run-off and leaching. In addition, groundwater contamination by nitrate leaching from fertiliser use is also taken into account. The legal and eco-toxicological limits through which the dilution volumes are calculated are, the legal limit for nitrates and groundwater, while for surface water bodies the contamination by drift and run-off are compared with the concentration for which no toxicological effect has been detected with respect to the active principle considered (Lamastra et al., 2014). With regard to the water used in the cellar, the products used for washing and sanitising the machinery are considered. If the winery has a water treatment plant for water used in the cellar, this is considered as it substantially mitigates the pollution of surface water and groundwater.

This type of analysis gives the producer the opportunity to understand exactly at which stage of his production process the greatest consumption of water is concentrated, allowing him to take corrective measures. This reduction, in addition to having an environmental value, leads to a real reduction in costs and can be used both to raise awareness among winemakers on mitigation strategies in the field, and for operators in the cellar on the rational use of the resource.

#### *3.3.1.3. VINEYARD – agronomic practices*

The wine is the result of the commitment of farmers to the vineyard and the characteristics of the soil on which it is located. An asset of inestimable value that if managed inappropriately, not only risks being irremediably lost, but also affects sequentially all the realities related to it such as the protection of the agricultural landscape, the fertility of soils and the richness in biodiversity.

It was therefore necessary to consider the environmental risks influenced by agronomic management of the vineyard, taking into account the great historical, technological, territorial and ideological diversity of the different agronomic management techniques used. The indicator should therefore be applicable to all vineyards and all types of management (traditional, organic, biodynamic and integrated).

The research group have therefore developed software that makes it possible to assess, on the basis of qualitative/quantitative factors, the impact of agronomic management on soil (Lamastra et al., 2016).

The software is structured in six sections (Structural Data; Phytosanitary Defence; Fertilization, Fertility, Erosion and Landscape) and in particular it analyses:

- the environmental risk deriving from the use of crop protection products based on their chemical properties and ecotoxicological limits, assessing their potential impact according to the type of soil of the company and the hydrogeological and meteorological characteristics of the area;

- the use of organic and mineral fertilisers, assessing potentially harmful effects such as excess nutrients in the soil and contamination of water bodies. The indicator also assesses the effects on biodiversity on the basis of the percentage of organic matter, the physical characteristics of the soil, the C/N ratio, the N, $P_2O_5$ and $K_2O$ content and how the fertilisers are applied;
- the problems relating to soil compaction arising from cultivation operations, with particular reference to the use of agricultural machinery and the effects of rain;
- the development of soil organic matter as a result of soil management practices;
- soil losses caused by erosion in connection with agronomic management practices and the use of agricultural machinery;
- the influence of agronomic management practices on biodiversity.

The use of this indicator makes it possible to rationalise the agronomic management of the vineyard by pursuing quality and land management objectives while respecting the environment.

The software issues both an overall assessment (A to E) and a broken down assessment for each section considered. The interpretation of the result allows the vine-grower to understand which factors of the agronomic management adopted are concrete risk factors, giving him the possibility to evaluate which solutions are suitable to reduce that specific risk.

#### *3.3.1.4. TERRITORY – Consequences of company activities on the territory and its landscape and winery cultural commitment*

In the overall panorama of Italian agriculture, the landscape designed by the cultivation of vines has a fundamental importance and is already subject to protection, as for example in the Prosecco area in the Treviso area, in the Collio and Colli Orientali del Friuli or even as in the case of the Langhe, where it has been recognized as a World Heritage Site.

The indicator was developed with the aim of raising wine producers' awareness of sustainability practices not considered in environmental indicators such as climate or water footprint. Sustainability cannot be properly assessed on the basis of environmental parameters alone, but must also, by definition, integrate economic and social aspects. To this end, a set of qualitative and quantitative indicators has been developed, capable of measuring the impact on the territory of the actions undertaken by the companies. These indicators are divided into 4 sections (Biodiversity; Landscape; Society; Economy).

The influence on the territory is intended as a transdisciplinary effect of the different sections. In fact, a correct management of the landscape leads to the protection of biodiversity, to the provision of services for the benefit of society in general and to the improvement of the economic impact on society and the territory of which the farm is a part.

With reference to the “Biodiversity” section, the holdings are assessed on the basis of their position in relation to protected areas or areas with a high level of biodiversity, but giving greater weight to the ability of the vine-grower to protect the biodiversity present compared to that existing in the area of the vineyard concerned.

In the “Landscape” section, the integration of the farm with respect to valuable wine-growing areas is evaluated, favouring, as well as for biodiversity, the ability to manage the landscape in this case. In this regard, account is taken of the commitment to combat rural abandonment, the harmonization of vineyards with the environmental context, the use of eco-sustainable materials in the normal management of the vineyard, the use of native species in non-cultivated areas of the company and the tourist enhancement of the landscape.

The “Company” section analyses the company's behaviour towards the local community, personnel and consumers. An attitude aimed at encouraging the use of local resources and the creation of events for the benefit of the local community, remuneration, health, safety in the workplace and the training and professional development of the staff employed, safety with respect to products and the dissemination of conscious consumption of wine is considered sustainable.

The “Economy” section analyses the economic sustainability of the company, also considering the contributions received and the impact of company policies on the territory, with reference to the supply and hiring carried out.

Finally, the “Culture” section analyses the company commitment in cultural events, and take into account the investments in investments in staff training, and consumers training in the field of sustainability.

These requirements allow the companies to enhance the transversal role that the viticulture has on the territory.

### 3.3.2. The VIVA – “Sustainability and Culture” Label

The VIVA label is issued to companies which, following the signing of the voluntary agreement with the IMELS in the framework of the VIVA project, have concluded the analysis of the four indicators and obtained the certificate of verification from an independent third party.


FIGURE 3: VIVA – SUSTAINABILITY AND CULTURE INTERNATIONAL LABEL

Next to the label there is a QR code that allows consumers, through a smartphone/tablet, or by connecting to the website www.viticolturasostenibile.org, where are available information on the sustainability performance of the product.

In particular, in a transparent way, is possible to see the results related to the detail of each indicator so as shown in Figure 4, Figure 5, Figure 6 and Figure 7. Near the result to the consumers is given the possibility to download an external communication report for each indicator that is an explanation of the analysis made and an interpretation of the result.

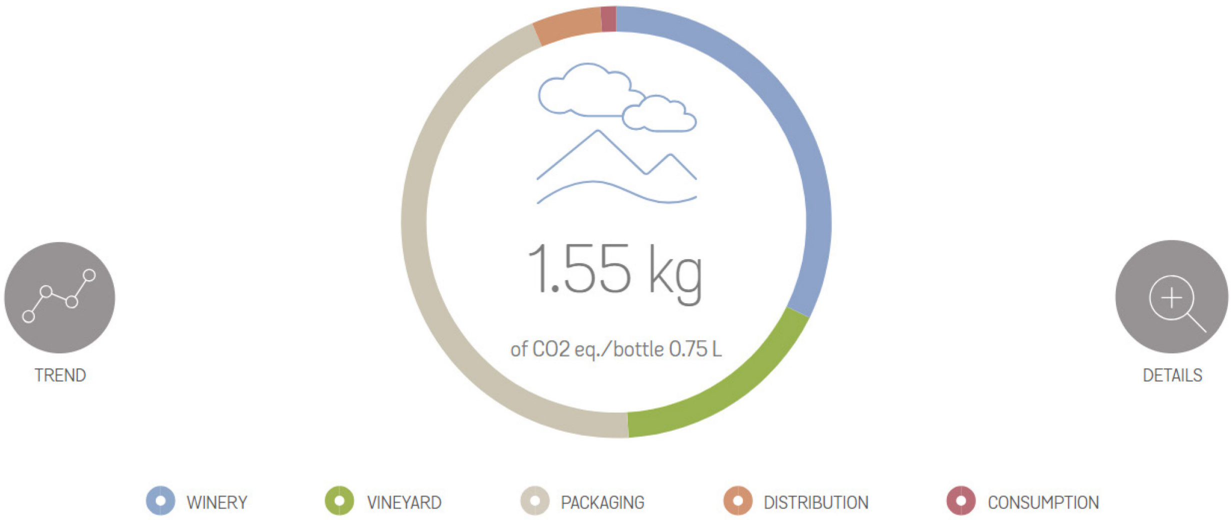



FIGURE 4: VIVA AIR INDICATOR ONLINE RESULTS

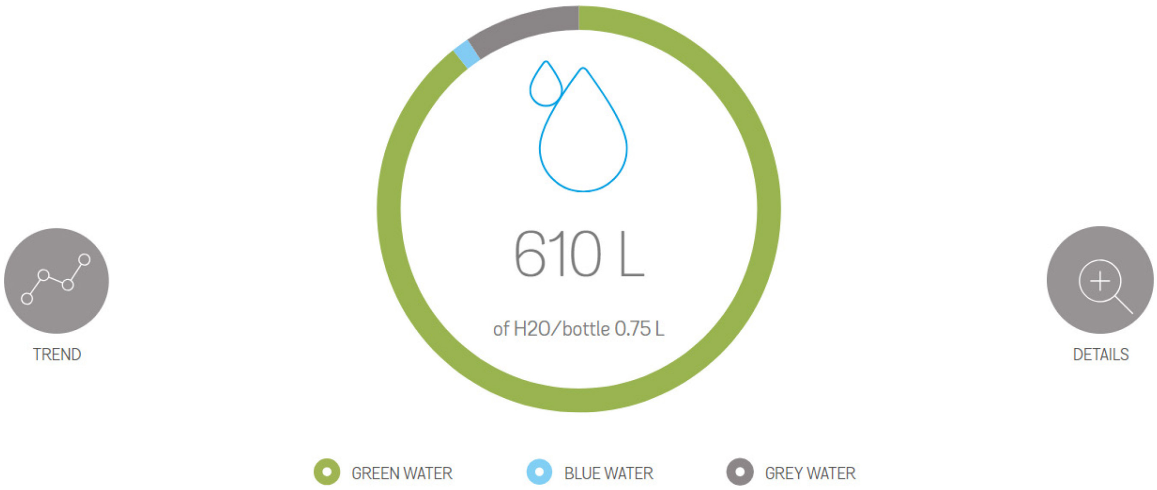



FIGURE 5: VIVA WATER INDICATOR ONLINE RESULTS


FIGURE 6: VIVA VINEYARD INDICATOR ONLINE RESULT

FIGURE 7: VIVA TERRITORY ONLINE RESULT

### 3.3.3. The importance of common methodological approach for the assessment of the VIVA AIR Indicator

Life cycle assessment (LCA) and carbon footprint (CF) are established methodologies for quantification of product environmental performance, and are commonly used in several sectors (Arzoumanidis et al., 2013a; Bacenetti et al., 2018; Lehmann et al., 2015; Meier et al., 2015) as a basis for labels and reports that inform purchasers in a Business to Business (B2B) and Business to Consumer (B2C) perspective (Fava et al., 2011). Common life cycle-based quantitative claims exist in two forms: multi-criteria claims called environmental product declarations (EPDs) and single criteria claims such as product carbon footprints (CFPs).

Life cycle-based quantitative claims for products require the analysts to make a lot of choices regarding data sources, system boundaries, allocation choices between coproducts, energy source management (Subramanian et al., 2012). Despite existing and emerging international standards for these methodologies (European Commission, 2013b; ISO, 2013), there is insufficient standardization within the specific product categories to make fair and comparable claims (Subramanian et al., 2012), which is essential for differentiating products in the marketplace based on their environmental performance.

The experience acquired with the IMELS - Italian National Programme for the Assessment of the Environmental Footprint, started in 2011, has shown how it was necessary to invest, within the same sector, on a unique methodology that could guide companies and their consultants in the implementation of CFP and LCA studies. The elements that most increased the incomparability between the different studies were the use of different reference standards (BSI, 2011; ISO, 2013, 2006a; WRI & Wbcsd, 2011), the use or not of a Product Category Rule (PCR) and the choice of unambiguous secondary data.

Following these conclusions, the Italian Ministry for the Environment Land and Sea has decided, at the end of the VIVA project pilot process, to experiment for VIVA the application of a unique CF methodology with the use of a PCR. The choices made are explained here below.

Once the project had decided to invest in CFP studies, keeping the characteristics of the AIR indicator, it was necessary to select a reference methodology from among those existing on the international scene.

The methodologies that existed at that time for CFP were:

1. BSI PAS 2050:2011 - Specification for the assessment of the life cycle greenhouse gas emissions of goods and services (BSI, 2011);
2. Greenhouse Gas Protocol: Product Life Cycle Accounting and Reporting Standard (WRI & Wbcsd, 2011);
3. ISO 14040-14044:2006 - Environmental management -- Life cycle assessment -- Principles and framework & Requirements and guidelines (ISO, 2006b, 2006a);

4. ISO/TS 14067: 2013 - Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication (ISO, 2013).

After careful analysis and also on the basis of the experience gained with the national programme for the environmental footprint assessment, the technical specification ISO/TS 14067:2013 was chosen for the VIVA project.

The ISO technical specification was born with the intent to regulate the application of CFP studies through the application of the LCA approach, the TS version of the ISO was a pre-standard published in order to allow and test a first application of the specification on the market.

After the ISO technical committee succeeded in publishing this regulatory instrument, it was decided to focus on its dissemination and application at national level in order to promote a correct use of CFP analysis and avoid its misuse, especially in the field of communication. The most recent standard largely incorporated the principles of ISO 14040-14044 concerning the Life Cycle approach, but was specific related to the "climate change" impact category.

Compared to the PAS 2050 and the GHG Protocol Product Standard, it took up the principles and the focus on the "climate change" category, introducing however, for the first time, the use of PCR for CFP studies.

The technical specification ISO TS 14067 was also very specific on the communication aspects "intended to be public available", clearly regulating how this should be done and what elements of transparency it should contain, eliminating the inefficient and very confused system of self-declarations standardized by ISO 14021 (ISO, 1999). In fact, the technical specification specified the communication tools both from a B2B and B2C point of view and introducing both the Critical Review of the study, from a LCA expert, and the certification by a third party of the documents and statements addressed to the final consumer.

This technical specification obliging also the adoption of CFP-PCR (CFP - Product Category Rules) to carry out the studies, lead to a harmonization within the same product categories.

As there is currently no CFP-PCR for the wine sector related to ISO TS 14067:2013, IMELS has decided to carry out a state of the art of product category rules in the wine sector.

The documents that were available and that were analysed for the implementation of the guideline were:

3. ISO TS 14067:2013 – Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication (ISO, 2013).

4. PCR International EPD System – UN CPC 24211 – Sparkling wine of fresh grapes (International EPD System, 2014).

5. PCR International EPD System – UN CPC 24212 – Wine of fresh Grapes, except sparkling wine (International EPD System, 2010).
6. Disciplinare VIVA 2014/1.1 (MATTM, 2014).
7. ISO 14040:2006 - Environmental management -- Life cycle assessment -- Principles and framework (ISO, 2006b).
8. EU PEF Guidance for the implementation of the EU PEF during the Environmental Footprint pilot Phase – Version 5.2 - February 2016 (European Commission, 2016).
9. Product Environmental Footprint Category Rules Wine (Pilot Phase) – Version 02 – February 2016 (CEEV, 2016).
10. General Programme Instruction for the International EPD System – Version 2.5 – 11 May 2015 (International EPD System, 2015).

Working at IMELS as an expert on environmental footprints, I was privileged to be a member of the Technical Advisory Board and of the Steering Committee of the European Product Environmental Footprint, thus having access to the most recent documents on Environmental Footprints, LCA and PCR.

These documents, although not publicly available at that time, were used to transpose the first European indications in the field of PEF and to test or apply the proposed methodologies in the national territory.

More specifically, the main methodological aspects, which were incorporated into the existing standards, used to produce the VIVA - ARIA specification are set out below:

- For the definition of the scope and the functional unit, reference was made to the PCR developed within the EPD System.
    - The scope refers to the UN CPC classification 24211 e 24212. Division 24: Beverages – Group 242 Wine – Class 2421 Wine of fresh grapes, whether or not flavoured: grape must – Subclasses 24211 e 24212 Sparkling wine e wine of fresh Grapes, except sparkling wine; grape must.
- With regard to the sampling rules, a round table, coordinated by prof. Capri, was opened. In this roundtable the Università Cattolica del Sacro Cuore researcher, the Life Cycle Engineering (LCE) consulting firm and the IMELS technician were involved, in order to develop a single project methodology, which is widely represented in the public VIVA Technical Specification (MATTM, 2016).
- As regards the allocation rules between must, lees and marc, reference was made to the principle of economic allocation since the economic value best reflects the relative importance of the

different co-products within the wine industry (Gazulla et al., 2010). The economic values were defined, within the above described roundtable, using the information contained in (Fusi et al., 2014; Gazulla et al., 2010) and in the pilot PEFCR - Wine Screening Report produced as part of the PEFCR Wine (CEEV, 2016). The impact of grape production, transport and pressing was allocated 96% to must and 4% to lees and marc.

- With regard to the allocation in the case of reuse and recycling, reference was made to the "Polluter-pay principle" (PPP) used within the framework of the International EPD System General Programme, which combines different product systems in which the by-products or waste from a system after transport and initial processing become raw materials from other systems. Applying this principle, the boundary between the two different systems is set at the point where the by-product or waste reaches its lowest market value. This means that the system that generated the waste is responsible for its impact up to the point where the waste or by-product starts processing in the new plant. The subsequent system is therefore responsible for the impact related to the treatment of the by-product or waste, but not for the "previous" phases of the life cycle.
- As regards the transport of the final product from the distribution centre to the final consumer's home, the EU PEF Guidance then available was used, which provided for:

| **From:** | **To:** | **Km** | **Transport:** |
|---|---|---|---|
| Distribution Center | Final Retailer | 300 | Camion 7.5 – 16 ton Euro4 |
| Final Retailer | Consumer Home | 4 | Average Passenger Car |

- The VIVA specification has fully adopted the communication strategy proposed by ISO/TS 14067:2013 In order to be able to communicate the results of the analysis to the final consumer and obtain the VIVA mark, companies must submit their study to a third-party certification registered in the VIVA lists.
- After the certification, in compliance with what has been defined by ISO/TS 14067:2013, the companies make available on the project website the External Communication Reports related to the 4 project indicators. This choice adopts the most stringent requirements in terms of transparency to the final consumer who, if interested, can have access to complete information about the company, the product being studied and the results of the analysis.

### 3.4. The Wine Product Environmental Footprint Pilot

So as reported before, for companies wishing to demonstrate that the way in which they are producing their products is environmentally friendly, the provision of this information is complicated by the existence of a wide range of different environmental footprint assessment methodologies. As a response to this problem, the Commission announced a pilot phase for testing the creation of product-groups and sector-specific rules for the verification of environmental footprint information and communication vehicles, under the Product Environmental Footprint and Organisation Environmental Footprint methods. This pilot phase was kicked off in late 2013 and was planned to run until the end of 2016 (due to some delays, part of the final deliverables will only be available from mid-2019).

The aim of the pilot phase was to test the rules of the methodological framework, and the stakeholder engagement towards agreeing common ways of quantifying environmental footprint of products and organizations.

One of the pilot projects that participated the call of the European Commission activating a sectoral table is the "Wine of fresh grapes" Pilot. The coordinator of the project's technical secretariat was the Comité Européen des Entreprises Vins (CEEV, 2018a) who represents the wine companies in the European Union. It brings together 24 national organisations. With more than 7.000 companies, mainly SMEs.

The other organizations involved in the technical secretariat were:

- Pernod Ricard Winemakers Spain;
- Comité Interprofessionnel du Vin de Champagne (CIVC) and three Champagne producers represented by CIVC;
- Unione Italiana Vini (UIV);
- Soc. Agr. Salcheto;
- The European Container Glass Federation (FEVE);
- Amcor;
- Nomacorc;
- C.E. Liège;
- IHOBE – Public agency of environment of the Basque Government;
- Institut Français de la Vigne et du Vin (IFV);
- Lavola;
- Ecole supérieure d'agricultures (ESA) – Angers.

On April 24, 2018, the technical secretariat published the product environmental footprint category rules for wine, giving interested companies the opportunity to use the document for the preparation of PEF studies for still and sparkling wines.

This set of rules was used as a reference for the study described in the following chapters.

# 4. Goal and Scope

The VIVA project of the Italian Ministry for the Environment Land and Sea (IMELS) is the Italian reference program for assessing the sustainability performance in the wine sector. Twenty-five wineries have joined the project, with 44 certified products using the VIVA label (Viticolturasostenibile.org, 2017). Despite its widespread use, the application of the VIVA protocol is currently limited to those companies that have a high level of control over the entire production life cycle. Those companies that, due to their structure or size, do not have access to data from a part of the supply chain (e.g. the agricultural or bottling phase), and that therefore are unable or only able to collect data from certain processing phases, need a reference set of data with which to compare themselves or to use in order to complete the study. The data of 12 companies have been analysed to create an average inventory for sparkling and still products, based on the analysis of 27 products.

From a methodological point of view, after the European Environmental Footprint pilot project, the publication of the "Product Environmental Footprint Category Rules (PEFCR) for still and sparkling wine" (CEEV, 2018b) and the release of the Ministerial decree n. 56 of march 2018 approving the Made Green in Italy Voluntary Scheme (MATTM, 2018), the regulatory references on the subject of LCA application in the wine sector are rapidly evolving both at international and national level. The direction taken goes clearly toward the product environmental footprint (PEF) methodology developed by the European Commission (European Commission, 2013d).

In the framework of the Made Green in Italy scheme, in the near future the adoption of the PEF method in Italy will be plausible and therefore an integration of the PEF method with the VIVA project is possible.

Most likely the work of the European Commission on Environmental Footprint will also have implications in the field of sustainability certifications in Europe and Italy.

Assuming what the future developments of the VIVA Protocol may be in the medium and long term, the intent of this research is to:

a) create an average inventory of VIVA certified still and sparkling products;

b) assess the major difference between the VIVA Project and the PEF method;

c) evaluate the possible implications of a future transition from VIVA - AIR (Carbon footprint) to the PEF method.

# 5. Materials and methods

## 5.1. Life cycle inventories design

At the time of the study's application, twelve companies joined VIVA and were certified after the introduction of the 2016/2.0 version of the VIVA technical specification. The certified studies of these companies have been analysed, and through the checklists and study reports provided to the IMELS in the framework of the VIVA project, the individual inventories used to calculate the AIR indicator have been reconstructed, and an average inventory for sparkling and still VIVA products has been created.

### 5.1.1. LCI of still and sparkling products that have joined the VIVA project

To characterize the state of the art of Italian Wine companies that have joined the VIVA project, the CFP studies submitted to the IMELS were analysed.

The filled check lists were not always available, so a detailed analysis of the study reports linked to the VIVA indicators and the companies' declarations were carried out.

The number of wineries analysed does not fully reflect national wine production and is not a reliable representation of it. The aim was to characterize as much as possible the profile of the companies participating in the VIVA project, and therefore those companies that by choice and transparency have a greater awareness and attention to the sustainability of their products.

The following paragraphs describe all the data collected, divided into still and sparkling wines.

Once the data were collected, an average dataset was created representing the average profile of a sparkling wine and a still wine, and relative statistical analysis. A first comparison of the most relevant processes was made with bibliographic data of the Italian context.

The wines selected have certified their studies following the VIVA Version 2016/2.0 Specification (MATTM, 2016). As the rules are more specific with regard to transparency, companies, since 2016, are obliged to provide more accurate data, and must also be transparent with regard to the secondary dataset used, citing the source and version of the data. This allowed us to characterise the primary data used when this was not described in the report. Unfortunately, however, this procedure has not allowed us to have very detailed data, often the information is incomplete or some data is aggregated at the winery or vineyard level. Despite the difficulty, using average national data or data from the PEF Wine Screening study it was possible to reconstruct the companies' inventories.

For all value reported in the following tables, when the value entered in the cell is 0.00 it means that the data was available but that particular operation or product was not used. When the value "-" is reported in the cell it means that the above information was not available and that therefore the cell is excluded from the average when the average database was created.

It was not possible to comment adequately the collected data since data collection was not carried out directly on the field.

The VIVA sustainability and culture project involved companies with very different characteristics. The project has been joined by both small and medium sized companies with an overall control of the production chain from the cultivation of grapes to the distribution of the final product, as well as by the big "industrial" producers who purchase and process the raw material without a real control of the production chain. This allowed a complete analysis of all the realities that characterize the national panorama, highlighting also the specific differences and critical points that characterize each type of wine producer. For each wine studied information related to region, wine typology, cultivar of grape, hectare of vineyard, yields, and total production was collected (Table 1 and Table 2).

TABLE 1: GENERAL INFORMATION SPARKLING WINES

| Producer | Product Code | Region | Grape | Vintage | Color | Surface | Average Yield |
|---|---|---|---|---|---|---|---|
| | | | | | | ha | kg/ha |
| **P1** | P1W1SPARK | Emilia Romagna | 55% Barbera<br>45% Croatina | 2014 | Red | 17.39 | 11333.0 |
| **P1** | P1W2SPARK | Emilia Romagna | 100% Malvasia Bianca Aromatica di Candia | 2014 | White | 2.82 | 12000.0 |
| **P2** | P2W3SPARK | Emilia Romagna | 100% Lambrusco | 2016 | Red | 3.72 | 18400.0 |
| **P2** | P2W4SPARK | Emilia Romagna | 100% Pignoletto | 2016 | White | 5.88 | 18000.0 |
| **P3** | P3W5SPARK | Emilia Romagna | 100% Lambrusco | 2016 | Red | 12.04 | 18400.0 |
| **P4** | P4W6SPARK | Emilia Romagna | 100% Lambrusco Grasparossa | 2015 | Red | 6.40 | 14610.7 |
| **P5** | P5W7SPARK | Tuscany | 100% Chardonnay | 2015 | White | 1.01 | 8471.0 |

Seven sparkling wines were analysed, three of which were white and four red. They are all young wines, except the W7. Almost all the wines analysed were produced in the Emilia Romagna region (six out of seven wines in total), 4 of them (W3, W4, W5 and W6) are produced near Modena in the Lambrusco Region, those areas are characterized by very high yield, and cultivations mainly in lowlands.

W1 and W2 wines are bottled in the Piacenza district. All Emilian companies are cooperatives, social wineries or large industrial groups to which grapes from small or medium producers are delivered.

The Wine W7 instead is produced by a small organic farm in the district of Florence, is a "*méthode champenoise*" characterized by low yield and a very limited production. Another characteristic that distinguishes it from other wines is the fact that it is not a young wine but has a bottle fermentation on yeasts of 36 months.

TABLE 2: GENERAL INFORMATION STILL WINES

| Producer | Product Code | Region | Grape | Vintage | Color | Parcels Surfaces | Average Yield |
|---|---|---|---|---|---|---|---|
| | | | | | | ha | kg/ha |
| **P5** | P5W8STILL | Tuscany | 100% Malbec | 2015 | RED | 0.302 | 9545.0 |
| **P5** | P5W9STILL | Tuscany | 90% Sangiovese<br>10% Alicante Bouschet | 2015 | RED | 0.316 | 7411.5 |
| **P5** | P5W10STILL | Tuscany | 90% Sangiovese<br>10% Malvasia Nera | 2015 | RED | 2.221 | 7702.7 |
| **P5** | P5W11STILL | Tuscany | 24% Merlot<br>14% Malbech<br>48% Cabernet Sauvignon<br>14% Petit Verdot | 2015 | RED | 0.845 | 7539.5 |
| **P5** | P5W12STILL | Tuscany | 100% Chardonnay | 2015 | WHITE | 0.335 | 8354.0 |
| **P6** | P6W13STILL | Tuscany | 100% Sangiovese | 2016 | RED | 3.950 | 7595.0 |
| **P6** | P6W14STILL | Tuscany | 70% Sangiovese<br>30% Merlot, Cabernet S. , Cabernet Franc, Syrah, Petit Verdot | 2016 | RED | 69.326 | 6387.6 |
| **P6** | P6W15STILL | Tuscany | 33% Cabernet Sauvignon<br>67% Merlot | 2016 | RED | 3.091 | 5794.6 |
| **P7** | P7W16STILL | Veneto | 100% Garganega | 2016 | WHITE | 7.876 | 11000.0 |
| **P8** | P8W17STILL | Tuscany | 55% Cabernet Sauvignon<br>20% Merlot<br>15% Alicante-Bouschet<br>5% Petit Verdot<br>5% Cabernet Franc | 2012 | RED | 25.250 | 5486.0 |
| **P9** | P9W18STILL | Piedmont | 100% Cortese | 2013 | WHITE | 1.500 | 9170.0 |
| **P10** | P10W19STILL | Tuscany | 90% Sangiovese<br>10% altri vitigni | 2013 | RED | 262.390 | 7413.0 |
| **P11** | P11W20STILL | Sicily | 100% Caberent Sauvignon | 2016 | RED | 7.656 | 5200.0 |
| **P12** | P12W21STILL | Piedmont | 100% Nebbiolo | 2014 | RED | 2.700 | 7519.0 |
| **P12** | P12W22STILL | Piedmont | 100% Nebbiolo | 2014 | RED | 0.500 | 7000.0 |
| **P12** | P12W23STILL | Piedmont | 100% Nebbiolo | 2014 | RED | 0.910 | 7802.0 |
| **P12** | P12W24STILL | Piedmont | 100% Nebbiolo | 2014 | RED | 0.550 | 7818.0 |
| **P12** | P12W25STILL | Piedmont | 100% Nebbiolo | 2014 | RED | 1.060 | 8000.0 |
| **P12** | P12W26STILL | Piedmont | 100% Barbera | 2014 | RED | 3.700 | 6892.0 |
| **P12** | P12W27STILL | Piedmont | 100% Barbera | 2014 | RED | 0.450 | 6667.0 |

Among the Still Wines analysed out of twenty total wines, half (ten) are produced in Tuscany, eight are produced in Piedmont and the remaining two in Veneto and Sicily. All wines except one (yield of 110 q per ha) have a medium or low production yield compared to the sparkling ones, between 95 q per ha and 52 q per ha.

All wines except W16 and W19 are produced by small or medium producers who directly cultivate their vineyards and then autonomously transform the grapes into wine. These small and medium-sized producers have high-quality production with low yields and a greater control over all the production stages.

Among the twenty wines analysed, seventeen are red wines and three are white wines.

TABLE 3: VINEYARD CULTIVATION DATA – SPARKLING WINES

| Product Code | Average Yield | Wine Yield | Cultivation Density | N | P2O5 | K2O | Organic Fertilizer | N Organic | P2O5 Organic | Water for Pesticide application | Water for Irrigation | Diesel Consumption | CER150106 | CER130205 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg/ha | % | vine/ha | kg /ha | kg /ha | kg/ha | kg | kg/ha | kg/ha | m3/ha | m3/ha | kg/ha | kg/ha | kg/ha |
| **P1W1SPARK** | 11333.00 | 0.700 | 4000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - | 0.00 | 224.34 | 0.00 | 5.22 |
| **P1W2SPARK** | 12000.00 | 0.700 | 4000 | 17.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - | 0.00 | 224.34 | 0.00 | 5.22 |
| **P2W3SPARK** | 18400.00 | 0.686 | 4000 | 39.96 | 39.96 | 56.61 | 0.00 | 0.00 | 0.00 | 3.86 | 200.00 | 334.72 | - | - |
| **P2W4SPARK** | 18000.00 | 0.686 | 4000 | 39.96 | 39.96 | 56.61 | 0.00 | 0.00 | 0.00 | 3.45 | 200.00 | 618.18 | - | - |
| **P3W5SPARK** | 18400.00 | 0.686 | 4000 | 39.96 | 39.96 | 56.61 | 0.00 | 0.00 | 0.00 | 3.86 | 200.00 | 334.72 | - | - |
| **P4W6SPARK** | 14610.73 | 0.531 | 4000 | 2.21 | 0.00 | 0.00 | 84.46 | 0.34 | 0.08 | 19.00 | 343.00 | 162.05 | - | - |
| **P5W7SPARK** | 8470.96 | 0.699 | 5000 | 16.80 | 49.40 | 42.18 | 0.00 | 0.00 | 0.00 | - | 72.23 | 459.26 | 42.48 | 18.39 |

Table 3 shows the data of the products under examination. In particular, the quantities of water used for irrigation and distribution of plant protection products, the quantities of mineral and organic fertilizers used, the density of vine cultivation and the grape yield in wine are reported.

This table also shows the quantities of waste produced at the vineyard stage.

Fertilizer application it has been divided in organic and inorganic fertilizers. Only one producer uses organic fertilisers (W6), whereas the use of inorganic fertilisers is more widespread for sparkling wines. Some producers declare to not fertilise their vineyards every year.

Irrigation is not always permitted by the wine IG product specifications, therefore is not always used. The products with higher yields are irrigated.

The diesel consumption varies considerably, in some cases can exceed 600 kg per hectare. It was not possible to investigate whether this variability is linked to a greater degree of mechanization of the farms or whether it is instead linked to particular climatic conditions. A high variability was noticed also between products of the same brand; this is due to the fact that the company is a cooperative reality with different grapes suppliers.

All the sparkling wine analysed report high yield (from 113 q to 184 q) an exception is W7 that have a medium yield (84 q).

TABLE 4: VINEYARD CULTIVATION DATA – STILL WINES

| Product Code | Average Yield | Wine Yield | Cultivation Density | N | P2O5 | K2O | Organic Fertilizer | N Organic | P2O5 Organic | Water for Pesticide application | Water for Irrigation | Diesel Consumption | Electricity Consumption |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg/ha | % | Vine/ha | kg/ha | kg/ha | kg/ha | kg/ha | kg/ha | kg/ha | mc/ha | mc/ha | kg/ha | kWh/ha |
| **P5W8STILL** | 9545.0 | 69.93% | 5000 | 16.80 | 49.40 | 42.18 | 0.00 | 0.00 | 0.00 | 0.00 | 82.53 | 459.26 | 0.00 |
| **P5W9STILL** | 7411.5 | 69.93% | 5000 | 16.80 | 49.40 | 42.18 | 0.00 | 0.00 | 0.00 | 0.00 | 64.08 | 459.26 | 0.00 |
| **P5W10STILL** | 7702.7 | 69.93% | 5000 | 16.80 | 49.40 | 42.18 | 0.00 | 0.00 | 0.00 | 0.00 | 66.60 | 459.26 | 0.00 |
| **P5W11STILL** | 7539.5 | 69.93% | 5000 | 16.80 | 49.40 | 42.18 | 0.00 | 0.00 | 0.00 | 0.00 | 65.19 | 459.26 | 0.00 |
| **P5W12STILL** | 8354.0 | 69.93% | 5000 | 16.80 | 49.40 | 42.18 | 0.00 | 0.00 | 0.00 | 0.00 | 72.23 | 459.26 | 0.00 |
| **P6W13STILL** | 7595.0 | 70.42% | 5000 | 0.00 | 2.00 | 1.60 | 0.00 | 0.00 | 0.00 | - | 0.00 | 254.15 | 0.00 |
| **P6W14STILL** | 6387.6 | 70.42% | 5000 | 0.00 | 2.00 | 1.60 | 0.00 | 0.00 | 0.00 | - | 0.00 | 254.15 | 0.00 |
| **P6W15STILL** | 5794.6 | 70.42% | 5000 | 0.00 | 2.00 | 1.60 | 0.00 | 0.00 | 0.00 | - | 0.00 | 254.15 | 0.00 |
| **P7W16STILL** | 11000.0 | 70.00% | 4000 | 0.00 | 0.00 | 0.00 | 180.00 | 0.72 | 0.18 | 0.31 | 943.00 | 315.75 | 0.00 |
| **P8W17STILL** | 5486.0 | 63.29% | 6600 | 35.20 | 20.08 | 40.09 | 11.09 | 0.31 | 0.28 | - | 0.00 | 175.80 | 2148.99 |
| **P9W18STILL** | 9170.0 | 70.00% | 5000 | 14.00 | 28.00 | 56.00 | 0.00 | 0.00 | 0.00 | - | 0.00 | 171.17 | 0.00 |
| **P10W19STILL** | 7413.0 | 70.03% | 4000 | 3.79 | 4.46 | 41.17 | 0.00 | 0.00 | 0.00 | - | 0.00 | 228.96 | 227.02 |
| **P11W20STILL** | 5200.0 | 69.78% | 4000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | - | 0.00 | 200.00 | 0.00 |
| **P12W21STILL** | 7519.0 | 68.00% | 4800 | 0.00 | 0.00 | 90.00 | 800.00 | 4.48 | 1.34 | - | 0.00 | 125.63 | 0.00 |
| **P12W22STILL** | 7000.0 | 68.00% | 4800 | 0.00 | 0.00 | 90.00 | 2100.00 | 11.76 | 3.53 | - | 0.00 | 125.63 | 0.00 |
| **P12W23STILL** | 7802.0 | 68.00% | 4800 | 0.00 | 0.00 | 0.00 | 3000.00 | 36.20 | 33.36 | - | 0.00 | 142.38 | 0.00 |
| **P12W24STILL** | 7818.0 | 68.00% | 4800 | 0.00 | 0.00 | 0.00 | 2000.00 | 11.20 | 3.36 | - | 0.00 | 150.75 | 0.00 |
| **P12W25STILL** | 8000.0 | 68.00% | 4800 | 0.00 | 0.00 | 0.00 | 2000.00 | 11.20 | 3.36 | - | 0.00 | 142.38 | 0.00 |
| **P12W26STILL** | 6892.0 | 70.00% | 5500 | 0.00 | 0.00 | 84.00 | 1200.00 | 6.72 | 2.02 | - | 0.00 | 123.95 | 0.00 |
| **P12W27STILL** | 6667.0 | 70.00% | 5500 | 0.00 | 0.00 | 84.00 | 1500.00 | 8.40 | 2.52 | - | 0.00 | 123.95 | 0.00 |

Table 4 shows the data of the still products under examination. In particular, the quantities of water used for irrigation and distribution of plant protection products, the quantities of mineral and organic fertilizers used, the density of vine cultivation and the grape yield in wine are reported.

Only for the companies P5 and P10 data on the production of waste in the vineyard were available (Table 5).

All the analysed still wines company are located in wine vocated areas, and most of the producers are high quality wine producers.

Fertilizer application it has been divided in organic and inorganic fertilizers. For nine products only organic fertilisers were used (W16, W17, W211, W22, W23, W24, W25, W26 and W27), whereas for the other 11 products only inorganic fertilisers were used.

The most of the analysed wines have low yields (from 52 to 95 q/ha) only W16 has a higher yield (110 q/ha).

Irrigation is not always permitted by the wine IG product specifications, only 6 up to 20 producers irrigate their fields. W16 have a really high consumption of water related to irrigation, this data was further investigated directly with the producer that confirm the value.

The consumption of diesel varies considerably and is between 123.95 and 459.26 kg/ha. Also for Still wines it was not possible to investigate whether this variability is linked to a greater degree of mechanization of the farms or whether it is instead linked to particular climatic conditions.

TABLE 5:WASTE PRODUCED IN VINEYARD - STILL WINE

| **Product Code** | **CER150106** | **CER170403** | **CER130205** | **CER150110** | **CER150102** |
|---|---|---|---|---|---|
| | kg/ha | kg/ha | kg/ha | kg/ha | kg/ha |
| **P5W8STILL** | 48.53 | 0.00 | 21.01 | 0.00 | 0.00 |
| **P5W9STILL** | 37.69 | 0.00 | 16.31 | 0.00 | 0.00 |
| **P5W10STILL** | 39.17 | 0.00 | 16.95 | 0.00 | 0.00 |
| **P5W11STILL** | 38.34 | 0.00 | 16.60 | 0.00 | 0.00 |
| **P5W12STILL** | 42.48 | 0.00 | 18.39 | 0.00 | 0.00 |
| **P10W19STILL** | 19.39 | 15.75 | 2.56 | 2.01 | 0.24 |

The CER code list defines the following waste categories:

- CER150106: Packaging waste mixed material.

- CER170403: waste steel and iron.
- CER130205: waste engine oil density.
- CER150110: packaging waste containing residues of or contaminated by dangerous substances.
- CER150102: Packaging Waste Plastic.

TABLE 6: PHYTOSANITARY COMPOUNDS – SPARKLING WINES

| Product Code | [sulfonyl]urea compounds | Acetamide anillide compounds | copper oxide | Cyclic N compounds | Folpet | Fosetyl-Al | Glyphosate | Mancozeb | Organo phosphorus compounds | Pyrethroid compounds | Pyridine compounds | Sulphur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P1W1SPARK** | 0.00 | 0.35 | 12.83 | 33.88 | 0.91 | 49.71 | 0.00 | 9.05 | 0.09 | 0.00 | 0.16 | 150.00 |
| **P1W2SPARK** | 0.00 | 0.35 | 12.83 | 33.88 | 0.91 | 49.71 | 0.00 | 9.05 | 0.09 | 0.00 | 0.16 | 150.00 |
| **P2W3SPARK** | 0.00 | 0.55 | 16.67 | 1.74 | 0.69 | 9.07 | 1.44 | 3.90 | 0.53 | 0.00 | 0.91 | 37.14 |
| **P2W4SPARK** | 0.00 | 0.55 | 14.93 | 1.74 | 0.00 | 8.03 | 1.44 | 3.90 | 0.53 | 0.00 | 0.91 | 33.84 |
| **P3W5SPARK** | 0.00 | 0.55 | 16.67 | 1.74 | 0.69 | 9.07 | 1.44 | 3.90 | 0.53 | 0.00 | 0.91 | 37.14 |
| **P4W6SPARK** | 0.00 | 0.14 | 2.62 | 0.35 | 0.21 | 0.76 | 0.07 | 0.81 | 0.16 | 0.02 | 0.00 | 7.89 |
| **P5W7SPARK** | 0.00 | 0.21 | 8.72 | 1.39 | 0.65 | 0.00 | 1.31 | 4.14 | 0.00 | 0.00 | 0.55 | 50.24 |

The list of plant protection products in Annex III shows the active substances and the average quantities of products used in vineyards to produce the grapes under analysis. In order to model the production of the active ingredients in the LCA software, the products used were grouped into twelve product classes defined by PEFCR Wine (CEEV, 2018b). The subdivision into classes of Sparkling and Still products is shown in

Table 6 and Table 7. For the product P10W19STILL no information about the use of phytosanitary product were available from the VIVA report so to model this product the medium value of still product was used.

The product with a higher consumption per ha is sulphur followed by copper oxide. Only the product W16 uses [sulfonyl]urea compounds

TABLE 7 PHYTOSANITARY COMPOUNDS – STILL WINES

| Product Code | [sulfonyl]urea compounds | Acetamide Anillide compounds | copper oxide | Cyclic N compounds | Folpet | Fosetyl-Al | Glyphosate | Mancozeb | Organo Phosphorus compounds | Pyrethroid compounds | Pyridine compounds | Sulphur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P5W8STILL** | 0.00 | 0.21 | 14.73 | 1.39 | 0.65 | 0.00 | 1.79 | 4.14 | 0.00 | 0.00 | 0.55 | 70.24 |
| **P5W9STILL** | 0.00 | 0.21 | 14.14 | 1.39 | 0.65 | 0.00 | 1.79 | 4.34 | 0.00 | 0.00 | 0.55 | 70.24 |
| **P5W10STILL** | 0.00 | 0.21 | 14.14 | 1.39 | 0.65 | 0.00 | 1.79 | 4.34 | 0.00 | 0.00 | 0.55 | 70.24 |
| **P5W11STILL** | 0.00 | 0.21 | 14.73 | 1.39 | 0.65 | 0.00 | 1.79 | 4.14 | 0.00 | 0.00 | 0.55 | 70.24 |
| **P5W12STILL** | 0.00 | 0.21 | 8.72 | 1.39 | 0.65 | 0.00 | 1.31 | 4.14 | 0.00 | 0.00 | 0.55 | 50.24 |
| **P6W13STILL** | 0.00 | 1.30 | 10.08 | 1.12 | 0.60 | 4.00 | 0.00 | 2.64 | 0.00 | 0.00 | 0.30 | 5.40 |
| **P6W14STILL** | 0.00 | 1.64 | 30.80 | 1.12 | 0.81 | 4.00 | 0.00 | 6.11 | 0.00 | 0.00 | 0.30 | 9.60 |
| **P6W15STILL** | 0.00 | 1.10 | 21.48 | 0.92 | 0.60 | 4.00 | 0.00 | 2.64 | 0.00 | 0.00 | 0.30 | 5.40 |
| **P7W16STILL** | 0.01 | 5.81 | 16.18 | 3.71 | 14.84 | 5.28 | 3.15 | 23.87 | 0.84 | 0.00 | 0.57 | 150.00 |
| **P8W17STILL** | 0.00 | 0.34 | 1.73 | 0.38 | 0.61 | 3.71 | 1.07 | 0.63 | 0.00 | 0.00 | 0.00 | 42.50 |
| **P9W18STILL** | 0.00 | 0.40 | 13.50 | 1.32 | 0.00 | 0.00 | 2.00 | 6.40 | 0.00 | 0.00 | 0.84 | 93.75 |
| **P10W19STILL** | 0.00 | 1.07 | 8.85 | 1.11 | 1.43 | 4.70 | 0.73 | 4.12 | 1.15 | 0.00 | 0.27 | 37.27 |
| **P11W20STILL** | 0.00 | 0.25 | 0.00 | 0.20 | 1.16 | 0.00 | 0.00 | 2.42 | 0.00 | 0.00 | 0.30 | 54.66 |
| **P12W21STILL** | 0.00 | 1.17 | 2.08 | 0.86 | 0.85 | 9.07 | 0.00 | 2.08 | 2.77 | 0.00 | 0.00 | 6.57 |
| **P12W22STILL** | 0.00 | 1.17 | 2.08 | 0.86 | 0.85 | 9.07 | 0.00 | 2.08 | 2.77 | 0.00 | 0.00 | 6.57 |
| **P12W23STILL** | 0.00 | 1.17 | 2.08 | 0.86 | 0.85 | 9.07 | 0.00 | 2.08 | 2.77 | 0.00 | 0.00 | 6.57 |
| **P12W24STILL** | 0.00 | 3.04 | 5.37 | 1.96 | 2.19 | 23.49 | 0.00 | 5.37 | 7.16 | 0.00 | 0.00 | 17.01 |
| **P12W25STILL** | 0.00 | 0.85 | 1.50 | 0.55 | 0.61 | 6.56 | 0.00 | 1.50 | 2.00 | 0.00 | 0.00 | 4.75 |
| **P12W26STILL** | 0.00 | 1.02 | 1.80 | 0.66 | 0.73 | 7.85 | 0.00 | 1.80 | 2.39 | 0.00 | 0.00 | 5.69 |
| **P12W27STILL** | 0.00 | 1.02 | 1.80 | 0.66 | 0.73 | 7.85 | 0.00 | 1.80 | 2.39 | 0.00 | 0.00 | 5.69 |

TABLE 8: WINERY PRODUCTION DATA SPARKLING

| Product Code | Grape Transport | Electricity Grape Pressing | Electricity Wine Making and storage | Natural Gas | Groundwater | Well water | Waste water | R134a | R125 | R143a | R32 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | km | kWh/kg of grape | kWh/kg of grape | m3/kg of grape | m3/kg of grape | m3/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape |
| **P1W1SPARK** | 1.00 | 5.60E-03 | 9.83E-01 | 4.20E-01 | 1.70E-03 | - | - | 9.00E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P1W2SPARK** | 1.00 | 5.60E-03 | 9.83E-01 | 4.20E-01 | 1.70E-03 | - | - | 9.00E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P2W3SPARK** | 0.50 | 5.60E-03 | 9.71E-01 | 2.10E-02 | 7.00E-03 | - | - | 6.30E-05 | 5.27E-05 | 1.49E-06 | 2.57E-05 |
| **P2W4SPARK** | 0.50 | 5.60E-03 | 9.71E-01 | 2.10E-02 | 7.00E-03 | - | - | 6.30E-05 | 5.27E-05 | 1.49E-06 | 2.57E-05 |
| **P3W5SPARK** | 0.50 | 5.60E-03 | 9.71E-01 | 2.20E-02 | 1.00E-03 | - | - | 6.30E-05 | 5.27E-05 | 1.49E-06 | 2.57E-05 |
| **P4W6SPARK** | 5.46 | 5.60E-03 | 4.30E-01 | 8.29E-02 | - | - | - | 6.74E-07 | 1.78E-05 | 8.77E-06 | 1.04E-05 |
| **P5W7SPARK** | 1.00 | 5.60E-03 | 1.13E+00 | 4.34E-01 | - | - | - | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

TABLE 9: WINERY PRODUCTION DATA STILL

| Product Code | Grape Transport | Electricity Grape Pressing | Electricity Wine Making and storage | Diesel | LPG | Natural Gas | Groundwater | Well water | Waste water | R134a | R125 | R143a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | km | kWh/kg of grape | kWh/kg of grape | kg/kg of grape | kg/kg of grape | mc/kg of grape | mc/kg of grape | mc/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape |
| **P5W8STILL** | 1.00 | 5.60E-03 | 1.13E+00 | 0.00E+00 | 0.00E+00 | 4.34E-01 | - | - | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W9STILL** | 1.00 | 5.60E-03 | 1.13E+00 | 0.00E+00 | 0.00E+00 | 4.34E-01 | - | - | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W10STILL** | 1.00 | 5.60E-03 | 1.13E+00 | 0.00E+00 | 0.00E+00 | 4.34E-01 | - | - | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W11STILL** | 1.00 | 5.60E-03 | 1.13E+00 | 0.00E+00 | 0.00E+00 | 4.34E-01 | - | - | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W12STILL** | 1.00 | 5.60E-03 | 1.13E+00 | 0.00E+00 | 0.00E+00 | 4.34E-01 | - | - | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W13STILL** | 1.00 | 5.60E-03 | 1.12E+00 | 6.34E-04 | 0.00E+00 | 4.38E-02 | 9.31E-03 | 0.00E+00 | 7.23E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W14STILL** | 1.00 | 5.60E-03 | 1.12E+00 | 6.34E-04 | 0.00E+00 | 4.38E-02 | 9.31E-03 | 0.00E+00 | 7.23E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W15STILL** | 1.00 | 5.60E-03 | 1.12E+00 | 6.34E-04 | 0.00E+00 | 4.38E-02 | 9.31E-03 | 0.00E+00 | 7.23E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P7W16STILL** | 6.63 | 1.26E-03 | 2.09E-01 | 0.00E+00 | 0.00E+00 | 1.37E-01 | 4.29E-02 | 0.00E+00 | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P8W17STILL** | 1.00 | 5.60E-03 | 1.12E+00 | 5.45E-03 | 1.61E-02 | 0.00E+00 | 0.00E+00 | 1.60E-02 | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P9W18STILL** | 1.00 | 5.60E-03 | 5.46E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.09E-03 | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P10W19STILL** | 43.60 | 5.60E-03 | 3.66E-01 | 0.00E+00 | 2.10E+00 | 0.00E+00 | - | - | 1.53E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P11W20STILL** | 1.00 | 5.60E-03 | 2.95E-03 | 0.00E+00 | 3.10E-06 | 0.00E+00 | 2.27E-05 | 0.00E+00 | - | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **P12W21STILL** | 49.00 | 5.60E-03 | 6.96E-01 | 0.00E+00 | 0.00E+00 | 8.01E-02 | 6.06E-03 | 6.76E-04 | 6.75E+00 | 2.18E-06 | 2.39E-05 | 2.83E-05 |
| **P12W22STILL** | 49.00 | 5.60E-03 | 6.96E-01 | 0.00E+00 | 0.00E+00 | 8.01E-02 | 6.06E-03 | 6.76E-04 | 6.75E+00 | 2.18E-06 | 2.39E-05 | 2.83E-05 |
| **P12W23STILL** | 53.00 | 5.60E-03 | 6.96E-01 | 0.00E+00 | 0.00E+00 | 8.01E-02 | 6.06E-03 | 6.76E-04 | 6.75E+00 | 2.18E-06 | 2.39E-05 | 2.83E-05 |
| **P12W24STILL** | 30.00 | 5.60E-03 | 6.96E-01 | 0.00E+00 | 0.00E+00 | 8.01E-02 | 6.06E-03 | 6.76E-04 | 6.75E+00 | 2.18E-06 | 2.39E-05 | 2.83E-05 |
| **P12W25STILL** | 30.00 | 5.60E-03 | 6.96E-01 | 0.00E+00 | 0.00E+00 | 8.01E-02 | 6.06E-03 | 6.76E-04 | 6.75E+00 | 2.18E-06 | 2.39E-05 | 2.83E-05 |
| **P12W26STILL** | 8.00 | 5.60E-03 | 6.76E-01 | 0.00E+00 | 0.00E+00 | 7.79E-02 | 5.89E-03 | 6.57E-04 | 6.56E+00 | 2.11E-06 | 2.33E-05 | 2.75E-05 |
| **P12W27STILL** | 8.00 | 5.60E-03 | 6.76E-01 | 0.00E+00 | 0.00E+00 | 7.79E-02 | 5.89E-03 | 6.57E-04 | 6.56E+00 | 2.11E-06 | 2.33E-05 | 2.75E-05 |

Table 8 and Table 9 shows the wine cellar's consumption of Sparkling and Still products in terms of electricity, methane gas, water, and losses of refrigerant gases per kg of grapes entering the vinery stage. The electric energy data for grape pressing, if not available, was taken from PEFCR Wine (CEEV, 2018b) and subtracted from the value reported for the vinery stage. The only company that had information about the electricity consumption for the Grape pressing phase was P7 for W16 and report a lower value than the average PEF value. In some cases, Still wine vineries use LPG instead of Natural Gas, and one company do not report fossil fuel consumptions in the Winery. Most of producers have the vineyard annexed to the vinery reducing the distance for grape transport. For sparkling wines, the value is equal or less than 1 km with an exception of 1 producer with a mean distance of 5.6 km. For still wines the distance are similar, but producer P12 collect grape in different vocated areas in Piedmont, so the distance increase to a minimum of 8 to a maximum of 53 km.

TABLE 10: WASTE PRODUCED AT THE WINERY – SPARKLING WINES

| **Product Code** | **CER150106** | **CER150110** | **CER150102** | **CER150103** | **CER150101** | **CER170403** | **CER170202** | **CER020705** | **CER161002** | **CER020103** |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape |
| **P1W1SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.30E-01 | 0.00E+00 | 2.30E-03 | 0.00E+00 | 2.27E-01 | 0.00E+00 |
| **P1W2SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.30E-01 | 0.00E+00 | 2.30E-03 | 0.00E+00 | 2.27E-01 | 0.00E+00 |
| **P2W3SPARK** | 3.79E-03 | 0.00E+00 | 3.50E-03 | 7.29E-04 | 5.98E-03 | 1.46E-04 | 3.64E-03 | 0.00E+00 | 0.00E+00 | 7.87E-02 |
| **P2W4SPARK** | 3.79E-03 | 0.00E+00 | 3.50E-03 | 7.29E-04 | 5.98E-03 | 1.46E-04 | 3.64E-03 | 0.00E+00 | 0.00E+00 | 7.87E-02 |
| **P3W5SPARK** | 3.79E-03 | 0.00E+00 | 3.50E-03 | 7.29E-04 | 5.98E-03 | 1.46E-04 | 3.64E-03 | 0.00E+00 | 0.00E+00 | 7.87E-02 |
| **P4W6SPARK** | 1.07E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.00E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W7SPARK** | - | - | - | - | - | - | - | - | - | - |

TABLE 11: WASTE PRODUCED AT THE WINERY – STILL WINES

| Product Code | CER150106 | CER150110 | CER150102 | CER150103 | CER150101 | CER170403 | CER170202 | CER020705 | CER161002 | CER020103 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape | Kg/Kg of grape |
| **P5W8STILL** | - | - | - | - | - | - | - | - | - | - |
| **P5W9STILL** | - | - | - | - | - | - | - | - | - | - |
| **P5W10STILL** | - | - | - | - | - | - | - | - | - | - |
| **P5W11STILL** | - | - | - | - | - | - | - | - | - | - |
| **P5W12STILL** | - | - | - | - | - | - | - | - | - | - |
| **P6W13STILL** | 3.84E-04 | 1.37E-04 | 1.20E-02 | 1.92E-04 | 1.52E-02 | 2.32E-02 | 3.71E-03 | 1.20E-01 | 2.56E-02 | 3.84E-03 |
| **P6W14STILL** | 3.84E-04 | 1.37E-04 | 1.20E-02 | 1.92E-04 | 1.52E-02 | 2.32E-02 | 3.71E-03 | 1.20E-01 | 2.56E-02 | 3.84E-03 |
| **P6W15STILL** | 3.84E-04 | 1.37E-04 | 1.20E-02 | 1.92E-04 | 1.52E-02 | 2.32E-02 | 3.71E-03 | 1.20E-01 | 2.56E-02 | 3.84E-03 |
| **P7W16STILL** | 0.00E+00 | 0.00E+00 | 3.14E-02 | 0.00E+00 | 5.57E-02 | 0.00E+00 | 9.29E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P8W17STILL** | 1.75E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P9W18STILL** | - | - | - | - | - | - | - | - | - | - |
| **P10W19STILL** | - | - | - | - | - | - | - | - | - | - |
| **P11W20STILL** | 0.00E+00 | 1.32E-06 | 2.71E-05 | 0.00E+00 | 4.51E-05 | 0.00E+00 | 4.78E-05 | 1.09E-05 | 0.00E+00 | 0.00E+00 |
| **P12W21STILL** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W22STILL** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W23STILL** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W24STILL** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W25STILL** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W26STILL** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W27STILL** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

Table 10 and Table 11 shows the quantity of waste produced at the winery, for Wines of the P5, P9 and P10 producer no information related to waste were available. For producer P12 the information was in aggregated form.

The CER code list defines the following waste categories:

- CER150106: Packaging waste mixed material.
- CER150110: Packaging waste containing residues of or contaminated by dangerous substances.
- CER150102: Packaging Waste Plastic.

- CER150103: Packaging waste wood.
- CER150101: Packaging waste paper.
- CER170403: Waste steel and iron.
- CER170202: Waste glass.
- CER020705: Sludges from on-site effluent treatment
- CER161002: Non-hazardous aqueous waste solutions.
- CER020103: Plant waste.

TABLE 12: ADDITIVES AND PROCESSING AIDS FOR OENOLOGICAL PRACTICES – SPARKLING WINE

| Product name | Ammonium sulphate | Calcium Tartrate | Enzymes | Yeast | Sugar | Tannins | Thiamine hydrochloride | Yeast mannoproteins |
|---|---|---|---|---|---|---|---|---|
| | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine |
| **P5W7SPARK** | 1.70E-04 | 0.00E+00 | 9.29E-04 | 0.00E+00 | 2.86E-04 | 3.16E-02 | 1.43E-04 | 4.46E-04 |

TABLE 13: ADDITIVES AND PROCESSING AIDS FOR OENOLOGICAL PRACTICES – STILL WINE

| Product Code | Ammonium bisulphite | Ammonium sulphate | Calcium Tartrate | Enzymes | Yeast | Tannins | Thiamine hydrochloride | Yeast mannoproteins |
|---|---|---|---|---|---|---|---|---|
| | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine |
| **P5W8STILL** | 1.70E-04 | - | 1.40E-03 | 1.00E-05 | 2.00E-04 | 1.90E-04 | 2.00E-04 | 2.00E-04 |
| **P5W9STILL** | 1.70E-04 | - | 1.40E-03 | 1.00E-05 | 2.00E-04 | 1.90E-04 | 2.00E-04 | 2.00E-04 |
| **P5W10STILL** | 1.70E-04 | - | 1.40E-03 | 1.00E-05 | 2.00E-04 | 1.90E-04 | 2.00E-04 | 2.00E-04 |
| **P5W11STILL** | 1.70E-04 | - | 1.40E-03 | 1.00E-05 | 2.00E-04 | 1.90E-04 | 2.00E-04 | 2.00E-04 |
| **P5W12STILL** | 1.70E-04 | - | 6.50E-04 | - | 2.00E-04 | 1.00E-04 | 2.00E-04 | - |
| **P6W13STILL** | 2.20E-04 | - | 1.80E-03 | 9.00E-05 | 2.50E-04 | 3.50E-04 | - | 1.50E-04 |
| **P6W14STILL** | 3.20E-04 | - | 1.80E-03 | 6.00E-05 | 2.60E-04 | 3.10E-04 | - | 1.50E-04 |
| **P6W15STILL** | 3.20E-04 | - | 1.80E-03 | 1.00E-05 | 3.40E-04 | 2.80E-04 | - | 3.50E-04 |
| **P7W16STILL** | - | - | - | - | - | - | - | - |
| **P8W17STILL** | - | - | - | - | - | - | - | - |
| **P9W18STILL** | 8.00E-05 | | 6.27E-04 | | 2.00E-04 | - | - | - |
| **P10W19STILL** | - | - | - | 1.18E-03 | - | - | - | - |
| **P11W20STILL** | 2.20E-04 | 1.50E-04 | - | - | 1.50E-02 | - | - | 3.01E-04 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **P12W21STILL** | 2.50E-04 | - | - | - | 2.00E-04 | - | 3.00E-04 | - |
| **P12W22STILL** | 2.50E-04 | - | - | - | 2.00E-04 | - | 3.00E-04 | - |
| **P12W23STILL** | 2.50E-04 | - | - | - | 2.00E-04 | - | 3.00E-04 | - |
| **P12W24STILL** | 2.50E-04 | - | - | - | 2.00E-04 | - | 3.00E-04 | - |
| **P12W25STILL** | 2.50E-04 | - | - | - | 2.00E-04 | - | 3.00E-04 | - |
| **P12W26STILL** | 2.50E-04 | - | - | - | 2.00E-04 | - | 3.00E-04 | - |
| **P12W27STILL** | 2.50E-04 | - | - | - | 2.00E-04 | - | 3.00E-04 | - |

Table 12 and Table 13 shows the quantity of additives and processing aids for oenological practices, For sparkling wines only for the P5W7SPARK product this information was available. The VIVA data collection requires information about the use of yeasts, enzymes and tannins, and single companies can add some more information like nutrients, antioxidants, clarifiers or activators. In VIVA – AIR those elements are counted only for transport. The transposition to this check list taken from the Wine PEFCR (CEEV, 2018b), followed this rule:

Yeast; Enzymes and Tannins have been transposed correctly; Nutrients have been transposed as Yeast mannoproteins; activators as Thiamine hydrochloride; clarifiers as Calcium Tartrate and antioxidant as Ammonium bisulphite.

TABLE 14: BOTTLING AND PACKAGING – SPARKLING WINES

| Product name | Electricity bottling | Glass | Paper label | Cork stopper | Aluminium overcap | Aluminium screw cap | Plastic film | Cardboard | Wood | Wooden Pallet |
|---|---|---|---|---|---|---|---|---|---|---|
| | kWh/liter | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU |
| **P1W1SPARK** | 0.00E+00 | 5.52E-01 | 9.00E-04 | 6.75E-03 | 6.60E-04 | 0.00E+00 | 1.85E-04 | 4.40E-02 | 0.00E+00 | 3.10E-03 |
| **P1W2SPARK** | 0.00E+00 | 5.52E-01 | 9.00E-04 | 6.75E-03 | 6.60E-04 | 0.00E+00 | 1.85E-04 | 4.40E-02 | 0.00E+00 | 3.10E-03 |
| **P2W3SPARK** | 7.40E-02 | 7.00E-01 | 1.80E-03 | 9.00E-03 | 1.20E-03 | 5.10E-03 | 1.29E-03 | 3.80E-02 | 0.00E+00 | 1.67E-03 |
| **P2W4SPARK** | 7.40E-02 | 7.00E-01 | 1.80E-03 | 9.00E-03 | 1.20E-03 | 5.10E-03 | 1.29E-03 | 5.25E-02 | 0.00E+00 | 1.67E-03 |
| **P3W5SPARK** | 1.15E-01 | 5.80E-01 | 2.80E-03 | 6.40E-03 | 9.00E-04 | 0.00E+00 | 1.29E-03 | 4.42E-02 | 0.00E+00 | 1.67E-03 |
| **P4W6SPARK** | 9.79E-02 | 6.04E-01 | 9.00E-04 | 9.30E-03 | 9.00E-04 | 5.00E-03 | 1.00E-03 | 3.12E-02 | 0.00E+00 | 2.53E-03 |
| **P5W7SPARK** | 0.00E+00 | 8.38E-01 | 5.00E-03 | 7.00E-03 | 4.00E-03 | 4.00E-03 | 5.56E-04 | 6.92E-02 | 0.00E+00 | 2.78E-03 |

TABLE 15: BOTTLING AND PACKAGING – STILL WINES

| Product Code | Electricity bottling | Glass | Paper label | Cork stopper | Aluminium overcap | Plastic film | Cardboard | Wood | Wooden Pallet |
|---|---|---|---|---|---|---|---|---|---|
| | kWh/liter | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU |
| **P5W8STILL** | 0.00E+00 | 4.53E-01 | 5.00E-03 | 5.00E-03 | 1.12E-03 | 5.56E-04 | 5.00E-02 | 0.00E+00 | 2.78E-03 |
| **P5W9STILL** | 0.00E+00 | 6.13E-01 | 5.00E-03 | 6.00E-03 | 1.50E-03 | 5.56E-04 | 5.81E-02 | 0.00E+00 | 2.78E-03 |
| **P5W10STILL** | 0.00E+00 | 4.53E-01 | 1.00E-03 | 5.00E-03 | 1.12E-03 | 1.29E-03 | 4.42E-02 | 0.00E+00 | 1.67E-03 |
| **P5W11STILL** | 0.00E+00 | 6.13E-01 | 1.00E-03 | 6.00E-03 | 1.50E-03 | 1.29E-03 | 6.21E-02 | 0.00E+00 | 2.78E-03 |
| **P5W12STILL** | 0.00E+00 | 7.05E-01 | 5.00E-03 | 5.00E-03 | 1.50E-03 | 5.56E-04 | 6.82E-02 | 0.00E+00 | 2.78E-03 |
| **P6W13STILL** | 0.00E+00 | 6.51E-01 | 5.00E-03 | 3.30E-03 | 4.40E-03 | 1.32E-04 | 3.65E-02 | 2.77E-01 | 1.61E-03 |
| **P6W14STILL** | 0.00E+00 | 4.95E-01 | 5.00E-03 | 3.90E-03 | 1.10E-03 | 7.53E-05 | 4.67E-02 | 0.00E+00 | 8.85E-04 |
| **P6W15STILL** | 0.00E+00 | 5.99E-01 | 5.00E-03 | 3.30E-03 | 4.00E-03 | 1.43E-04 | 5.07E-02 | 0.00E+00 | 2.42E-03 |
| **P7W16STILL** | 1.53E-02 | 5.02E-01 | 4.20E-03 | 5.60E-03 | 1.30E-03 | 1.21E-03 | 1.32E-01 | 0.00E+00 | 2.37E-03 |
| **P8W17STILL** | 3.43E-03 | 4.40E-01 | 6.00E-04 | 4.00E-03 | 1.20E-03 | 2.22E-04 | 4.97E-02 | 0.00E+00 | 2.78E-03 |
| **P9W18STILL** | 0.00E+00 | 3.90E-01 | 5.00E-04 | 6.00E-03 | 4.00E-03 | 2.78E-04 | 4.93E-02 | 0.00E+00 | 2.78E-03 |
| **P10W19STILL** | 0.00E+00 | 4.10E-01 | 2.80E-04 | 4.00E-03 | 7.30E-04 | 3.00E-02 | 4.67E-02 | 0.00E+00 | 1.89E-03 |
| **P11W20STILL** | 0.00E+00 | 7.45E-01 | 2.13E-03 | 3.80E-03 | 1.12E-03 | 2.70E-02 | 0.00E+00 | 2.92E-01 | 1.49E-03 |
| **P12W21STILL** | 7.20E-02 | 5.00E-01 | 1.70E-03 | 4.20E-03 | 1.20E-03 | 1.39E-04 | 4.44E-02 | 4.87E-02 | 2.31E-03 |
| **P12W22STILL** | 7.20E-02 | 5.00E-01 | 1.70E-03 | 4.20E-03 | 1.20E-03 | 1.39E-04 | 4.44E-02 | 4.87E-02 | 2.31E-03 |
| **P12W23STILL** | 7.20E-02 | 5.00E-01 | 1.70E-03 | 4.20E-03 | 1.20E-03 | 1.39E-04 | 4.44E-02 | 4.87E-02 | 2.31E-03 |
| **P12W24STILL** | 7.20E-02 | 5.00E-01 | 1.70E-03 | 4.20E-03 | 1.20E-03 | 1.39E-04 | 4.44E-02 | 4.87E-02 | 2.31E-03 |
| **P12W25STILL** | 7.20E-02 | 5.00E-01 | 1.70E-03 | 4.20E-03 | 1.20E-03 | 1.39E-04 | 4.44E-02 | 4.87E-02 | 2.31E-03 |
| **P12W26STILL** | 7.20E-02 | 5.00E-01 | 1.70E-03 | 4.20E-03 | 1.20E-03 | 1.39E-04 | 4.44E-02 | 4.87E-02 | 2.31E-03 |
| **P12W27STILL** | 7.20E-02 | 5.00E-01 | 1.70E-03 | 4.20E-03 | 1.20E-03 | 1.39E-04 | 4.44E-02 | 4.87E-02 | 2.31E-03 |

Packaging play a really important role in the CFP evaluation; the production of glass bottle has a great impact on climate change and packaging production impact can range in the analysed products from 23% to 55% of the total CFP of a wine. For Electricity consumption related to the bottling phase when the value is zero it means that the consumption was included in the overall Winery consumption.

Sparkling products due to their characteristics are bottled in heavy glass bottles with values that ranges 0.552 and 0.838 kg. Still wines analysed are only bottled in glass bottles, no carton box or bag in box solutions are used at the moment in VIVA certified products. The weight of bottles used for still wines ranges from 0.390 and 0.745 kg, we notice low differences between still and sparkling wines.

TABLE 16: DISTRIBUTION OF THE FINAL PRODUCT – SPARKLING WINE

| Product code | Mass functional Unit | Lorry: transport distance | Train: transport distance | Barge: transport distance | % Center Europe | % USA and Canada | % Italy |
|---|---|---|---|---|---|---|---|
| | kg | Km | km | km | % | % | % |
| **P1W1SPARK** | 1.38 | 58.13 | 0.00 | 0.00 | 0.00% | 0.00% | 100.00% |
| **P1W2SPARK** | 1.38 | 62.26 | 0.00 | 0.00 | 0.00% | 0.00% | 100.00% |
| **P2W3SPARK** | 1.51 | 277.62 | 0.00 | 0.00 | 5.20% | 0.00% | 94.80% |
| **P2W4SPARK** | 1.52 | 2000.00 | 0.00 | 0.00 | 100.00% | 0.00% | 0.00% |
| **P3W5SPARK** | 1.39 | 229.92 | 0.00 | 0.00 | 0.30% | 0.00% | 99.70% |
| **P4W6SPARK** | 1.40 | 50.15 | 0.00 | 0.00 | 0.00% | 0.00% | 100.00% |
| **P5W7SPARK** | 1.68 | 136.61 | 0.00 | 0.00 | 13.60% | 0.00% | 86.40% |

TABLE 17: DISTRIBUTION OF THE FINAL PRODUCT – STILL WINES

| Product Code | Functional Unit Mass | Lorry: transport distance | Barge: transport distance | % Center Europe | % USA and Canada | % Italy |
|---|---|---|---|---|---|---|
| | kg | km/FU | km/FU | | | |
| **P5W8STILL** | 1.27 | 584.24 | 0.00 | 45.50% | 0.00% | 54.50% |
| **P5W9STILL** | 1.44 | 569.09 | 3203.46 | 51.50% | 18.50% | 30.00% |
| **P5W10STILL** | 1.26 | 1313.87 | 744.59 | 64.50% | 4.30% | 31.20% |
| **P5W11STILL** | 1.44 | 803.53 | 4275.28 | 68.50% | 24.00% | 7.50% |
| **P5W12STILL** | 1.54 | 218.35 | 0.00 | 16.80% | 0.00% | 83.20% |
| **P6W13STILL** | 1.73 | 448.38 | 10706.40 | 19.72% | 70.03% | 10.25% |
| **P6W14STILL** | 1.30 | 331.21 | 12210.89 | 9.88% | 87.06% | 3.06% |
| **P6W15STILL** | 1.41 | 578.39 | 2074.86 | 74.96% | 21.53% | 3.51% |
| **P7W16STILL** | 1.40 | 537.64 | 2158.98 | 16.24% | 27.06% | 56.70% |
| **P8W17STILL** | 1.25 | 5498.39 | 31507.38 | 11.66% | 85.40% | 2.94% |
| **P9W18STILL** | 1.20 | 161.00 | 744.00 | 4.00% | 8.00% | 88.00% |

| | | | | | | |
|---|---|---|---|---|---|---|
| **P10W19STILL** | 1.24 | 271.90 | 350.59 | 5.96% | 3.83% | 90.21% |
| **P11W20STILL** | 1.82 | 1963.34 | 1706.36 | 5.00% | 6.00% | 89.00% |
| **P12W21STILL** | 1.35 | 470.00 | 4899.00 | 28.57% | 44.64% | 26.79% |
| **P12W22STILL** | 1.35 | 472.00 | 6377.00 | 33.33% | 46.67% | 20.00% |
| **P12W23STILL** | 1.35 | 399.00 | 4115.00 | 51.02% | 36.73% | 12.24% |
| **P12W24STILL** | 1.35 | 356.00 | 6404.00 | 23.73% | 64.41% | 11.86% |
| **P12W25STILL** | 1.35 | 356.00 | 6404.00 | 23.73% | 64.41% | 11.86% |
| **P12W26STILL** | 1.35 | 582.00 | 5201.00 | 25.00% | 50.00% | 25.00% |
| **P12W27STILL** | 1.35 | 375.00 | 3180.00 | 22.73% | 31.82% | 45.45% |

Table 16 and Table 17 show data on the distribution of the final product. The average kilometres travelled and the use of the various means of transport are reliable, while it was not possible to identify the individual countries were the product was distributed, but only the continent of destination. In order to be able to model the end of life of the product in a consistent manner, three geographical areas and the respective percentage of distribution have been identified.

The areas are: Italy; Central Europe; USA and Canada

The sparkling products analysed are mainly marketed on the Italian market with the exception of W4, which is sold all in central Europe. This is certainly not representative of the sale of sparkling products produced in Italy but gives an indication of how the national market is ready to use environmental labels and enhances the products that affix environmental labels.

For the analysed still wine, also due to the greater sample, show a greater uniformity with VIVA certified product sold not only in Italy but also in Europe and US.

The disposal scenarios used refer to the USA as far as the USA and Canada are concerned, to Italy as far as the product distributed on the national territory is concerned and to Germany as far as the products distributed in central Europe are concerned (Germany is the largest importer of Italian wines in Europe).

TABLE 18: STILL AND SPARKLING BOTTLE PRICES IN EURO

| Name | Bottle Price |
|---|---|
| P1W1SPARK | 7.20 € |
| P1W2SPARK | 7.20 € |
| P2W3SPARK | 8.35 € |
| P2W4SPARK | 9.70 € |
| P3W5SPARK | 5.49 € |
| P4W6SPARK | 5.10 € |
| P5W7SPARK | 18.00 € |
| P5W8STILL | 14.00 € |
| P5W9STILL | 20.90 € |
| P5W10STILL | 8.40 € |
| P5W11STILL | 31.00 € |
| P5W12STILL | 12.00 € |
| P6W13STILL | 29.00 € |
| P6W14STILL | 35.00 € |
| P6W15STILL | 29.00 € |
| P7W16STILL | 10.50 € |
| P8W17STILL | 12.90 € |
| P9W18STILL | 10.00 € |
| P10W19STILL | 6.20 € |
| P11W20STILL | 33.50 € |
| P12W21STILL | 65.00 € |
| P12W22STILL | 120.00 € |
| P12W23STILL | 65.00 € |
| P12W24STILL | 47.00 € |
| P12W25STILL | 48.00 € |
| P12W26STILL | 14.00 € |
| P12W27STILL | 49.00 € |

In Table 18 the average prices of the analysed product are reported in euro. The prices were collected in online shops (also form large scale retailers) or directly on the internet site of the producer. The lowest price found was selected for the individual products, in order to avoid, especially for high quality wines, an effect linked to the increase in the value of the bottles in particular years.

The table shows how the VIVA project has been joined by different types of products, which can be characterized by price range in medium quality, high quality and premium products (Medium Quality (MQ): 5.00€-13.00€; High Quality (HQ): 13.01€ - 35.00€ and Premium Quality (PQ): 35.01€ - 120.00€).

Considering this classification, 12 products are of medium quality and in particular 6 products out of 7 Sparkling wines analysed belong to this class and 6 Still products fall into this category. 9 products are High Quality of which 1 sparkling 8 still, finally 6 products are premium all of the still category and all of the same producer.

### 5.1.2. Average Sparkling product LCI.

Below are reported the average data for the Sparkling product. For each data a basic statistical analysis is reported with mean, median, minimum and maximum value, 25th and 75th percentile and positive and negative delta as difference from the 25% and 75% percentile from the Arithmetical mean.

TABLE 19: VINEYARD CULTIVATION DATA – AVERAGE SPARKLING

| AVERAGE SPARKLING | Average Yield | Wine Yield | Cultivation Density | N | P2O5 | K2O | Organic Fertilizer | N Organic | P2O5 Organic | Water Pesticide application | Water Irrigation | Diesel | CER150106 | CER130205 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg/ha | % | vine/ha | kg/ha | kg/ha | kg/ha | kg | kg/ha | kg/ha | m3/ha | m3/ha | kg/ha | kg/ha | kg/ha |
| **ARITHMETICAL MEAN** | 14459.24 | 67% | 4142.86 | 22.27 | 24.18 | 30.29 | 12.07 | 0.05 | 0.01 | 7.54 | 145.03 | 336.80 | 14.16 | 9.61 |
| **MEDIAN** | 14610.73 | 69% | 4000.00 | 17.00 | 39.96 | 42.18 | 0.00 | 0.00 | 0.00 | 3.86 | 200.00 | 334.72 | 0.00 | 5.22 |
| **SD** | 3689.75 | 6% | 349.93 | 16.45 | 21.17 | 26.65 | 29.55 | 0.12 | 0.03 | 6.62 | 116.88 | 146.39 | 20.03 | 6.21 |
| **MAX VALUE** | 18400.00 | 70% | 5000.00 | 39.96 | 49.40 | 56.61 | 84.46 | 0.34 | 0.08 | 19.00 | 343.00 | 618.18 | 42.48 | 18.39 |
| **MIN VALUE** | 8470.96 | 53% | 4000.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.45 | 0.00 | 162.05 | 0.00 | 5.22 |
| **25% PERC** | 11666.50 | 69% | 4000.00 | 9.51 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.76 | 36.12 | 224.34 | 0.00 | 5.22 |
| **75% PERC** | 18200.00 | 70% | 4000.00 | 39.96 | 39.96 | 56.61 | 0.00 | 0.00 | 0.00 | 7.65 | 200.00 | 396.99 | 21.24 | 11.81 |
| **POSITIVE DELTA** | 3740.76 | 3% | -142.86 | 17.69 | 15.78 | 26.32 | -12.07 | -0.05 | -0.01 | 0.10 | 54.97 | 60.19 | 7.08 | 2.20 |
| **NEGATIVE DELTA** | 2792.74 | -2% | 142.86 | 12.76 | 24.18 | 30.29 | 12.07 | 0.05 | 0.01 | 3.79 | 108.92 | 112.46 | 14.16 | 4.39 |

TABLE 20: PHYTOSANITARY COMPOUNDS – AVERAGE SPARKLING

| AVERAGE SPARKLING | [sulfonyl] urea compounds | Acetamide anillide compounds | copper oxide | Cyclic N compounds | Folpet | Fosetyl-Al | Glyphosate | Mancozeb | Organo Phosphorus compounds | Pyrethroid compounds | Pyridine compounds | Sulphur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 0.00 | 0.38 | 12.18 | 10.67 | 0.58 | 18.05 | 0.82 | 4.96 | 0.28 | 0.00 | 0.51 | 66.61 |
| **MEDIAN** | 0.00 | 0.35 | 12.83 | 1.74 | 0.69 | 9.07 | 1.31 | 3.90 | 0.16 | 0.00 | 0.55 | 37.14 |
| **SD** | 0.00 | 0.16 | 4.66 | 14.69 | 0.32 | 20.32 | 0.69 | 2.79 | 0.22 | 0.01 | 0.38 | 54.03 |
| **MAX VALUE** | 0.00 | 0.55 | 16.67 | 33.88 | 0.91 | 49.71 | 1.44 | 9.05 | 0.53 | 0.02 | 0.91 | 150.00 |
| **MIN VALUE** | 0.00 | 0.14 | 2.62 | 0.35 | 0.00 | 0.00 | 0.00 | 0.81 | 0.00 | 0.00 | 0.00 | 7.89 |
| **25% PERC** | 0.00 | 0.28 | 10.78 | 1.56 | 0.43 | 4.40 | 0.03 | 3.90 | 0.09 | 0.00 | 0.16 | 35.49 |
| **75% PERC** | 0.00 | 0.55 | 15.80 | 17.81 | 0.80 | 29.39 | 1.44 | 6.59 | 0.53 | 0.00 | 0.91 | 100.12 |
| **POSITIVE DELTA** | 0.00 | 0.16 | 3.62 | 7.14 | 0.22 | 11.34 | 0.63 | 1.63 | 0.25 | 0.00 | 0.40 | 33.51 |
| **NEGATIVE DELTA** | 0.00 | 0.11 | 1.40 | 9.11 | 0.15 | 13.65 | 0.78 | 1.06 | 0.18 | 0.00 | 0.36 | 31.12 |

TABLE 21: WINERY PRODUCTION DATA – AVERAGE SPARKLING

| AVERAGE SPARKLING | Grape Transport | Electricity Grape Pressing | Electricity Wine Making and storage | Diesel | PLG | Natural Gas | Groundwater | Well Water* | Waste Water* | R134a | R125 | R143a | R32 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | km | kWh/kg of grape | kWh/kg of grape | kg/kg of grape | kg/kg of grape | m3/kg of grape | m3/kg of grape | m3/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape |
| **ARITHMETICAL MEAN** | 1.42E+00 | 5.60E-03 | 9.20E-01 | 0.00E+00 | 0.00E+00 | 2.03E-01 | 3.68E-03 | 8.06E-03 | 1.56E-03 | 5.28E-05 | 2.51E-05 | 1.89E-06 | 1.25E-05 |
| **MEDIAN** | 1.00E+00 | 5.60E-03 | 9.71E-01 | 0.00E+00 | 0.00E+00 | 8.29E-02 | 1.70E-03 | 6.06E-03 | 6.67E-04 | 6.30E-05 | 1.78E-05 | 1.49E-06 | 1.04E-05 |
| **SD** | 1.66E+00 | 0.00E+00 | 2.07E-01 | 0.00E+00 | 0.00E+00 | 1.93E-01 | 2.72E-03 | | | 3.50E-05 | 2.46E-05 | 2.89E-06 | 1.19E-05 |
| **MAX VALUE** | 5.46E+00 | 5.60E-03 | 1.13E+00 | 0.00E+00 | 0.00E+00 | 4.34E-01 | 7.00E-03 | 4.29E-02 | 1.60E-02 | 9.00E-05 | 5.27E-05 | 8.77E-06 | 2.57E-05 |
| **MIN VALUE** | 5.00E-01 | 5.60E-03 | 4.30E-01 | 0.00E+00 | 0.00E+00 | 2.10E-02 | 1.00E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 5.00E-01 | 5.60E-03 | 9.71E-01 | 0.00E+00 | 0.00E+00 | 2.15E-02 | 1.70E-03 | 5.89E-03 | 0.00E+00 | 3.18E-05 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 1.00E+00 | 5.60E-03 | 9.83E-01 | 0.00E+00 | 0.00E+00 | 4.20E-01 | 7.00E-03 | 8.50E-03 | 6.76E-04 | 7.65E-05 | 5.27E-05 | 1.49E-06 | 2.57E-05 |
| **POSITIVE DELTA** | -4.23E-01 | 0.00E+00 | 6.31E-02 | 0.00E+00 | 0.00E+00 | 2.17E-01 | 3.32E-03 | 4.34E-04 | -8.81E-04 | 2.37E-05 | 2.76E-05 | -4.03E-07 | 1.32E-05 |
| **NEGATIVE DELTA** | 9.23E-01 | 0.00E+00 | -5.16E-02 | 0.00E+00 | 0.00E+00 | 1.81E-01 | 1.98E-03 | 2.18E-03 | 1.56E-03 | 2.10E-05 | 2.51E-05 | 1.89E-06 | 1.25E-05 |

*the value of waste water and well water was taken from the still mean due to the fact that non data were available for sparkling wines.

TABLE 22: WASTE PRODUCED AT THE WINERY – AVERAGE SPARKLING

| AVERAGE SPARKLING | CER150106 | CER150110 | CER150102 | CER150103 | CER150101 | CER170403 | CER170202 | CER020705 | CER161002 | CER020103 |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape |
| **ARITHMETICAL MEAN** | 3.68E-03 | 0.00E+00 | 1.75E-03 | 3.64E-04 | 4.65E-02 | 7.29E-05 | 2.72E-03 | 0.00E+00 | 7.58E-02 | 3.94E-02 |
| **MEDIAN** | 3.79E-03 | 0.00E+00 | 1.75E-03 | 3.64E-04 | 5.98E-03 | 7.29E-05 | 2.97E-03 | 0.00E+00 | 0.00E+00 | 3.94E-02 |
| **SD** | 3.57E-03 | 0.00E+00 | 1.75E-03 | 3.64E-04 | 5.94E-02 | 7.29E-05 | 1.05E-03 | 0.00E+00 | 1.07E-01 | 3.94E-02 |
| **MAX VALUE** | 1.07E-02 | 0.00E+00 | 3.50E-03 | 7.29E-04 | 1.30E-01 | 1.46E-04 | 3.64E-03 | 0.00E+00 | 2.27E-01 | 7.87E-02 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.00E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 9.48E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.98E-03 | 0.00E+00 | 2.30E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 3.79E-03 | 0.00E+00 | 3.50E-03 | 7.29E-04 | 9.93E-02 | 1.46E-04 | 3.64E-03 | 0.00E+00 | 1.71E-01 | 7.87E-02 |
| **POSITIVE DELTA** | 1.12E-04 | 0.00E+00 | 1.75E-03 | 3.64E-04 | 5.28E-02 | 7.29E-05 | 9.22E-04 | 0.00E+00 | 9.48E-02 | 3.94E-02 |
| **NEGATIVE DELTA** | 2.73E-03 | 0.00E+00 | 1.75E-03 | 3.64E-04 | 4.05E-02 | 7.29E-05 | 4.22E-04 | 0.00E+00 | 7.58E-02 | 3.94E-02 |

TABLE 23: ADDITIVES AND PROCESSING AIDS FOR OENOLOGICAL PRACTICES – AVERAGE SPARKLING

| AVERAGE SPARKLING | Ammonium sulphate | Calcium Tartrate | Enzymes | Yeast | Sugar | Tannins | Thiamine hydrochloride | Yeast mannoproteins |
|---|---|---|---|---|---|---|---|---|
| | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine |
| **ARITHMETICAL MEAN** | 0.00017 | - | 0.000929 | - | 0.000286 | 0.031603 | 0.000143 | 0.000446 |

TABLE 24: BOTTLING AND PACKAGING – AVERAGE SPARKLING

| AVERAGE SPARKLING | Electricity bottling | Glass | Paper label | Cork stopper | Aluminium overcap | Aluminium screw cap | Plastic film | Cardboard | Wood | Wooden Pallet |
|---|---|---|---|---|---|---|---|---|---|---|
| | kWh/liter | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU |
| **ARITHMETICAL MEAN** | 5.16E-02 | 6.47E-01 | 2.01E-03 | 7.74E-03 | 1.36E-03 | 3.20E-03 | 8.29E-04 | 4.61E-02 | 0.00E+00 | 2.36E-03 |
| **MEDIAN** | 7.40E-02 | 6.04E-01 | 1.80E-03 | 7.00E-03 | 9.00E-04 | 4.50E-03 | 1.00E-03 | 4.40E-02 | 0.00E+00 | 2.53E-03 |
| **SD** | 4.65E-02 | 9.74E-02 | 1.38E-03 | 1.19E-03 | 1.10E-03 | 2.40E-03 | 4.74E-04 | 1.12E-02 | 0.00E+00 | 6.26E-04 |
| **MAX VALUE** | 1.15E-01 | 8.38E-01 | 5.00E-03 | 9.30E-03 | 4.00E-03 | 5.10E-03 | 1.29E-03 | 6.92E-02 | 0.00E+00 | 3.10E-03 |
| **MIN VALUE** | 0.00E+00 | 5.52E-01 | 9.00E-04 | 6.40E-03 | 6.60E-04 | 0.00E+00 | 1.85E-04 | 3.12E-02 | 0.00E+00 | 1.67E-03 |
| **25% PERC** | 0.00E+00 | 5.66E-01 | 9.00E-04 | 6.75E-03 | 7.80E-04 | 1.00E-03 | 3.70E-04 | 4.10E-02 | 0.00E+00 | 1.67E-03 |
| **75% PERC** | 8.60E-02 | 7.00E-01 | 2.30E-03 | 9.00E-03 | 1.20E-03 | 5.08E-03 | 1.29E-03 | 4.83E-02 | 0.00E+00 | 2.94E-03 |
| **POSITIVE DELTA** | 3.44E-02 | 5.35E-02 | 2.86E-04 | 1.26E-03 | -1.60E-04 | 1.88E-03 | 4.63E-04 | 2.19E-03 | 0.00E+00 | 5.80E-04 |
| **NEGATIVE DELTA** | 5.16E-02 | 8.05E-02 | 1.11E-03 | 9.93E-04 | 5.80E-04 | 2.20E-03 | 4.58E-04 | 5.14E-03 | 0.00E+00 | 6.92E-04 |

TABLE 25: DISTRIBUTION OF THE FINAL PRODUCT – AVERAGE SPARKLING

| AVERAGE SPARKLING | Mass functional Unit | Lorry: transport distance | Train: transport distance | Barge: transport distance | % Center Europe | % USA and Canada | % Italy |
|---|---|---|---|---|---|---|---|
| | kg | Km | km | km | % | % | % |
| **ARITHMETICAL MEAN** | 1.47 | 402.1 | 0.0 | 0.0 | 17.0% | 0.0% | 83.0% |
| **MEDIAN** | 1.40 | 136.6 | 0.0 | 0.0 | 0.3% | 0.0% | 99.7% |
| **SD** | 0.10 | 657.6 | 0.0 | 0.0 | 34.2% | 0.0% | 34.2% |
| **MAX VALUE** | 1.68 | 2000.0 | 0.0 | 0.0 | 100.0% | 0.0% | 100.0% |
| **MIN VALUE** | 1.38 | 50.2 | 0.0 | 0.0 | 0.0% | 0.0% | 0.0% |
| **25% PERC** | 1.39 | 60.2 | 0.0 | 0.0 | 0.0% | 0.0% | 90.6% |
| **75% PERC** | 1.52 | 253.8 | 0.0 | 0.0 | 9.4% | 0.0% | 100.0% |
| **POSITIVE DELTA** | 0.05 | -148.3 | 0.0 | 0.0 | -7.6% | 0.0% | 17.0% |
| **NEGATIVE DELTA** | 0.08 | 341.9 | 0.0 | 0.0 | 17.0% | 0.0% | -7.6% |

TABLE 26:PRICE – AVERAGE SPARKLING

| COMPANY | P1 | P1 | P2 | P2 | P3 | P4 | P5 |
|---|---|---|---|---|---|---|---|
| CODE | P1W1SPARK | P1W2SPARK | P2W3SPARK | P2W4SPARK | P3W5SPARK | P4W6SPARK | P5W7SPARK |
| BOTTLE PRICE | 7.20 € | 7.20 € | 8.35 € | 9.70 € | 5.49 € | 5.10 € | 18.00 € |
| ARITHMETICAL MEAN | 8.72 € | | | | | | |
| MEDIAN | 7.20 € | | | | | | |
| SD | 4.06 € | | | | | | |
| MAX VALUE | 18.00 € | | | | | | |
| MIN VALUE | 5.10 € | | | | | | |
| 25% PERC | 6.35 € | | | | | | |
| 75% PERC | 9.03 € | | | | | | |
| POSITIVE DELTA | 2.38 € | | | | | | |
| NEGATIVE DELTA | -0.30 € | | | | | | |

### 5.1.3. Average Still product LCI.

Below are the average data for the Still product. For each data a basic statistical analysis is reported with mean, median, Standard deviation, minimum and maximum value, 25th and 75th percentile and positive and negative delta.

TABLE 27: VINEYARD CULTIVATION DATA – AVERAGE STILL

| AVERAGE STILL | Average Yield | Wine Yield | Cultivation Density | N | P2O5 | K2O | Organic Fertilizer | N Organic | P2O5 Organic | Water Pesticide application | Water Irrigation | Diesel | Electricity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg/ha | % | Vine/ha | kg/ha | kg/ha | kg/ha | kg/ha | kg/ha | kg/ha | mc/ha | mc/ha | kg/ha | kWh/ha |
| **ARITHMETICAL MEAN** | 7514.8 | 69.20% | 4930 | 6.85 | 15.28 | 35.05 | 639.55 | 4.55 | 2.50 | 0.05 | 64.68 | 254.25 | 118.80 |
| **MEDIAN** | 7529.2 | 69.93% | 5000 | 0.00 | 2.00 | 41.67 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 214.48 | 0.00 |
| **SD** | 1327.8 | 1.63% | 555 | 9.80 | 20.92 | 32.47 | 937.87 | 8.43 | 7.20 | 0.12 | 203.76 | 0.00 | 129.10 |
| **MAX VALUE** | 11000.0 | 70.42% | 6600 | 35.20 | 49.40 | 90.00 | 3000.00 | 36.20 | 33.36 | 0.31 | 943.00 | 459.26 | 2148.99 |
| **MIN VALUE** | 5200.0 | 63.29% | 4000 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 123.95 | 0.00 |
| **25% PERC** | 6835.8 | 68.00% | 4800 | 0.00 | 0.00 | 1.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 142.38 | 0.00 |
| **75% PERC** | 7863.5 | 70.00% | 5000 | 16.80 | 33.35 | 45.63 | 1275.00 | 7.14 | 2.14 | 0.00 | 64.36 | 351.63 | 0.00 |
| **POSITIVE DELTA** | 348.7 | 0.80% | 70 | 9.95 | 18.07 | 10.58 | 635.45 | 2.59 | -0.36 | -0.05 | -0.32 | 97.37 | -118.80 |
| **NEGATIVE DELTA** | 679.1 | 1.20% | 130 | 6.85 | 15.28 | 33.85 | 639.55 | 4.55 | 2.50 | 0.05 | 64.68 | 111.88 | 118.80 |

TABLE 28: WASTE PRODUCED AT THE VINEYARD – AVERAGE STILL

| AVERAGE STILL | CER150106 | CER170403 | CER130205 | CER150110 | CER150102 |
|---|---|---|---|---|---|
| | kg/ha | kg/ha | kg/ha | kg/ha | kg/ha |
| **ARITHMETICAL MEAN** | 37.60 | 2.63 | 15.30 | 0.34 | 0.04 |
| **MEDIAN** | 38.75 | 0.00 | 16.78 | 0.00 | 0.00 |
| **SD** | 8.93 | 5.87 | 5.91 | 0.75 | 0.09 |
| **MAX VALUE** | 48.53 | 15.75 | 21.01 | 2.01 | 0.24 |
| **MIN VALUE** | 19.39 | 0.00 | 2.56 | 0.00 | 0.00 |
| **25% PERC** | 37.85 | 0.00 | 16.38 | 0.00 | 0.00 |
| **75% PERC** | 41.65 | 0.00 | 18.03 | 0.00 | 0.00 |
| **POSITIVE DELTA** | 4.05 | -2.63 | 2.73 | -0.34 | -0.04 |
| **NEGATIVE DELTA** | -0.25 | 2.63 | -1.08 | 0.34 | 0.04 |

TABLE 29: PHYTOSANITARY COMPOUNDS – AVERAGE STILL

| AVERAGE STILL | [sulfonyl]urea compounds | Acetamide Anillide compounds | Copper oxide | Cyclic N compounds | Folpet | Fosetyl-Al | Glyphosate | Mancozeb | Organo phosphorus compounds | Pyrethroid compounds | Pyridine compounds | Sulphur |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 0.00 | 1.12 | 9.29 | 1.16 | 1.51 | 4.93 | 0.77 | 4.33 | 1.21 | 0.00 | 0.28 | 39.13 |
| **MEDIAN** | 0.00 | 1.02 | 8.78 | 1.11 | 0.69 | 4.00 | 0.00 | 3.38 | 0.00 | 0.00 | 0.30 | 27.14 |
| **SD** | 0.003 | 1.27 | 7.97 | 0.71 | 3.09 | 5.43 | 0.95 | 4.74 | 1.77 | 0.00 | 0.26 | 38.58 |
| **MAX VALUE** | 0.01 | 5.81 | 30.80 | 3.71 | 14.84 | 23.49 | 3.15 | 23.87 | 7.16 | 0.00 | 0.84 | 150.00 |
| **MIN VALUE** | 0.00 | 0.21 | 0.00 | 0.20 | 0.00 | 0.00 | 0.00 | 0.63 | 0.00 | 0.00 | 0.00 | 4.75 |
| **25% PERC** | 0.00 | 0.24 | 2.01 | 0.81 | 0.64 | 0.00 | 0.00 | 2.08 | 0.00 | 0.00 | 0.00 | 6.35 |
| **75% PERC** | 0.00 | 1.17 | 14.29 | 1.39 | 0.85 | 7.85 | 1.79 | 4.34 | 2.39 | 0.00 | 0.55 | 70.24 |
| **POSITIVE DELTA** | 0.00 | 0.06 | 5.00 | 0.23 | -0.66 | 2.92 | 1.02 | 0.00 | 1.18 | 0.00 | 0.27 | 31.11 |
| **NEGATIVE DELTA** | 0.00 | 0.88 | 7.28 | 0.35 | 0.87 | 4.93 | 0.77 | 2.26 | 1.21 | 0.00 | 0.28 | 32.78 |

TABLE 30: WINERY PRODUCTION DATA – AVERAGE STILL

| AVERAGE STILL | Grape Transport | Electricity Grape Pressing | Electricity Wine Making and storage | Diesel | PLG | Natural Gas | Groundwater | Well water | Waste water | R134a | R125 | R143a |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | km | kWh/kg of grape | kWh/kg of grape | kg/kg of grape | kg/kg of grape | mc/kg of grape | mc/kg of grape | mc/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape | kg/kg of grape |
| **ARITHMETICAL MEAN** | 1.44E+01 | 5.38E-03 | 8.04E-01 | 3.68E-04 | 1.06E-01 | 1.50E-01 | 8.06E-03 | 1.56E-03 | 2.54E+01 | 7.56E-07 | 8.31E-06 | 9.82E-06 |
| **SD** | 1.92E+01 | 9.47E-04 | 3.37E-01 | 1.19E-03 | 4.57E-01 | 1.68E-01 | 1.01E-02 | 4.03E-03 | 2.88E+01 | 1.03E-06 | 1.13E-05 | 1.34E-05 |
| **MEDIAN** | 1.00E+00 | 5.60E-03 | 6.96E-01 | 0.00E+00 | 0.00E+00 | 8.01E-02 | 6.06E-03 | 6.67E-04 | 6.75E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **MAX VALUE** | 5.30E+01 | 5.60E-03 | 1.13E+00 | 5.45E-03 | 2.10E+00 | 4.34E-01 | 4.29E-02 | 1.60E-02 | 7.23E+01 | 2.18E-06 | 2.39E-05 | 2.83E-05 |
| **MIN VALUE** | 1.00E+00 | 1.26E-03 | 2.95E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.56E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 1.00E+00 | 5.60E-03 | 6.76E-01 | 0.00E+00 | 0.00E+00 | 4.38E-02 | 5.89E-03 | 0.00E+00 | 6.75E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 3.00E+01 | 5.60E-03 | 1.13E+00 | 0.00E+00 | 0.00E+00 | 2.11E-01 | 8.50E-03 | 6.76E-04 | 4.38E+01 | 2.13E-06 | 2.34E-05 | 2.77E-05 |
| **POSITIVE DELTA** | 1.56E+01 | 2.17E-04 | 3.21E-01 | -3.68E-04 | -1.06E-01 | 6.16E-02 | 4.34E-04 | -8.81E-04 | 1.84E+01 | 1.37E-06 | 1.51E-05 | 1.79E-05 |
| **NEGATIVE DELTA** | 1.34E+01 | -2.17E-04 | 1.28E-01 | 3.68E-04 | 1.06E-01 | 1.06E-01 | 2.18E-03 | 1.56E-03 | 1.86E+01 | 7.56E-07 | 8.31E-06 | 9.82E-06 |

TABLE 31: WASTE PRODUCED AT THE WINERY – AVERAGE STILL

| AVERAGE STILL | CER150106 | CER150110 | CER150102 | CER150103 | CER150101 | CER170403 | CER170202 | CER020705 | CER161002 | CER020103 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Kg/Kg of grape | Kg/Kg of grape | kg/KG of grape | kg/KG of grape | kg/KG of grape | kg/KG of grape | kg/KG of grape | kg/KG of grape | kg/KG of grape | kg/KG of grape |
| **ARITHMETICAL MEAN** | 1.64E-01 | 3.17E-05 | 5.20E-03 | 4.43E-05 | 7.80E-03 | 5.34E-03 | 8.00E-03 | 2.77E-02 | 5.90E-03 | 8.85E-04 |
| **MEDIAN** | 5.44E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **SD** | 4.59E-01 | 5.76E-05 | 9.08E-03 | 8.08E-05 | 1.52E-02 | 9.75E-03 | 2.45E-02 | 5.07E-02 | 1.08E-02 | 1.62E-03 |
| **MAX VALUE** | 1.75E+00 | 1.37E-04 | 3.14E-02 | 1.92E-04 | 5.57E-02 | 2.32E-02 | 9.29E-02 | 1.20E-01 | 2.56E-02 | 3.84E-03 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 3.84E-04 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 5.44E-02 | 1.32E-06 | 1.20E-02 | 0.00E+00 | 1.52E-02 | 0.00E+00 | 3.71E-03 | 1.09E-05 | 0.00E+00 | 0.00E+00 |
| **POSITIVE DELTA** | -1.10E-01 | -3.04E-05 | 6.84E-03 | -4.43E-05 | 7.41E-03 | -5.34E-03 | -4.29E-03 | -2.77E-02 | -5.90E-03 | -8.85E-04 |
| **NEGATIVE DELTA** | 1.64E-01 | 3.17E-05 | 5.20E-03 | 4.43E-05 | 7.80E-03 | 5.34E-03 | 8.00E-03 | 2.77E-02 | 5.90E-03 | 8.85E-04 |

TABLE 32: ADDITIVES AND PROCESSING AIDS FOR OENOLOGICAL PRACTICES – AVERAGE STILL

| AVERAGE STILL | Ammonium bisulphite | Ammonium sulphate | Calcium Tartrate | Enzymes | Yeast | Tannins | Thiamine hydrochloride | Yeast mannoproteins |
|---|---|---|---|---|---|---|---|---|
| | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine | kg/liter of wine |
| **ARITHMETICAL MEAN** | 2.21E-04 | 1.50E-04 | 1.36E-03 | 1.73E-04 | 1.09E-03 | 2.25E-04 | 2.58E-04 | 2.19E-04 |
| **MEDIAN** | 2.50E-04 | 1.50E-04 | 1.40E-03 | 1.00E-05 | 2.00E-04 | 1.90E-04 | 3.00E-04 | 2.00E-04 |
| **SD** | 5.86E-05 | 0.00E+00 | 4.25E-04 | 3.82E-04 | 3.48E-03 | 7.62E-05 | 4.93E-05 | 6.60E-05 |
| **MAX VALUE** | 3.20E-04 | 1.50E-04 | 1.80E-03 | 1.18E-03 | 1.50E-02 | 3.50E-04 | 3.00E-04 | 3.50E-04 |
| **MIN VALUE** | 8.00E-05 | 1.50E-04 | 6.27E-04 | 1.00E-05 | 2.00E-04 | 1.00E-04 | 2.00E-04 | 1.50E-04 |
| **25% PERC** | 1.70E-04 | 1.50E-04 | 1.40E-03 | 1.00E-05 | 2.00E-04 | 1.90E-04 | 2.00E-04 | 1.88E-04 |
| **75% PERC** | 2.50E-04 | 1.50E-04 | 1.80E-03 | 6.75E-05 | 2.00E-04 | 2.88E-04 | 3.00E-04 | 2.25E-04 |
| **POSITIVE DELTA** | 2.88E-05 | 0.00E+00 | 4.36E-04 | -1.05E-04 | -8.85E-04 | 6.25E-05 | 4.17E-05 | 6.34E-06 |
| **NEGATIVE DELTA** | 5.12E-05 | 0.00E+00 | -3.59E-05 | 1.63E-04 | 8.85E-04 | 3.50E-05 | 5.83E-05 | 3.13E-05 |

TABLE 33: BOTTLING AND PACKAGING – AVERAGE STILL

| AVERAGE STILL | Electricity bottling | Glass | Paper label | Cork stopper | Aluminium overcap | Plastic film | Cardboard | Wood | Wooden Pallet |
|---|---|---|---|---|---|---|---|---|---|
| | kWh/liter | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU | kg/FU |
| **ARITHMETICAL MEAN** | 0.0275 | 0.5285 | 0.0026 | 0.0045 | 0.0016 | 0.0032 | 0.0502 | 0.0455 | 0.0023 |
| **MEDIAN** | 0.0000 | 0.5000 | 0.0017 | 0.0042 | 0.0012 | 0.0002 | 0.0455 | 0.0000 | 0.0023 |
| **SD** | 0.0338 | 0.0928 | 0.0018 | 0.0008 | 0.0011 | 0.0085 | 0.0226 | 0.0828 | 0.0005 |
| **MAX VALUE** | 0.0720 | 0.7450 | 0.0050 | 0.0060 | 0.0044 | 0.0300 | 0.1322 | 0.2917 | 0.0028 |
| **MIN VALUE** | 0.0000 | 0.3900 | 0.0003 | 0.0033 | 0.0007 | 0.0001 | 0.0000 | 0.0000 | 0.0009 |
| **25% PERC** | 0.0000 | 0.4845 | 0.0015 | 0.0040 | 0.0012 | 0.0001 | 0.0444 | 0.0000 | 0.0022 |
| **75% PERC** | 0.0720 | 0.6025 | 0.0050 | 0.0050 | 0.0015 | 0.0007 | 0.0501 | 0.0487 | 0.0028 |
| **POSITIVE DELTA** | 0.0445 | 0.0740 | 0.0024 | 0.0005 | -0.0001 | -0.0025 | -0.0001 | 0.0032 | 0.0005 |
| **NEGATIVE DELTA** | 0.0275 | 0.0440 | 0.0011 | 0.0005 | 0.0005 | 0.0031 | 0.0058 | 0.0455 | 0.0001 |

TABLE 34: DISTRIBUTION OF THE FINAL PRODUCT – AVERAGE STILL

| AVERAGE STILL | Functional Unit Mass | Lorry: transport distance | Barge: transport distance | % Center Europe | % USA and Canada | % Italy |
|---|---|---|---|---|---|---|
| | kg | km/FU | km/FU | | | |
| **ARITHMETICAL MEAN** | 1.39 | 814.47 | 5313.14 | 30.12% | 34.72% | 35.16% |
| **MEDIAN** | 1.35 | 471.00 | 3659.23 | 23.73% | 29.44% | 25.89% |
| **SD** | 0.15 | 1146.18 | 6834.81 | 21.33% | 27.61% | 30.40% |
| **MAX VALUE** | 1.82 | 5498.39 | 31507.38 | 74.96% | 87.06% | 90.21% |
| **MIN VALUE** | 1.20 | 161.00 | 0.00 | 4.00% | 0.00% | 2.94% |
| **25% PERC** | 1.29 | 356.00 | 1465.92 | 15.10% | 7.50% | 11.46% |
| **75% PERC** | 1.42 | 582.56 | 6383.75 | 46.88% | 53.60% | 55.05% |
| **POSITIVE DELTA** | 0.03 | -231.91 | 1070.61 | 16.76% | 18.88% | 19.89% |
| **NEGATIVE DELTA** | 0.09 | 458.47 | 3847.22 | 15.02% | 27.22% | 23.70% |

TABLE 35: PRICE – AVERAGE STILL

| COMPANY | CODE | BOTTLE PRICE | MEDIUM PRICE | SD | MIN VALUE | MAX VALUE | 25% PERC | 75% PERC | POSITIVE DELTA | NEGATIVE DELTA |
|---|---|---|---|---|---|---|---|---|---|---|
| **P5** | **P5W8STILL** | 14.00 € | 33.02 € | 26.84 € | 6.20 € | 120.00 € | 12.68 € | 47.25 € | 20.35 € | -14.23 € |
| **P5** | **P5W9STILL** | 20.90 € | | | | | | | | |
| **P5** | **P5W10STILL** | 8.40 € | | | | | | | | |
| **P5** | **P5W11STILL** | 31.00 € | | | | | | | | |
| **P5** | **P5W12STILL** | 12.00 € | | | | | | | | |
| **P6** | **P6W13STILL** | 29.00 € | | | | | | | | |
| **P6** | **P6W14STILL** | 35.00 € | | | | | | | | |
| **P6** | **P6W15STILL** | 29.00 € | | | | | | | | |
| **P7** | **P7W16STILL** | 10.50 € | | | | | | | | |
| **P8** | **P8W17STILL** | 12.90 € | | | | | | | | |
| **P9** | **P9W18STILL** | 10.00 € | | | | | | | | |
| **P10** | **P10W19STILL** | 6.20 € | | | | | | | | |
| **P11** | **P11W20STILL** | 33.50 € | | | | | | | | |
| **P12** | **P12W21STILL** | 65.00 € | | | | | | | | |
| **P12** | **P12W22STILL** | 120.00 € | | | | | | | | |
| **P12** | **P12W23STILL** | 65.00 € | | | | | | | | |
| **P12** | **P12W24STILL** | 47.00 € | | | | | | | | |
| **P12** | **P12W25STILL** | 48.00 € | | | | | | | | |
| **P12** | **P12W26STILL** | 14.00 € | | | | | | | | |
| **P12** | **P12W27STILL** | 49.00 € | | | | | | | | |

### 5.1.4. LCI analysis of VIVA Average Still and Sparkling products.

The sparkling products have a high average yield per hectare of 144.6 q while the average value of transformation of grapes into wine is 67% (Table 19). Still products, on the other hand, have a much lower average yield per hectare of 75.14 q/ha and a more efficient value for grapes into wine transformation of 69.2% (Table 27). Those big differences in yields are due to a higher quality of the still products analysed, therefore with much lower yields.

An interesting finding regarding the average of all the products is the division between red berry products and white berry products, on average, white berry varieties have higher yields (111.65 q/ha) than red berry cultivars (87.87 q/ha).

Fertilizer use variability is very high, this is mainly due to the fact that not all products report fertilization activities during the reference year, the data of standard deviation is therefore high compared to the average value especially for P and K for both sparkling and still products.

The average load of N and P used in sparkling products are 22.27 kg/ha and 24.18 kg/ha respectively (Table 19). For still products, the values are lower even when the mineral and the organic component are summed, and are respectively equal to 11.94 kg/ha and 17.77 kg/ha (Table 27). This difference is due to the higher yields of sparkling products and therefore the higher need for nutrients.

The value of water consumption for irrigation and for phytosanitary products dilution is very variable with an average of 145.03 m3/ha for Sparkling products (Table 19), and 64.73 m3/ha for still products (Table 27). Also in this case, the very high variability is related to the fact that irrigation is not always carried out. In any case, on average, irrigated production have higher yields at the vineyard.

Finally, if we compare red berry and white berry production in sparkling products, the average yield per ha of red berry production is higher (156.85 q compared to 128.24 q), while white berry production uses higher quantities of fertilizers on average (N +3.97, P +9.81 and K +4.62 kg/ha). As far as still products are concerned, the average yield per ha of white berry products is higher (95.05 q compared to 71.63 q), while, white berry products use, on average, fertilizers quantities in kg per ha slightly lower for N and K and higher for P (N -1.7, P +9.5, K -2.7 kg/ha).

Analysing the average plant protection products used, we can see that for sparkling products the most widely used product class is Sulphur, followed by Fosetyl-Al, Copper Oxide and Cyclic N compouds (Table 20). Still products confirm the most relevant class (Sulphur), followed by Copper Oxide, Fosetyl-Al and Mancozeb (Table 29).

In sparkling products, the total amount of active ingredients used is 100.66 kg/ha, if we exclude the use of Sulphur and Copper oxide the amount of active ingredients used is 31.72 kg/ha (Table 20). In still products the average total quantity of active ingredients used is 60.70 kg/ha, if we exclude the use of Sulphur and Copper oxide the quantity of active ingredients used is 14.58 kg/ha (Table 29).

White berry production uses on average for both sparkling and still products a higher quantity of active ingredients per ha, equal to +26.20 kg/ha total and +6.25 kg/ha if we exclude copper oxide and sulphur for Sparkling products, and equal to +86.28 kg/ha total and +12.35 kg/ha if we exclude copper oxide and sulphur for still products.

For many products, no separate electricity consumption data were available, so the average European data present in the wine PEFCR (0.0056 kWh/kg of grape) was used to divide the grape pressing component from the electric consumption of wine making and storage. The average power consumption per winemaking and storage of sparkling products is 0.920 kWh/kg of processed grapes. The companies that produce Sparkling products use as a heat source the Natural gas with a use equal to 0.203 m3/kg of processed grapes (Table 21).

The average power consumption per winemaking and storage of still products is 0.804 kWh/kg of processed grapes. The companies that produce Still products use both natural gas and Diesel and LPG as heat sources with an average use of 0.15 m3/kg, 0.000368 kg/kg and 0.106 kg/kg of processed grapes respectively (Table 30).

The average waste generated per kg of grapes processed is 0.17 kg for Sparkling products, with a prevalence of CER codes 161002 - 150101 - 201003 which are non-hazardous aqueous solutions, paper and vegetable residues respectively (Table 22). For still products the value is instead equal to 0.23 kg, with a prevalence of codes CER150106 - Mixed material packaging (Table 31).

The value of oenological additives for still and sparkling products is equal to 0.00711 kg/litre of wine with a prevalence of tartrates and yeasts.

Not all companies were able to provide electricity data for the bottling phase separately from winery electricity consumption. Therefore, the value has a very high average variability. The average data elaborated with the available data (12 products) is 0.0680 kWh/litre higher than the PEFCR reference value of 0.0224 kWh/litre.

The weight of bottles for sparkling products ranges from a maximum of 0.838 kg per bottle to a minimum of 0.552 kg per bottle (Table 24). As regards cork stoppers weight, products W3, W4, W6 and W7 use sparkling wine stoppers while products W1, W2 and W5 use a lighter cork stopper. No product is packed in wooden boxes.

The weight of the still product bottles differs quite a bit and ranges from a maximum of 0.745 kg per bottle to a minimum of 0.390 kg per bottle (Table 33). There is an interesting average value of 0.0455 kg of wood as 9 high quality and premium quality products (3 companies) are packaged in wooden boxes due to the high quality.

For both types of products there is a great variability in the weight of the labels, linked to the presence or not of a double label on the bottle.

The overall weight of the packaging can vary up to about 18% for sparkling products and about 34% for Still products, depending on the company's policy.

The analysed Sparkling products (Table 25) have the peculiarity of being distributed on average mainly in Italy (83% of the products) and, to a limited extent, in Europe (17% of the products), with an average distribution distance by truck equal to 402.1 km with minimum peaks of 50.2 km and maximum of 2000 km and a very high variability (SD 657.6 km). The Still products (Table 34), on the other hand, are on average distributed all over the world (35.16% Italy, 30.12% Europe, 34.72% US and Canada) with an average distribution distance of 814.47 km by truck with minimum peaks of 161 km and maximum of 5498 km and a very high variability (SD 1146.18 km). Still products cover an average of 5313.14 km by ship.

Wine production in Italy has been analysed in various scientific publications. Seven publications report inventory data. Most relevant processes were selected and a comparison was made between the bibliographic data and the average inventory data for Sparkling and Still VIVA average products.

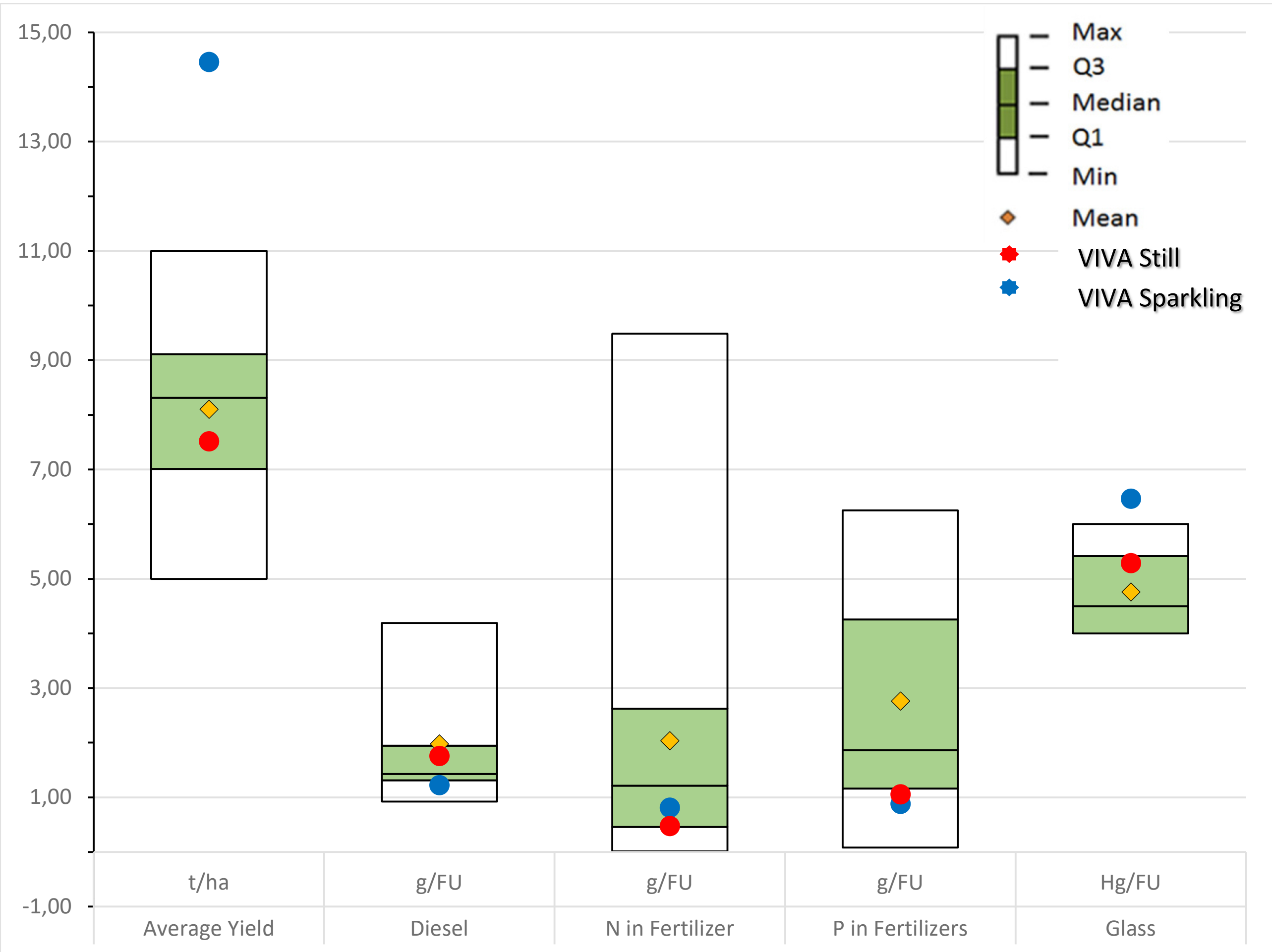



FIGURE 8: STATISTICAL COMPARISON OF MOST RELEVANT PROCESSES

TABLE 36: BIBLIOGRAPHICAL DATA

| Reference | Region | Color | Average Yield | N | P2O5 | Diesel | Bottle Glass |
|---|---|---|---|---|---|---|---|
| | | | kg/ha | kg/FU | kg/FU | kg/FU | kg/FU |
| **Bonamente et al 2016** | Umbria | RED | 9.43E+03 | 2.80E-03 | 1.17E-03 | 1.94E-02 | 4.50E-01 |
| **Ardente et al. 2006** | Sicily | RED | 7.01E+03 | 9.49E-03 | | 3.94E-02 | 5.23E-01 |
| **Bartocci et al. 2017** | Umbria | RED | 9.00E+03 | 2.63E-03 | | 1.43E-02 | |
| **Bartocci et al. 2017** | Umbria | RED | 7.00E+03 | 3.38E-03 | | 1.38E-02 | |
| **Bosco et al. 2011** | Tuscany | RED | 5.00E+03 | 2.03E-03 | 6.09E-03 | 1.50E-02 | 5.00E-01 |
| **Bosco et al. 2011** | Tuscany | RED | 6.00E+03 | 2.08E-03 | 6.25E-03 | 4.19E-02 | 6.00E-01 |
| **Bosco et al. 2011** | Tuscany | WHITE | 1.10E+04 | 1.22E-03 | 3.65E-03 | 9.24E-03 | 5.91E-01 |
| **Bosco et al. 2011** | Tuscany | RED | 9.00E+03 | 8.06E-04 | 2.42E-03 | 1.31E-02 | 4.10E-01 |
| **Falcone et. Al 2016** | Calabria | RED | 7.90E+03 | 4.55E-04 | | | |
| **Falcone et. Al 2016** | Calabria | RED | 9.60E+03 | 4.55E-04 | | | |
| **Falcone et. Al 2016** | Calabria | RED | 7.54E+03 | 3.54E-04 | 1.15E-03 | | |
| **Falcone et. Al 2016** | Calabria | RED | 8.72E+03 | 7.70E-04 | 1.31E-03 | | |
| **Fusi et al. 2014** | Sardinia | WHITE | | 1.35E-05 | 8.30E-05 | | 5.60E-01 |
| **Iannone et al 2016** | Campania | WHITE | | | | | 4.00E-01 |
| **Iannone et al 2016** | Campania | WHITE | | | | | 4.00E-01 |
| **Iannone et al 2016** | Campania | RED | | | | | 4.00E-01 |
| **Iannone et al 2016** | Campania | RED | | | | | 4.00E-01 |
| | | | | | | | |
| **ARITHMETICAL MEAN** | | | 8.10E+03 | 2.04E-03 | 2.76E-03 | 2.08E-02 | 4.76E-01 |
| **MEDIAN** | | | 8.31E+03 | 1.22E-03 | 1.86E-03 | 1.46E-02 | 4.50E-01 |
| **SD** | | | 1.61E+03 | 2.38E-03 | 2.20E-03 | 1.18E-02 | 7.78E-02 |
| **MAX VALUE** | | | 1.10E+04 | 9.49E-03 | 6.25E-03 | 4.19E-02 | 6.00E-01 |
| **MIN VALUE** | | | 5.00E+03 | 1.35E-05 | 8.30E-05 | 9.24E-03 | 4.00E-01 |
| **25% PERC** | | | 7.01E+03 | 4.55E-04 | 1.16E-03 | 1.36E-02 | 4.00E-01 |
| **75% PERC** | | | 9.11E+03 | 2.63E-03 | 4.26E-03 | 2.44E-02 | 5.41E-01 |
| **AVERAGE VIVA SPARKLING** | | | 1.45E+04 | 8.10E-04 | 8.79E-04 | 1.22E-02 | 6.47E-01 |
| **AVERAGE VIVA STILL** | | | 7.51E+03 | 4.73E-04 | 1.06E-03 | 1.76E-02 | 5.28E-01 |

The Figure 8 shows that the average VIVA products have values that are mainly consistent with bibliographic data.

On average, VIVA products have lower input consumption at the vineyard stage.

This aspect acquires a certain relevance for VIVA average Still products. In fact, the data represented in Figure 8 are referred to functional unit and therefore takes into account the vineyard yields, which for VIVA still products are lower than the average bibliographic data. Sparkling products, on the other hand, given their very high average yields, are placed in a favourable position in this graphic representation. In this particular case a better investigation was no possible because bibliographic data available are referred to FU.

It is also important to underline that both average VIVA products have a much heavier bottle than the values reported in Table 36. With regard to Sparkling products, this difference may depend on the fact that the bibliographic data mainly refer to still wines; with regard to still wines, however, this difference is an indication of how in Italy the high quality products are mainly packaged in heavy bottles, and from an environmental point of view that can have a great impact.

## 5.2. Product Environmental Footprint (PEF) of VIVA products

The main work of this thesis was to compare the impact of the average representative products released by the JRC at the end of June (JRC, 2018), with the inventories of products belonging to the VIVA project and with the average VIVA inventories.

PEF and Made Green in Italy (European Commission, 2018b, 2013b, 2013d; MATTM, 2017b) intend to insert the benchmark as an element that distinguishes products with a higher environmental efficiency from products with a lower environmental efficiency. The commission defines the benchmark as: A standard or point of reference against which any comparison can be made. In the context of PEF, the term 'benchmark' refers to the average environmental performance of the representative product sold in the EU market. A benchmark may eventually be used, if appropriate, in the context of communicating environmental performance of a product belonging to the same category (European Commission, 2018b).

As Nissinen et al., 2005 claim, Environmental LCA holds the potential to help environmentally-conscious consumers to sort out the available advice and find suitable and relevant environmental improvement options for their own lives. With time, it may also help consumers to assume a more powerful role in influencing global supply chains. More and more LCA results are becoming available, but the reports are extremely technical, featuring long lists of environmental pollutants and unfamiliar terms.

There is still is an obvious need to develop methods to interpret and present LCA results to consumers and the Single Market for Green Product Initiatives wants to fulfil this need (European Commission, 2013b).

Although the use of this element is extremely innovative in environmental terms and can lead to a real rush to "green economy", at the moment its use is immature and even the PEF has made it optional during the Transition phase that will take place in the next two years.

## 5.3. PEF Wine proposed benchmark - the point of view of Italy in the PEF European debate

During the PEFCR development round tables (technical advisory board and Steering Committee) at European level, Italy, represented by me or by my colleagues, strongly opposed the still wine benchmark proposal brought by the technical secretariat of wine.

The proposed and approved still wine European benchmark have in fact a virtual packaging products composed of 79% of glass bottle (with different types of stoppers), 16% of Bag in Box, 4% of PET bottle and 1% of beverage cartons (CEEV, 2018b), which, given the environmental impact linked to glass production, strongly penalizes all the high quality Italian Wines. The average area of Italian wineries in the 2010 census was around 1.6 ha per estate, a substantial difference compared to other European and international producers who have an average size of 6 ha in France, 3 ha in Spain, 14 ha in Chile and 18 ha in the USA (INumeridelVino, 2012). Within the last ten years, viticulture in Italy evolved significantly towards higher quality production (Cembalo et al., 2014; Di Vita et al., 2015), making the Italian wine sector one, if not the first, of major producers in the world. If we look the average yield of the analysed Still wines we can see that is equal to 49.79 hl/ha of wine, which is lower than the Italian and French average values 67 hl/ha, 53 hl/ha respectively, and slightly higher than the European average of 48 hl/ha (European Commission, 2009b).

This means that still Italian wines, or at least still wines that have participated in the VIVA project, and therefore have a greater sensitivity to issues related to sustainability, are potentially penalized both in terms of yields per ha and in terms of packaging compared to the representative European product.

The Italian proposal was to include different benchmarks depending on the type of packaging used. This suggestion was not taken into account and the PEFCR proposal passed with a minimum of the necessary votes.

## 5.4. Methodological approach used in the PEF study.

The individual and average inventories listed in the previous chapter were modelled on OPEN LCA Version 1.7.2 using the preliminary secondary datasets made available by the European Commission, carrying out a first application of a PEF study on VIVA products.

At the end of this first study the single products were compared with the preliminary versions of the European benchmarks made available by the European Commission (JRC, 2018), making a first environmental performance comparison. The following paragraphs specify in detail the approach used for this PEF application.

### 5.4.1. Functional Unit and reference flow

The FU is consumption of 0.75 litres of packaged wine.

The reference flow is the amount of product needed to fulfil the defined function and shall be measured in litres. All quantitative input and output data collected in the study shall be calculated in relation to this reference flow.

### 5.4.2. System boundaries

The system boundaries are reported in Table 37.

TABLE 37: ACTIVITIES INCLUDED IN EACH LIFE CYCLE STAGE

| LIFE CYCLE STAGE | ACTIVITY |
|---|---|
| **1. Raw material acquisition and pre-processing** | The life cycle of wine starts with the cultivation of grapes which entails different processes related with vine plantation, plants and soil management, grape harvesting and vine destruction.<br>This stage entails also the production of all packaging used for marketing still or sparkling wine. Packaging of sparkling wine may be part of the production process if the second fermentation occurs in the final bottle, which will need to be washed, labelled and encapsulated. |

| | |
|---|---|
| | Once produced, still wine may be marketed in bulk or in small size containers for the retail market. Therefore, filling operations may be carried out by the same winery producing the wine or by others. Different volumes and packaging options may be used for still wine, whereas sparkling wine shall be marketed in a specific type of glass bottles and mushroom-shaped sparkling wine closure6.<br><br>Finally, within this stage the production of oenological practices used during wine making is also included as well as the transportation of all inputs from supplier to producer. |
| **2. Manufacturing stage: wine making process** | Once at the winery, grapes are weighed, classified and usually crushed to liberate the juice without squashing the seeds. At this point, two co-products are obtained: grape must (used to make the wine) and grape pomace that derivate to the distillation industry to produce spirits, industrial alcohol, etc. Grape must may be transported to other wineries or used within the same production site where grapes have been crushed.<br><br>Then, the vinification process starts and it differs depending mainly on the type of wine: still or sparkling; white, red or rosé, and conventional or organic. Wine making includes different steps such as fermentation, clarification or stabilisation, entailing the use of permitted oenological practices (additives and processing aids) regulated by the EU wine legislation7 in the form of a positive list. In addition to wine, the wine making process produces lees which are also derivate to the distillation industry. |
| **3. Distribution stage** | Packaged or bulk wine is distributed to retail and then from retail to consumer. |
| **4. Use stage: wine consumption** | The use stage starts at the moment the end user consumes wine and till the product enters its end-of-life stage.<br><br>If maintained in the original (adequate) packaging and stored at room temperature, wine does not require chilling for its preservation. However, in the case of sparkling and white and rosé wines, serving temperatures are recommended by winemakers to improve consumer's experience, whereas for red wine room temperature is usually considered good enough. In such cases, the product may be cooled in a fridge before serving. |
| **5. End of life** | Once the wine is consumed, primary packaging materials are recovered (recycled or energy recovery) or disposed (landfilling or incineration without energy recovery). Waste management of product losses or left-overs shall also be included in this stage. |

### 5.4.3. Exclusion and cut-off

According to the PEFCR, the production of capital goods (including building, equipment and machinery) has been excluded based on the cut-off rule.

The cooling of the wine was not modelled because the average JRC data does not include the cooling phase and was therefore not included in the average product for a fair comparison.

### 5.4.4. Assumptions

The transport of input material excluded wine are assessed following the scenario reported in paragraph "6.1.2. Transportation of inputs from suppliers to producer" of the wine PEFCR.

The average data used for the modelling of the PEF studies later presented are reported in Table 38 and have been obtained from the following publications (BIOREX, 2018; Micheloni, 2006; TERCOMPOSTI, 2018; Tomasi and Marcuzzo, 2012).

TABLE 38: ORGANIC FERTILISER PROPERTIES

| | %DM | %OM | %N | %P2O5 | %K2O |
|---|---|---|---|---|---|
| **MANURE** | 22.00% | 16.00% | 0.40% | 0.10% | 0.30% |
| **SERMENT** | 40.00% | 17.80% | 0.56% | 0.17% | 0.84% |
| **DRY MANURE** | 84.00% | 24.00% | 2.50% | 3.00% | 2.00% |
| **BIOREX** | 84.00% | 65% | 2.80% | 2.50% | 3% |

A default scenario 5% product-losses during the use phase was considered.

Not having found details related to the production of barrels and related weight in steel and wood, a barrel of 228 litres weighing 50 kg of which 48.5 of wood, with an average use of 3 production cycles was considered.

Direct emission of phytosanitary product were modelled to soil, air and water at the following percentages (90% emitted to the agricultural soil compartment, 9% emitted to air and 1% emitted to water).

For the modelling, the use of iron wire for tying the vines was estimated at 475 kg/ha.

For the disposal scenarios, the average scenarios extracted from the sima-pro software and used in Ecoinvent 3.4 were used.

- Packaging waste (waste scenario) {US}| treatment of packaging waste | Cut-off, S
- Packaging waste (waste scenario) {DE}| treatment of packaging waste | Cut-off, S
- Packaging waste (waste scenario) {IT}| treatment of packaging waste | Cut-off, S

### 5.4.5. Impact categories, model and indicators

Here below the environmental impact categories of the study analysed using the ILCD 2011 Midpoint+ EU27 2010 (version 1.0.9) method (European Commission and Joint Research Centre, 2012): [1] climate change (CC) (time horizon of 100 years) using the characterisation factors proposed by Myhre et al. (Myhre et al., 2013) in the IPCC Fifth Assessment Report; [2] ozone depletion (OD) (time horizon of 100 years); [3] human toxicity, non-cancer effects (HT – nce); [4] human toxicity, cancer effects (HT - ce); [5] particulate matter (PM); [6] ionizing radiation human health (IR-HH); [7] Ionizing radiation ecosystems (IR-E); [8] photochemical ozone formation (POF); [9] acidification (A); [10] terrestrial eutrophication (ET); [11] freshwater eutrophication (EF); [12] marine eutrophication (EM); [13] freshwater ecotoxicity (FWE); [14] land use (LU); [15] water resource depletion (WRD); [16] mineral, fossil & renewable resource depletion (MF & RRD).

This method has been used because it is the most similar to the one proposed by PEF but not yet available on OpenLCA.

### 5.4.6. Normalisation and weighting factor

The normalisation factors used were the default ones referring to the impact categories used.

The weighing factors used were those proposed by Wine PEFCR in Annex I (CEEV, 2018b).

For the weighing of impact category [16] mineral, fossil & renewable resource depletion (MF & RRD), the sum of the two categories “Resource use, fossils” and “Resource use, minerals and metals” was used.

## 5.5. Errors found using the firs version of EU PEF Emission Factors

The emission factors developed as part of the PEF Pilot and published on the project page are still problematic and need to be adapted to the different software.

The first software where it was possible to import these emission factors was OpenLCA. At this stage there are no other commercial software where such data can be imported.

As a first application, these emission factors are still affected by several errors.

Here below are reported the errors found and the solutions adopted:

- Pyraclostrobin (prop) - the only possible emission is to soil – all direct emissions were allocated to soil;
- Quinoxyfen - Only emission to soil (not possible to model emission on air and water) - all direct emissions were allocated to soil;
- Spiroxamine - Only emission to soil (not possible to model emission on air and water) - all direct emissions were allocated to soil;
- Mandipropamid – the only possible emission is to soil (not possible to model emission on air and water) - all direct emissions were allocated to soil
- Pyraflufen-ethyl - Only emission to soil and air (not possible to model emission on water) - direct emissions related to water were allocated to soil
- Fungicide unspecified - Only emission to soil and water (not possible to model emission on air) - direct emissions related to air were allocated to soil
- Insecticide unspecified - Only emission to soil and water (not possible to model emission on air) - direct emissions related to water were allocated to soil
- Herbicide unspecified - Only emission to soil and water (not possible to model emission on air) - direct emissions related to air were allocated to soil
- There are no processes for natural gas at consumer home.
- The process: “Sugar, from sugar beet; from sugar production, production mix at plant” do not exist
- The process for glue for cartons did not exist

- All the processes for incineration have no reference flow that works, I have created a waste flow and corrected some processes. Therefore, it is possible that the results can be affected by this processes modification (es. LU).

# 6. Results

## 6.1. Average inventory of VIVA certified still and sparkling products

The data of 12 companies have been analysed to create an average inventory for sparkling and still products, based on the analysis of 27 products. The average inventory (chapter 5.1.2; 5.1.3; and Annex III), will be sent in electronic format to IMELS and will remain available to the Università Cattolica del Sacro Cuore (UCSC).

Reference values can be added to the VIVA AIR indicator Technical Specification, and in the future can be used to ease the work of certifiers for the validation of VIVA studies and at the same time to support those companies facing with problems on data collection due to a lower control on the supply chain and that are therefore currently unable to close the VIVA AIR indicator study.

Furthermore, the interest is simplified approaches has grown with the Environmental Footprint pilots (European Commission, 2013d). In the era future the inventory data provided to IMELS and to UCSC may be used within the Made Green in Italy scheme as a contribution to the creation of a national benchmark or to build the data framework of a simplified tool.

## 6.2. Major difference between the VIVA Project and the PEF method.

Life Cycle Assessment (LCA) is a method to investigate the environmental impact of products and all his supply chain. This method is used to give insights in possible improvements in the supply chain.

Both VIVA – AIR Indicator and PEF use the LCA method but the main difference between the two methods is related to the impact categories which are studied. VIVA – AIR indicator is focused on one environmental impact category: Climate Change. Meanwhile PEF takes more impact categories into account.

Different authors report that thanks to the multiple impact categories that can be considered, full LCA studies have proven to be useful methods to account the environmental burden associated in the different life cycle stages of wine (Neto et al., 2013; Petti et al., 2006; Vázquez-Rowe et al., 2013).

This study has allowed to highlight the differences in the VIVA-AIR and PEF approach and the possible improvements that can be made by the two projects, especially in view of the application of the recently approved Made Green in Italy.

The main differences between the two methods are reported here below. The analysis of the document is divided into six phases:

1. Vineyard;

2. Winery - must production

3. Winery - vinification and aging

4. Bottling and Packaging

5. Distribution, use and end of life

6. Other Indicators and Additional information

### 6.2.1. Vineyard

As regards the vineyard phase, it should be noted immediately that PEFCR requires the use of an average of the 3-year data for the vineyard data collection in order to reduce the effect and the variability of data due to extraordinary interventions. The VIVA project, on the other hand, foresees the use of only one year, even if the use of average data is a practice recommended for training meetings. The other main differences found in the data collection and calculation phase are as follows.

#### *6.2.1.1. Use of fertilizers*

Primary data on the use of fertilizers in vineyards are required both in VIVA - AIR and by PEFCR, however there are some differences:

In VIVA the inclusion of direct emissions to air and water due to N and P2O5 fertilizers is not simplified, and must be calculated by the operator who carries out the study. PEFCR instead provides a simplified table that based on the dose of fertilizer defines emissions to air and water.

<u>VIVA Improvements:</u> If IMELS wishes to update the VIVA specification in the future, it is advisable to follow the PEF table of direct emission to ease the work of modellers.

<u>PEF improvements: </u>PEFCR on wine does not provide average reference data for mineral and organic fertilization. This therefore means that in cases where it is not possible to collect a primary data, or the primary data collected on the farm has strange values, it is not possible to make a comparison with an average screening PEF data.

In both systems no reference values are given regarding the characteristics of organic fertilisers but it is requested to refer to the analyses of the substrates used. This is not always possible in agriculture and therefore a table with representative average data should be included in PEFCR and in the VIVA specification.

#### *6.2.1.2. Use of plant protection products*

The primary data on the quantity and active ingredients of phytosanitary products used in vineyards is required both in the VIVA specification and in the Wine PEFCR.

In VIVA - AIR, however, only the impact category “Climate Change” is considered and therefore the emissions into air, water and soil of the active ingredients used are excluded and only the transport of the active ingredient and the disposal of packaging waste is requested and calculated. On the other hand, for the other indicators (WATER and VINEYARD), the emission in water is estimated in great detail on the basis of the mitigation measures adopted by the company.

The Wine PEFCR instead requires that for every single active ingredient used not only the production and transport are modelled but also all the emissions related to its use. All active substances used must then be modelled as direct emissions to soil, air and water at the following percentages (90% emitted to the agricultural soil compartment, 9% emitted to air and 1% emitted to water) (CEEV, 2018b).

A debate remains on the amount of plant protection product that remains on the plant surface until it is completely degraded. Moreover, there is currently no mitigation strategy effect included. This will need to be further explored in the future.

During the modelling of the PEF studies, with the documentation provided in the PEFCR it was very complicated to subdivide the active substances into the classes proposed at PEF level in order to be able to calculate the impact of the production of these compounds. This naturally increases the possibility of modelling error with high difficulty for the operator and potential differentiation of the PEF studies.

The PEF classes are shown in Table 6 and Table 7.

Finally, PEF does not require data on waste produced in vineyards. While in VIVA these are required and considered (unless they fall within the cut-off).

PEF improvements: It is very difficult to break down plant protection products into different classes of emission factors. It would be appropriate to create a small tool for the transformation from a commercial product to an active substance and from an active substance to a reference class.

The active substances, on the other hand, must be inserted individually. This differentiation also requires work to identify the individual active ingredients and then group them into classes to assess the impacts associated with their production. At European level, individual processes should be set up to include direct emissions of active substances. This would simplify modelling and avoid duplication of work.

Again, there are no average data available that could be used for comparison purposes and that would allow an understanding of whether the doses of the active substance have been modelled correctly or not.

#### *6.2.1.3. Establishment and unproductive years of the vines*

In VIVA -AIR indicator the data regarding the vineyard planting are not requested because in the areas where the vine has historically been grown the plots are small and the vines are not established all at the same time but from year to year the old ones, the sick ones or the less productive ones are replaced. On the other hand, the production of rooted vines is excluded. The PEF Screening studies, instead, show that the phase of vineyard establishment and rearing of the rooted vines can have an impact of up to 20% in some impact categories.

VIVA Improvements: the PEF Screening Study has shown how the phases of planting and rearing of the rooted vines can have a considerable impact also with regard to the "Climate change" category; it is therefore necessary to verify whether the practice of vineyard new establishment is so frequent at national level or whether only maintenance and replacement of the plants are often carried out. An open question is also related to how much data are available about the establishment phase.

PEF improvements: Emission factors and data used in the vineyard establishment phase are not reported in PEFCR supporting material. This means that if, as in my case, the data is not available or is partially available, it cannot be supplemented with an average PEF data, and there is no indication of the degree of detail and an average list of products to refer to. It is therefore difficult to collect data for this phase. It appears necessary to collect data on the first unproductive years of vine with regard exclusively to fertilization, plant protection products and binding materials.

#### *6.2.1.4. Auxiliary materials*

Auxiliary materials are binding cables and cover materials for the vines. In the VIVA - AIR Indicator project, auxiliary materials for vineyard management are not mentioned in the check list and are not requested to wineries. For PEF, PEFCR requires the materials used for binding, but does not require the use of any covering materials.

VIVA Improvements: The PEF screening study showed that Auxiliary Materials can have a significant impact. In the future, this information could be requested to VIVA companies.

PEF improvements: PEFCR on wine does not provide average reference data for auxiliary material. This therefore means that in cases where it is not possible to collect a primary data or the primary data collected on the farm has strange value, it is not possible to make a comparison with a PEF average data.

#### *6.2.1.5. Carbon permanently stored at soil (vineyards and oak forests)*

PEFCR Wine proposes a methodology for calculating the permanent storage of carbon in cork trees and in vines if these exceed 100 years of age in the vineyard. This methodology is difficult to apply and, at least for vineyards, does not represent the realities analysed and has therefore not been taken into account.

### 6.2.2. Winery - must production

PEFCR asks for the production phase of the must to be subdivided from the wine production and ageing phase and from the bottling phase. This operation is carried out in order to correctly subdivide the company's electricity consumption used for the production of must and therefore subject to allocation with respect to all other operations. PEFCR also provides a default data of 0.0056 kWh of electricity per kg of grapes processed.

VIVA improvements: This approach is methodologically valid and can also be adopted by the VIVA project.

PEF improvements: The PEFCR on wine does not give the data on the amount of water linked to the grape washing phase, which even if optional is often used as a process and potentially could have a considerable water consumption compared to other operations in the cellar.

### 6.2.3. Winery - vinification and aging

At this stage, the differences identified concern:

#### *6.2.3.1. Energy*

The data relative to the electricity used for the storage and aging of wine is certainly relevant but often the companies have it only with an aggregate detail. Both VIVA and PEFCR Wine require aggregate data, but in order to use PEF as a tool for comparison and improvement at company level, average data to refer to would be useful, especially for the most sensitive companies that have different counters for the storage part.

#### *6.2.3.2. Additives and processing aids for oenological practices*

The raw materials used in winemaking for the oenological practices in VIVA are considered only with regard to transport to the winery and not for the impact related to their production. While the PEFCR shows the emission factors to be referred to and therefore more detail is required. As previously described in the description of Table 12 and

Table 13.

#### *6.2.3.3. Oak Barrel and Steel*

PEFCR Wine considers emissions related to the production of wooden barrels (including steel content). This data in VIVA is not taken into account.

In order to carry out the modelling of the wines analysed, a research was carried out to identify which wines were subject to aging in barrels.

For W9, W11, W12, W13, W14, W15, W17, W20, W21, W22, W23, W24, W25, W26, W27 (fifteen out of twenty Still wines) the impact related to the production and disposal of wooden barrels was included.

VIVA improvements: As soon as the emission factors are updated, it will be possible to better specify the raw materials used in the winery.

PEF improvements: PEFCR requires modelling both the oenological raw materials and the use of wooden barrels. The detail of the oenological raw materials may be excessive due to the small quantities and the data gaps found with regard to the emission factors even in the case of application of the PEF. As regards the barrels for the aging of wine, however, it is necessary to provide reference parameters also listing various sizes of barrels and their weights. This data is often very difficult to find and therefore an average data to consult could be useful. As already mentioned above, it would be useful to have an average reference data for energy consumption in the storage phase of wine.

### 6.2.4. Bottling and Packaging

The data required by VIVA certification and PEFCR Wine for packaging are the same for primary packaging, secondary packaging and tertiary packaging. There are no significant differences at this stage between the two schemes.

### 6.2.5. Distribution, use and end of life

With regard to this stage of the production cycle, both the VIVA project and PEFCR Wine require data on the disposal of packaging (primary, secondary and tertiary), distribution data and data on the eventual cooling of the bottle in the refrigerator.

The difference with regard to PEFCR Wine compared to the VIVA project is that PEFCR asks for the inclusion of a wine loss of 5% of the product as a product not consumed or discarded because it has a "corky" taste.

As far as distribution is concerned, the VIVA project adopted the indications of the PEF Guidance, adding also distribution from the distribution centre to the local market and then to the final consumer.

### 6.2.6. Other Indicators and Additional information

The wine sector generates multifunctional activities, such as good and service production, carrying out social, economic and environmental functions (Arcese et al., 2017).

The VIVA protocol to meet the need to cover this multifunctionality has been built on 4 different indicators.

AIR and WATER are two single issues indicators that investigate the impact generated by the activities of the wine industry with regard to emissions into the air and direct water consumption in its 3 forms (Green, Blue and Grey) (MATTM, 2016).

VINEYARD analyses the effects of a sustainable use of plant protection products by giving a "vote" to companies on the basis of their choices and also acts as a tool to support environmental decisions (MATTM, 2016).

TERRITORY, on the other hand, by compliance with certain requirements and responding to them, obliges companies to undertake a process of improvement on social, economic and cultural aspects (MATTM, 2016).

Precisely because of these characteristics, the VIVA protocol has been mentioned among the models recognized by the PEFCR of wine and put among the possible additional information PEF (CEEV, 2018b).

As a result of recent methodological developments in the field of LCA at European and national level, already mentioned several times in the previous paragraph (4. Goal and Scope), there is a growing ferment on the subject. In recent national debates on Made Green in Italy, to IMELS was asked what would be the developments of the VIVA protocol following the implementation of the MGI (MATTM, 2018), a first answer was developed by Prof. Capri (Capri, 2018).

Specifically regarding the viticulture sector a review by Rugani et al., (2013) points out other gaps that remain unexplored when life cycle thinking is applied to the wine sector. One of these gaps is directly connected to an in-depth analysis of the different viticulture techniques that may be used (i.e. organic, biodynamic, conventional).

## 6.3. VIVA average products - Impact assessment results

The results of the environmental impact assessment for the analysed VIVA average wines are presented in this paragraph, in aggregated form and highlighting the most relevant phases of the life cycle.

TABLE 39:IMPACT ASSESSMENT RESULT –VIVA AVERAGE SPARKLING WINE

| Impact Category | Unit | Total | Vineyard | Vinery | Packaging | Transport | End of life |
|---|---|---|---|---|---|---|---|
| A | molc H+ eq | **5.83E-03** | 1.72E-03 | 2.25E-03 | 2.91E-03 | 4.70E-05 | -1.63E-03 |
| CC | kg CO2 eq | **1.81E+00** | 1.73E-01 | 9.53E-01 | 7.89E-01 | 9.08E-02 | -3.59E-01 |
| FWE | CTUe | **2.44E+01** | 2.36E+00 | -1.82E-02 | 1.03E-01 | 9.71E-03 | -2.08E-01 |
| EF | kg P eq | **2.10E-04** | 1.41E-04 | -1.50E-06 | 5.40E-06 | 3.26E-07 | -1.13E-05 |
| HT-ce | CTUh | **9.13E-08** | 9.77E-08 | -1.72E-09 | 4.70E-09 | 4.08E-10 | -9.82E-09 |
| HT-nce | CTUh | **3.82E-07** | 3.34E-07 | 8.59E-09 | 3.75E-08 | 4.98E-09 | -2.77E-08 |
| IR-E (interim) | CTUe | **7.29E-07** | 7.42E-08 | 4.80E-07 | 8.27E-07 | 2.80E-09 | -6.55E-07 |
| IR-HH | kBq U235 eq | **6.76E-02** | 1.13E-02 | 3.77E-02 | 7.22E-02 | 2.99E-04 | -5.38E-02 |
| LU | kg C deficit | **-7.10E+00** | 2.42E-01 | 2.18E-01 | -7.52E+00 | 1.36E-03 | -3.86E-02 |
| EM | kg N eq | **1.92E-03** | 2.55E-04 | 8.75E-04 | 3.43E-04 | 1.60E-04 | -1.77E-04 |
| MF&RRD | kg Sb eq | **3.00E-04** | 3.01E-04 | -3.41E-07 | 1.03E-05 | 1.15E-08 | -8.15E-06 |
| OD | kg CFC-11 eq | **3.27E-08** | 1.29E-08 | 1.69E-10 | 5.71E-10 | 2.51E-13 | -8.73E-10 |
| PM | kg PM2.5 eq | **5.80E-04** | 1.58E-04 | 3.26E-04 | 1.61E-04 | 8.77E-06 | -9.27E-05 |
| POF | kg NMVOC eq | **2.82E-03** | 2.96E-04 | 1.82E-03 | 9.45E-04 | 3.19E-04 | -5.60E-04 |
| ET | molc N eq | **1.76E-02** | 4.09E-03 | 6.46E-03 | 6.36E-03 | 1.55E-04 | -1.80E-03 |
| WRD | m3 water eq | **1.20E-04** | 1.54E-03 | -6.55E-04 | 2.72E-05 | 5.64E-08 | -7.91E-04 |

TABLE 40: IMPACT ASSESSMENT RESULT –VIVA AVERAGE STILL WINE

| Impact Category | Unit | Total | Vineyard | Vinery | Packaging | Transport | End of life |
|---|---|---|---|---|---|---|---|
| A | molc H+ eq | **8.28E-03** | 3.60E-03 | 1.33E-03 | 1.96E-03 | 1.74E-03 | -1.07E-03 |
| CC | kg CO2 eq | **2.19E+00** | 3.50E-01 | 1.21E+00 | 6.04E-01 | 2.07E-01 | -2.44E-01 |
| FWE | CTUe | **8.47E+01** | 4.94E+00 | 1.27E-01 | 8.20E-02 | 3.74E-02 | -1.54E-01 |
| EF | kg P eq | **3.70E-04** | 2.81E-04 | -1.28E-08 | 4.37E-06 | 1.22E-06 | -9.32E-06 |
| HT-ce | CTUh | **2.22E-07** | 2.20E-07 | 2.94E-09 | 3.68E-09 | 1.60E-09 | -6.96E-09 |
| HT-nce | CTUh | **8.23E-07** | 7.33E-07 | 1.79E-08 | 2.86E-08 | 1.88E-08 | -1.74E-08 |
| IR-E (interim) | CTUe | **5.66E-07** | 1.18E-07 | 3.86E-07 | 4.88E-07 | 9.02E-09 | -4.35E-07 |
| IR-HH | kBq U235 eq | **6.02E-02** | 2.15E-02 | 2.91E-02 | 4.46E-02 | 9.25E-04 | -3.60E-02 |
| LU | kg C deficit | **4.91E-01** | 5.38E-01 | -1.33E-02 | -4.88E-03 | 5.08E-03 | -3.43E-02 |
| EM | kg N eq | **2.54E-03** | 4.90E-04 | 5.74E-04 | 2.68E-04 | 8.47E-04 | -1.10E-04 |
| MF&RRD | kg Sb eq | **6.70E-04** | 6.75E-04 | -5.02E-06 | 7.39E-06 | 4.54E-08 | -5.92E-06 |
| OD | kg CFC-11 eq | **2.23E-08** | 1.85E-08 | 4.01E-09 | 3.80E-10 | 1.25E-12 | -5.88E-10 |
| PM | kg PM2.5 eq | **6.10E-04** | 3.42E-04 | 2.64E-05 | 1.21E-04 | 1.80E-04 | -6.18E-05 |
| POF | kg NMVOC eq | **4.44E-03** | 5.60E-04 | 1.33E-03 | 7.16E-04 | 2.22E-03 | -3.82E-04 |
| ET | molc N eq | **2.79E-02** | 8.94E-03 | 3.89E-03 | 3.57E-03 | 9.23E-03 | -1.03E-03 |
| WRD | m3 water eq | **2.60E-04** | 1.28E-03 | -2.16E-04 | 3.06E-05 | 1.89E-07 | -8.41E-04 |

TABLE 41: FOCUS ON THE VINEYARD – VIVA AVERAGE SPARKLING WINE

| Impact Category | Unit | Total | Grafted Vine | Pesticide | Fertilizers | Waste |
|---|---|---|---|---|---|---|
| A | molc H+ eq | **2.88E-03** | 1.20E-03 | 7.76E-05 | 3.42E-04 | 7.90E-05 |
| CC | kg CO2 eq | **4.37E-01** | 1.25E-01 | 1.15E-02 | 1.92E-02 | 1.04E-02 |
| FWE | CTUe | **2.38E+00** | 1.79E+00 | 1.40E-02 | 5.15E-01 | 2.20E-02 |
| EF | kg P eq | **1.42E-04** | 8.21E-05 | 4.73E-07 | 5.34E-05 | 4.73E-06 |
| HT-ce | CTUh | **9.84E-08** | 9.13E-08 | 5.91E-10 | 3.75E-09 | 6.30E-10 |
| HT-nce | CTUh | **3.37E-07** | 2.72E-07 | 7.22E-09 | 5.13E-08 | 1.85E-09 |
| IR-E (interim) | CTUe | **2.06E-07** | 2.56E-08 | 0.00E+00 | 2.82E-08 | 1.06E-08 |
| IR-HH | kBq U235 eq | **2.73E-02** | 7.16E-03 | 2.20E-04 | 1.95E-03 | 9.20E-04 |
| LU | kg C deficit | **4.84E-01** | 2.18E-01 | 1.97E-03 | 1.31E-02 | 5.82E-03 |
| EM | kg N eq | **5.74E-04** | 1.80E-04 | 1.84E-05 | 4.64E-05 | 5.92E-06 |
| MF&RRD | kg Sb eq | **3.02E-04** | 2.80E-04 | 1.60E-08 | 1.51E-05 | 5.55E-06 |
| OD | kg CFC-11 eq | **2.60E-08** | 7.38E-09 | 3.52E-13 | 5.54E-09 | 5.00E-12 |
| PM | kg PM2.5 eq | **3.81E-04** | 1.20E-04 | 3.21E-06 | 2.21E-05 | 1.14E-05 |
| POF | kg NMVOC eq | **6.77E-04** | 1.60E-04 | 4.56E-05 | 6.10E-05 | 1.71E-05 |
| ET | molc N eq | **7.41E-03** | 3.58E-03 | 1.70E-04 | 1.83E-04 | 1.19E-04 |
| WRD | m3 water eq | **1.55E-03** | 1.23E-07 | 6.46E-08 | 8.74E-08 | 3.30E-08 |

TABLE 42: FOCUS ON THE VINEYARD – VIVA AVERAGE STILL WINE

| Impact Category | Unit | Total | Grafted Vine | Pesticide | Fertilizers | Waste |
|---|---|---|---|---|---|---|
| A | molc H+ eq | 3.63E-03 | 2.79E-03 | 1.24E-04 | 5.87E-04 | 1.06E-04 |
| CC | kg CO2 eq | 3.51E-01 | 2.89E-01 | 2.41E-02 | 1.85E-02 | 1.15E-02 |
| FWE | CTUe | 4.94E+00 | 4.16E+00 | 2.09E-02 | 7.15E-01 | 3.16E-02 |
| EF | kg P eq | 2.81E-04 | 1.90E-04 | 7.13E-07 | 8.35E-05 | 6.56E-06 |
| HT-ce | CTUh | 2.20E-07 | 2.12E-07 | 8.79E-10 | 5.54E-09 | 8.97E-10 |
| HT-nce | CTUh | 7.34E-07 | 6.32E-07 | 1.66E-11 | 9.76E-08 | 2.77E-09 |
| IR-E (interim) | CTUe | 1.18E-07 | 5.95E-08 | 1.24E-08 | 2.16E-08 | 1.28E-08 |
| IR-HH | kBq U235 eq | 2.16E-02 | 1.66E-02 | 9.90E-04 | 1.85E-03 | 1.14E-03 |
| LU | kg C deficit | 5.38E-01 | 5.07E-01 | 2.90E-03 | 1.61E-02 | 1.02E-02 |
| EM | kg N eq | 5.05E-04 | 4.10E-04 | 3.05E-05 | 4.15E-05 | 7.37E-06 |
| MF&RRD | kg Sb eq | 6.75E-04 | 6.40E-04 | 3.64E-08 | 2.59E-05 | 9.17E-06 |
| OD | kg CFC-11 eq | 1.85E-08 | 1.71E-08 | 1.83E-12 | 1.37E-09 | 7.03E-12 |
| PM | kg PM2.5 eq | 3.42E-04 | 2.90E-04 | 5.35E-06 | 3.70E-05 | 1.25E-05 |
| POF | kg NMVOC eq | 5.88E-04 | 3.81E-04 | 7.65E-05 | 7.97E-05 | 2.36E-05 |
| ET | molc N eq | 9.10E-03 | 8.32E-03 | 2.83E-04 | 2.25E-04 | 1.12E-04 |
| WRD | m3 water eq | 1.28E-03 | 2.84E-07 | 1.61E-07 | 9.87E-08 | 4.28E-08 |

### 6.3.1. Normalised and weighted results

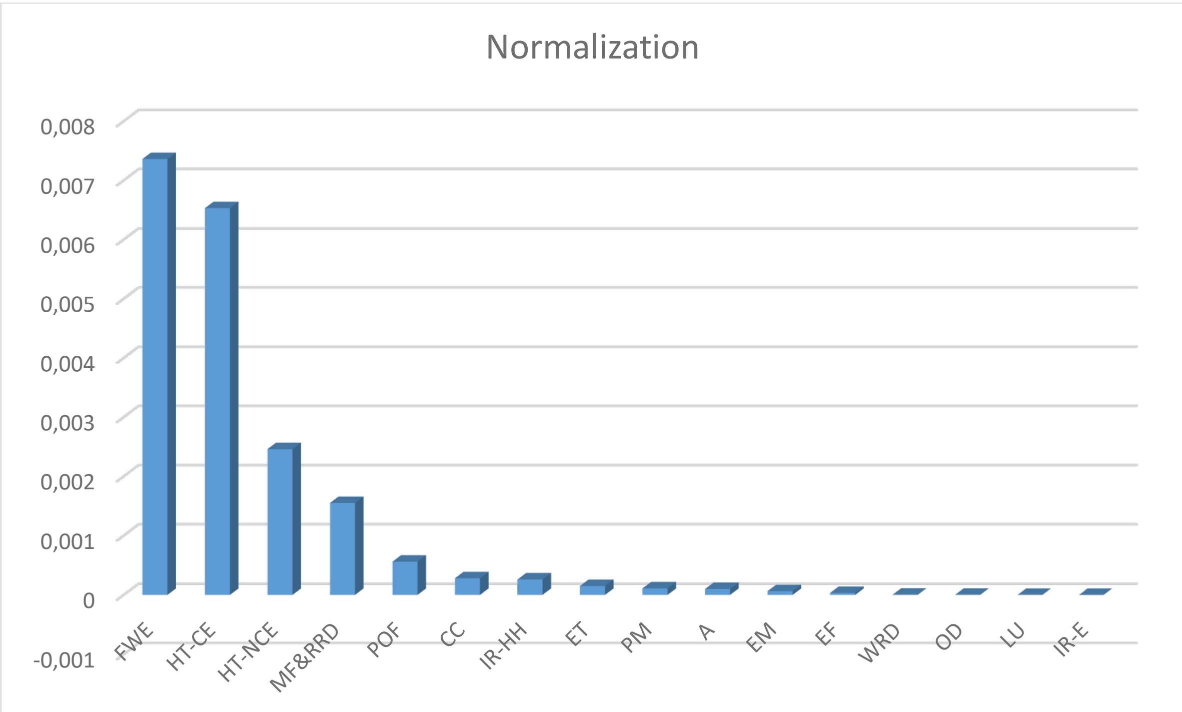
In the tables below are reported normalized and weighted results.

In order to determine which of the 16 impact categories are most relevant in this analysis, the results were normalized against global emission using the normalization factor EC-JRC Global, equal weighting of IPCC 2011.

TABLE 43: NORMALIZED RESULTS – VIVA AVERAGE SPARKLING WINE

| **Normalization** | | |
|---|---|---|
| **Impact category** | | **Amount** |
| **Freshwater ecotoxicity - ILCD 2011 Midpoint+** | FWE | 7.36E-03 |
| **Human toxicity, cancer effects - ILCD 2011 Midpoint+** | HT-CE | 6.53E-03 |
| **Human toxicity, non-cancer effects - ILCD 2011 Midpoint+** | HT-NCE | 2.46E-03 |
| **Mineral, fossil & ren resource depletion - ILCD 2011 Midpoint+** | MF&RRD | 1.55E-03 |
| **Photochemical ozone formation - ILCD 2011 Midpoint+** | POF | 5.60E-04 |
| **Ionizing radiation HH - ILCD 2011 Midpoint+** | CC | 2.80E-04 |
| **Climate change - IPCC 2013 GWP 100°** | IR-HH | 2.60E-04 |
| **Particulate matter - ILCD 2011 Midpoint+** | ET | 1.50E-04 |
| **Terrestrial eutrophication - ILCD 2011 Midpoint+** | PM | 1.10E-04 |
| **Acidification - ILCD 2011 Midpoint+** | A | 1.00E-04 |
| **Marine eutrophication - ILCD 2011 Midpoint+** | EM | 6.31E-05 |
| **Freshwater eutrophication - ILCD 2011 Midpoint+** | EF | 3.25E-05 |
| **Ozone depletion - ILCD 2011 Midpoint+** | WRD | 2.68E-06 |
| **Water resource depletion - ILCD 2011 Midpoint+** | OD | 1.75E-06 |
| **Ionizing radiation E (interim) - ILCD 2011 Midpoint+** | LU | 0.00E+00 |
| **Land use - ILCD 2011 Midpoint+** | IR-E | -1.40E-06 |

FIGURE 9: NORMALIZED RESULTS – VIVA AVERAGE SPARKLING WINE




Normalized output of sparkling wine production are shown in Figure 9, as frequently encountered in viticulture study, the most relevant impact category are those related to toxicity followed by resource depletion, POF and CC.

TABLE 44: WEIGHTED RESULT – VIVA AVERAGE SPARKLING WINE

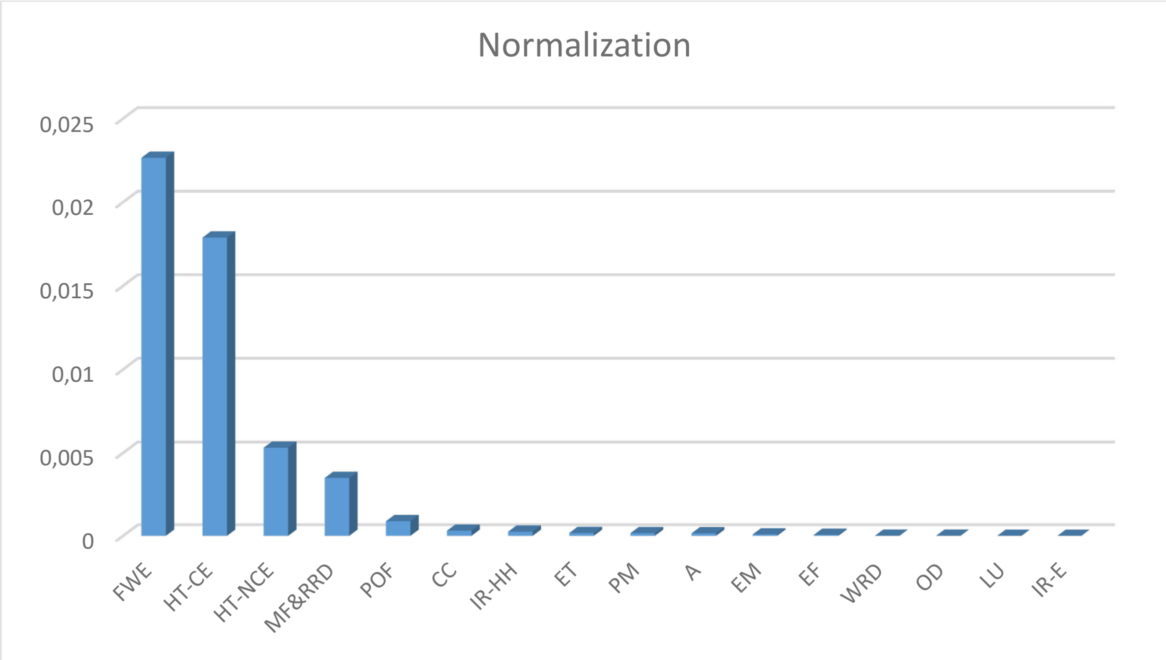
| Weighting | | | |
|---|---|---|---|
| **Impact category** | **Unit** | **Amount** | **Unit** |
| **Mineral, fossil & ren resource depletion - ILCD 2011 Midpoint+** | MF&RRD | 2.64E-02 | Pt |
| **Climate change - IPCC 2013 GWP 100°** | CC | 5.67E-03 | Pt |
| **Photochemical ozone formation - ILCD 2011 Midpoint+** | POF | 2.84E-03 | Pt |
| **Ionizing radiation HH - ILCD 2011 Midpoint+** | IR-HH | 1.51E-03 | Pt |
| **Particulate matter - ILCD 2011 Midpoint+** | PM | 1.45E-03 | Pt |
| **Acidification - ILCD 2011 Midpoint+** | A | 6.90E-04 | Pt |
| **Terrestrial eutrophication - ILCD 2011 Midpoint+** | ET | 4.20E-04 | Pt |
| **Marine eutrophication - ILCD 2011 Midpoint+** | EM | 2.00E-04 | Pt |
| **Freshwater eutrophication - ILCD 2011 Midpoint+** | EF | 9.58E-05 | Pt |
| **Ozone depletion - ILCD 2011 Midpoint+** | OD | 1.81E-05 | Pt |
| **Water resource depletion - ILCD 2011 Midpoint+** | WRD | 1.58E-05 | Pt |
| **Human toxicity, cancer effects - ILCD 2011 Midpoint+** | HT-CE | 0.00E+00 | Pt |
| **Freshwater ecotoxicity - ILCD 2011 Midpoint+** | FWE | 0.00E+00 | Pt |
| **Ionizing radiation E (interim) - ILCD 2011 Midpoint+** | IR-E | 0.00E+00 | Pt |
| **Human toxicity, non-cancer effects - ILCD 2011 Midpoint+** | HT-NCE | 0.00E+00 | Pt |
| **Land use - ILCD 2011 Midpoint+** | LU | -1.20E-05 | Pt |

Using the weighing factors proposed by Wine PEFCR – annex I, the most relevant impact categories for sparkling wines are: MF&RRD; CC; POF; IR-HH and PM. The toxicity Impact categories, due to inconsistencies related to the method are for the moment excluded and have a weighting factor equal to 0.

TABLE 45: NORMALIZED RESULTS – VIVA AVERAGE STILL WINE

| Normalization | | |
|---|---|---|
| **Impact category** | | **Amount** |
| **Freshwater ecotoxicity - ILCD 2011 Midpoint+** | FWE | 2.27E-02 |
| **Human toxicity, cancer effects - ILCD 2011 Midpoint+** | HT-CE | 1.79E-02 |
| **Human toxicity, non-cancer effects - ILCD 2011 Midpoint+** | HT-NCE | 5.31E-03 |
| **Mineral, fossil & ren resource depletion - ILCD 2011 Midpoint+** | MF&RRD | 3.49E-03 |
| **Photochemical ozone formation - ILCD 2011 Midpoint+** | POF | 8.80E-04 |
| **Climate change - IPCC 2013 GWP 100°** | CC | 3.10E-04 |
| **Ionizing radiation HH - ILCD 2011 Midpoint+** | IR-HH | 2.50E-04 |
| **Terrestrial eutrophication - ILCD 2011 Midpoint+** | ET | 1.70E-04 |
| **Particulate matter - ILCD 2011 Midpoint+** | PM | 1.60E-04 |
| **Acidification - ILCD 2011 Midpoint+** | A | 1.50E-04 |
| **Marine eutrophication - ILCD 2011 Midpoint+** | EM | 8.36E-05 |
| **Freshwater eutrophication - ILCD 2011 Midpoint+** | EF | 5.73E-05 |
| **Water resource depletion - ILCD 2011 Midpoint+** | WRD | 3.80E-06 |
| **Ozone depletion - ILCD 2011 Midpoint+** | OD | 1.83E-06 |
| **Land use - ILCD 2011 Midpoint+** | LU | 9.43E-08 |
| **Ionizing radiation E (interim) - ILCD 2011 Midpoint+** | IR-E | 0 |

FIGURE 10: NORMALIZED RESULTS – VIVA AVERAGE STILL WINE




Normalized output of still wine production are shown in Figure 10, as frequently encountered in viticulture study, the most relevant impact category are those related to toxicity followed by resource depletion, POF and CC. Following the weighting

TABLE 46: WEIGHTED RESULT – VIVA AVERAGE STILL WINE

| **Weighting** | | | |
|---|---|---|---|
| **Impact category** | | **Amount** | **Unit** |
| **Mineral, fossil & ren resource depletion - ILCD 2011 Midpoint+** | MF&RRD | 5.94E-02 | Pt |
| **Climate change - IPCC 2013 GWP 100°** | CC | 6.89E-03 | Pt |
| **Photochemical ozone formation - ILCD 2011 Midpoint+** | POF | 4.46E-03 | Pt |
| **Particulate matter - ILCD 2011 Midpoint+** | PM | 1.54E-03 | Pt |
| **Ionizing radiation HH - ILCD 2011 Midpoint+** | IR-HH | 1.34E-03 | Pt |
| **Acidification - ILCD 2011 Midpoint+** | A | 9.80E-04 | Pt |
| **Terrestrial eutrophication - ILCD 2011 Midpoint+** | ET | 6.60E-04 | Pt |
| **Marine eutrophication - ILCD 2011 Midpoint+** | EM | 2.60E-04 | Pt |
| **Freshwater eutrophication - ILCD 2011 Midpoint+** | EF | 1.70E-04 | Pt |
| **Water resource depletion - ILCD 2011 Midpoint+** | WRD | 3.43E-05 | Pt |
| **Ozone depletion - ILCD 2011 Midpoint+** | OD | 1.24E-05 | Pt |
| **Land use - ILCD 2011 Midpoint+** | LU | 7.94E-07 | Pt |
| **Human toxicity, cancer effects - ILCD 2011 Midpoint+** | HT-CE | 0 | Pt |
| **Freshwater ecotoxicity - ILCD 2011 Midpoint+** | FWE | 0 | Pt |
| **Ionizing radiation E (interim) - ILCD 2011 Midpoint+** | IR-E | 0 | Pt |
| **Human toxicity, non-cancer effects - ILCD 2011 Midpoint+** | HT-NCE | 0 | Pt |

Using the weighing factors proposed by Wine PEFCR – annex I, the most relevant impact categories for still wines are: MF&RRD; CC; POF; PM and IR-HH. The toxicity Impact categories, due to inconsistencies related to the method are for the moment excluded and have a weighting factor equal to 0.

### 6.3.2. Interpretation

#### *6.3.2.1. Most relevant life cycle phases*

TABLE 47: MOST RELEVANT LIFE CYCLE PHASES – VIVA AVERAGE SPARKLING WINE

| Impact Category | Unit | Vineyard | Vinery | Packaging | Transport | End of life |
|---|---|---|---|---|---|---|
| A | molc H+ eq | 29.44% | 38.53% | 49.99% | 0.81% | -27.95% |
| CC | kg CO2 eq | 9.58% | 52.73% | 43.69% | 5.03% | -19.85% |
| FWE | CTUe | 9.67% | -0.07% | 0.42% | 0.04% | -0.85% |
| EF | kg P eq | 67.07% | -0.72% | 2.57% | 0.16% | -5.39% |
| HT-ce | CTUh | 107.04% | -1.89% | 5.15% | 0.45% | -10.76% |
| HT-nce | CTUh | 87.52% | 2.25% | 9.82% | 1.31% | -7.24% |
| IR-E (interim) | CTUe | 10.18% | 65.90% | 113.43% | 0.38% | -89.89% |
| IR-HH | kBq U235 eq | 16.67% | 55.70% | 106.76% | 0.44% | -79.59% |
| LU | kg C deficit | -3.40% | -3.06% | 105.94% | -0.02% | 0.54% |
| EM | kg N eq | 13.27% | 45.55% | 17.85% | 8.35% | -9.24% |
| MF&RRD | kg Sb eq | 100.24% | -0.11% | 3.43% | 0.00% | -2.72% |
| OD | kg CFC-11 eq | 39.64% | 0.52% | 1.75% | 0.00% | -2.67% |
| PM | kg PM2.5 eq | 27.25% | 56.23% | 27.72% | 1.51% | -15.98% |
| POF | kg NMVOC eq | 10.50% | 64.56% | 33.50% | 11.32% | -19.86% |
| ET | molc N eq | 23.21% | 36.66% | 36.12% | 0.88% | -10.21% |
| WRD | m3 water eq | 1283.60% | -545.95% | 22.70% | 0.05% | -659.49% |

TABLE 48: MOST RELEVANT LIFE CYCLE PHASES VINEYARD FOCUS – VIVA AVERAGE SPARKLING WINE

| Impact Category | Unit | Grafted Vine | Pesticide | Fertilizers | Waste |
|---|---|---|---|---|---|
| A | molc H+ eq | 41.72% | 2.70% | 11.88% | 2.74% |
| CC | kg CO2 eq | 28.53% | 2.64% | 4.40% | 2.37% |
| FWE | CTUe | 75.20% | 0.59% | 21.65% | 0.92% |
| EF | kg P eq | 57.87% | 0.33% | 37.68% | 3.34% |
| HT-ce | CTUh | 92.84% | 0.60% | 3.82% | 0.64% |
| HT-nce | CTUh | 80.83% | 2.14% | 15.24% | 0.55% |
| IR-E (interim) | CTUe | 12.43% | 0.00% | 13.66% | 5.14% |
| IR-HH | kBq U235 eq | 26.24% | 0.81% | 7.13% | 3.37% |
| LU | kg C deficit | 45.14% | 0.41% | 2.70% | 1.20% |
| EM | kg N eq | 31.35% | 3.20% | 8.07% | 1.03% |
| MF&RRD | kg Sb eq | 92.72% | 0.01% | 5.01% | 1.84% |
| OD | kg CFC-11 eq | 28.42% | 0.00% | 21.32% | 0.02% |
| PM | kg PM2.5 eq | 31.56% | 0.84% | 5.80% | 3.00% |
| POF | kg NMVOC eq | 23.68% | 6.74% | 9.00% | 2.53% |
| ET | molc N eq | 48.29% | 2.29% | 2.46% | 1.61% |
| WRD | m3 water eq | 0.01% | 0.00% | 0.01% | 0.00% |

TABLE 49: MOST RELEVANT LIFE CYCLE PHASES – VIVA AVERAGE STILL WINE

| Impact Category | Unit | Vineyard | Vinery | Packaging | Transport | End of life |
|---|---|---|---|---|---|---|
| A | molc H+ eq | 43.50% | 16.07% | 23.65% | 20.98% | -12.95% |
| CC | kg CO2 eq | 15.96% | 55.26% | 27.51% | 9.44% | -11.13% |
| FWE | CTUe | 5.83% | 0.15% | 0.10% | 0.04% | -0.18% |
| EF | kg P eq | 75.95% | 0.00% | 1.18% | 0.33% | -2.52% |
| HT-ce | CTUh | 99.43% | 1.32% | 1.66% | 0.72% | -3.14% |
| HT-nce | CTUh | 89.16% | 2.17% | 3.48% | 2.28% | -2.12% |
| IR-E (interim) | CTUe | 20.85% | 68.31% | 86.22% | 1.60% | -76.97% |
| IR-HH | kBq U235 eq | 35.81% | 48.41% | 74.23% | 1.54% | -59.93% |
| LU | kg C deficit | 109.67% | -2.72% | -0.99% | 1.04% | -6.99% |
| EM | kg N eq | 19.30% | 22.61% | 10.55% | 33.33% | -4.32% |
| MF&RRD | kg Sb eq | 100.72% | -0.75% | 1.10% | 0.01% | -0.88% |
| OD | kg CFC-11 eq | 82.96% | 17.97% | 1.70% | 0.01% | -2.63% |
| PM | kg PM2.5 eq | 56.03% | 4.34% | 19.81% | 29.43% | -10.13% |
| POF | kg NMVOC eq | 12.61% | 29.85% | 16.13% | 50.07% | -8.59% |
| ET | molc N eq | 32.10% | 13.96% | 12.80% | 33.13% | -3.70% |
| WRD | m3 water eq | 492.52% | -82.98% | 11.76% | 0.07% | -323.48% |

TABLE 50: MOST RELEVANT LIFE CYCLE PHASES VINEYARD FOCUS – VIVA AVERAGE STILL WINE

| Impact Category | Unit | Grafted Vine | Pesticide | Fertilizers | Waste |
|---|---|---|---|---|---|
| A | molc H+ eq | 76.88% | 3.40% | 16.17% | 2.92% |
| CC | kg CO2 eq | 82.41% | 6.87% | 5.26% | 3.27% |
| FWE | CTUe | 84.13% | 0.42% | 14.47% | 0.64% |
| EF | kg P eq | 67.67% | 0.25% | 29.71% | 2.33% |
| HT-ce | CTUh | 96.15% | 0.40% | 2.52% | 0.41% |
| HT-nce | CTUh | 86.13% | 0.00% | 13.30% | 0.38% |
| IR-E (interim) | CTUe | 50.38% | 10.53% | 18.28% | 10.87% |
| IR-HH | kBq U235 eq | 77.20% | 4.59% | 8.56% | 5.29% |
| LU | kg C deficit | 94.19% | 0.54% | 3.00% | 1.89% |
| EM | kg N eq | 81.22% | 6.03% | 8.22% | 1.46% |
| MF&RRD | kg Sb eq | 94.85% | 0.01% | 3.83% | 1.36% |
| OD | kg CFC-11 eq | 92.46% | 0.01% | 7.39% | 0.04% |
| PM | kg PM2.5 eq | 84.81% | 1.56% | 10.80% | 3.66% |
| POF | kg NMVOC eq | 64.79% | 13.02% | 13.55% | 4.02% |
| ET | molc N eq | 91.42% | 3.11% | 2.48% | 1.23% |
| WRD | m3 water eq | 0.02% | 0.01% | 0.01% | 0.00% |

The results obtained from the study confirmed with evidence that the main environmental load in the Wine production is related to the grape production at the vineyard, some impact of the winery and to packaging production for both Sparkling and Still wines(Table 47 and Table 49).

Looking the focus on the Vineyard Phase (Table 48 and Table 50) the main environmental load are related to the production of grafted wine and to the use of Fertilizers for both Sparkling and Still Wines.

Taking as reference the impact on CC the most relevant life cycle stages reported in the Wine PEFCR are: Sparkling Wines:

a) CC: Packaging 41%; grape production 13% and wine making 15%

Still Wines:

a) CC: Packaging 32%; grape production 20% and wine making 20%

Looking at the result of VIVA sparkling wines the Grape production stage count for less than 10%, this factor is a little bit less than the PEFCR average and can be explained due to the really high medium yields o VIVA sparkling products. Result of still product also lower (16% compared to 20%) and this result can be related to the less consumed input at the vineyard reported in the comparison with bibliographic data. Regarding packaging Sparkling VIVA product have a higher impact on packaging (44%) and a very higher impact on wine production phase (53%). Regarding Still products, the impact on packaging is 27.51% and the impact on wine production phase is (55 %). In both cases the strange result is related to the Vinery phase.

Looking to Figure 12 and Figure 17, those results are related to thermal energy and electricity grid mix impacts. This difference can be related to the fact that Italian mix have lower Nuclear energy compared with the European average mix. A comparison with European mean inventory data is unfortunately not possible.

Impact of the vineyard stage related to Grafted wine phase is really high and the data varies from 50.38% to 96.15% depending from the impact category. This value is extremely high compared from the one declared in the PEFCR (22%). The process used was the one issued by JRC, this big difference was reported to the IMELS for further investigations.

#### 6.3.2.2. *Most relevant life cycle processes*

FIGURE 11: MINERAL, FOSSIL & REN RESOURCE DEPLETION – MOST RELEVANT PROCESSES – SPARKLING WINE

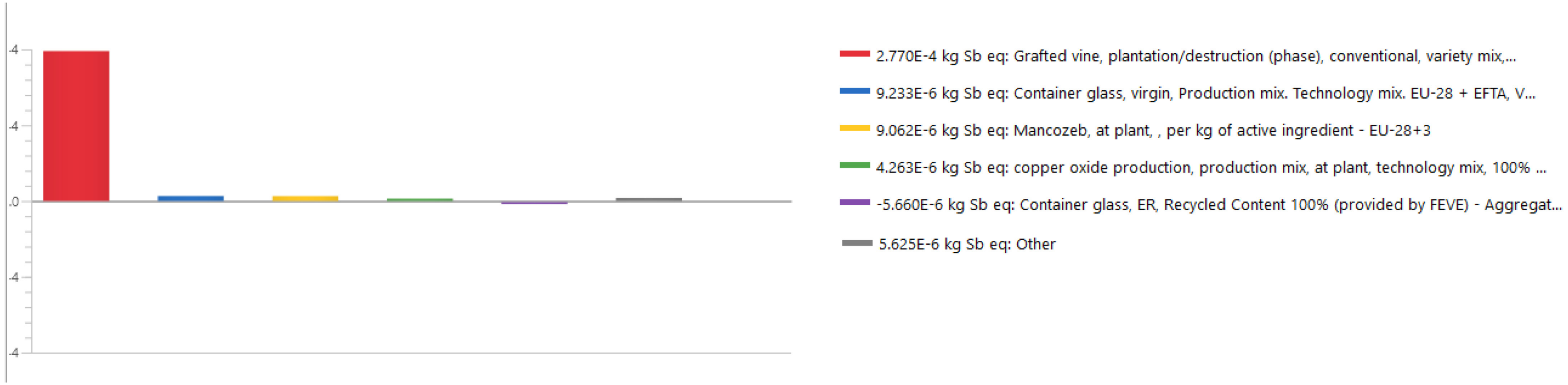



FIGURE 12: CLIMATE CHANGE – MOST RELEVANT PROCESSES – SPARKLING WINE

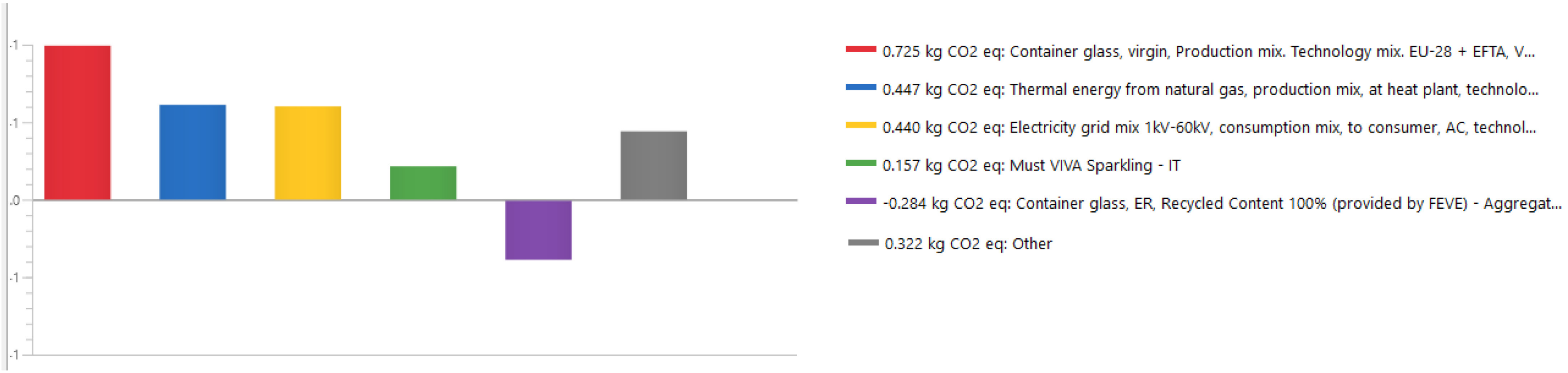


FIGURE 13: PARTICULATE MATTER - MOST RELEVANT PROCESSES – SPARKLING WINE

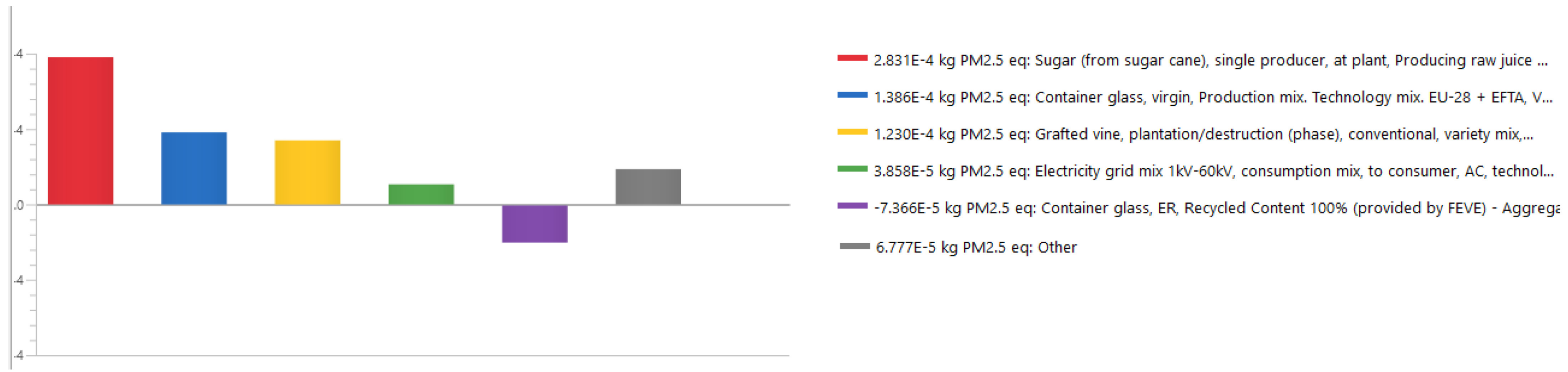



FIGURE 14: PHOTOCHEMICAL OZONE FORMATION – MOST RELEVANT PROCESSES – SPARKLING WINES

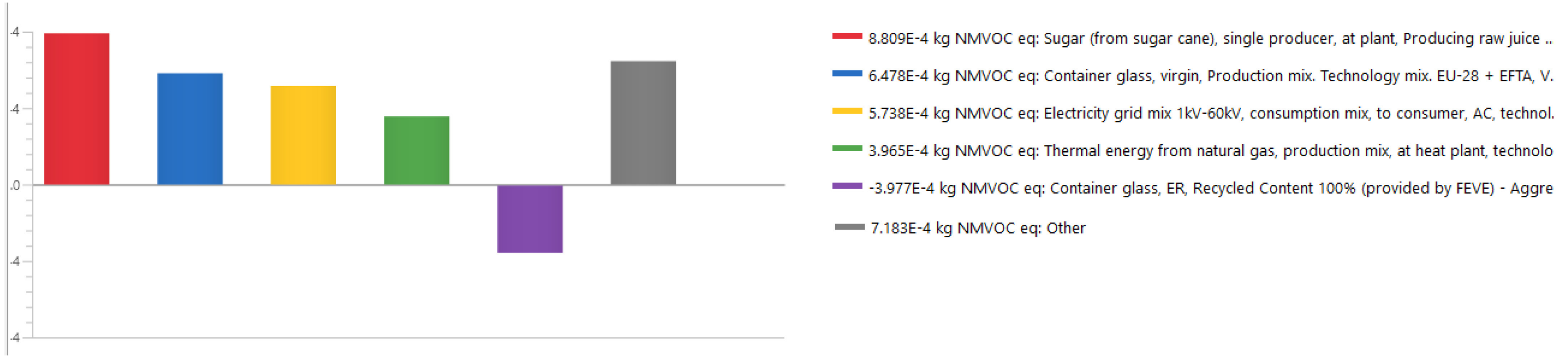


FIGURE 15: ACIDIFICATION – MOST RELEVANT PROCESSES – SPARKLING WINE

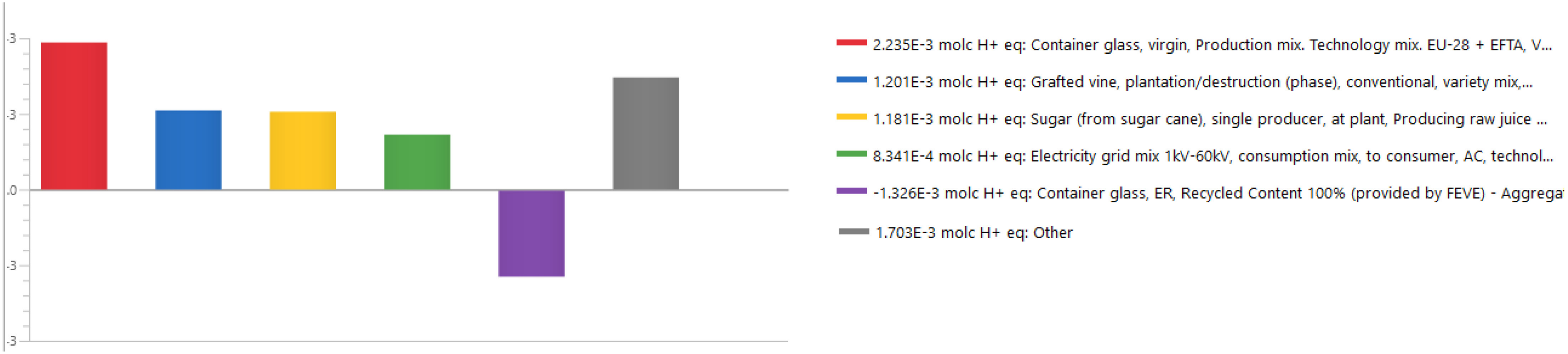



FIGURE 16: MINERAL, FOSSIL & REN RESOURCE DEPLETION – MOST RELEVANT PROCESSES – STILL WINE

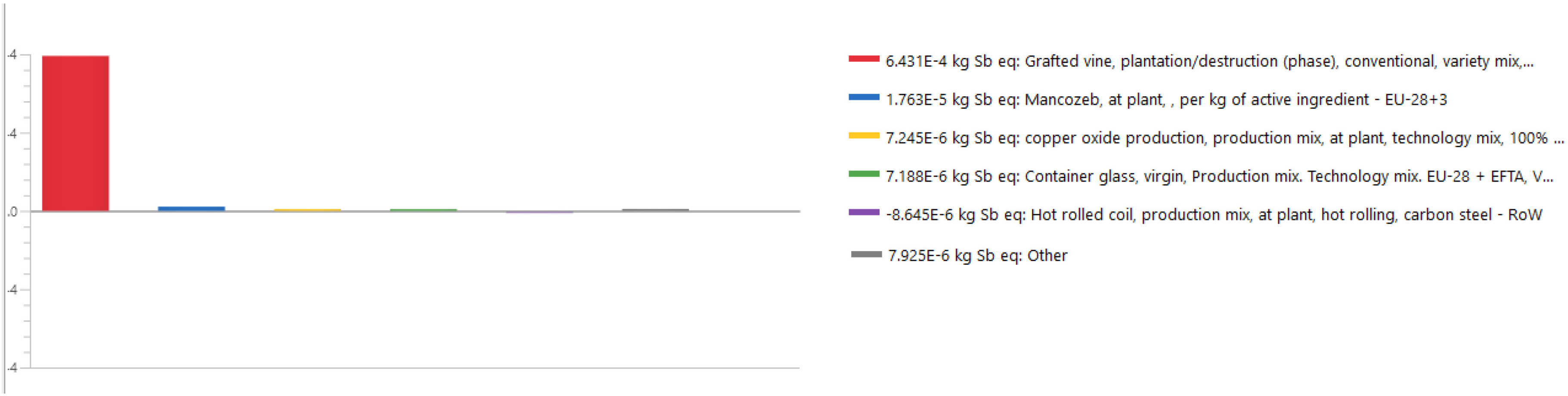


FIGURE 17: CLIMATE CHANGE – MOST RELEVANT PROCESSES – STILL WINE

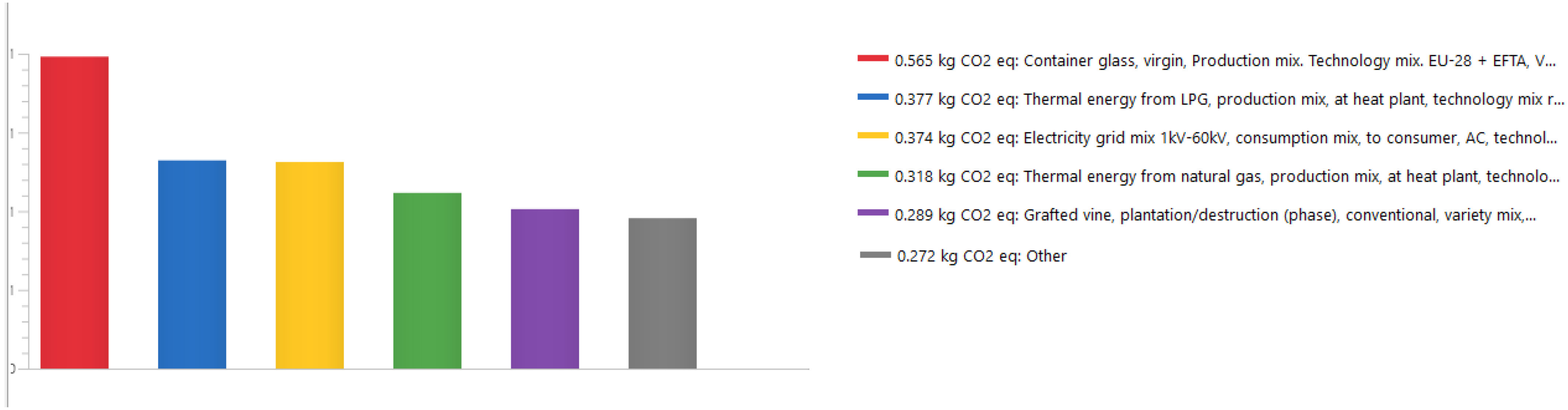



FIGURE 18: PARTICULATE MATTER - MOST RELEVANT PROCESSES – STILL WINE

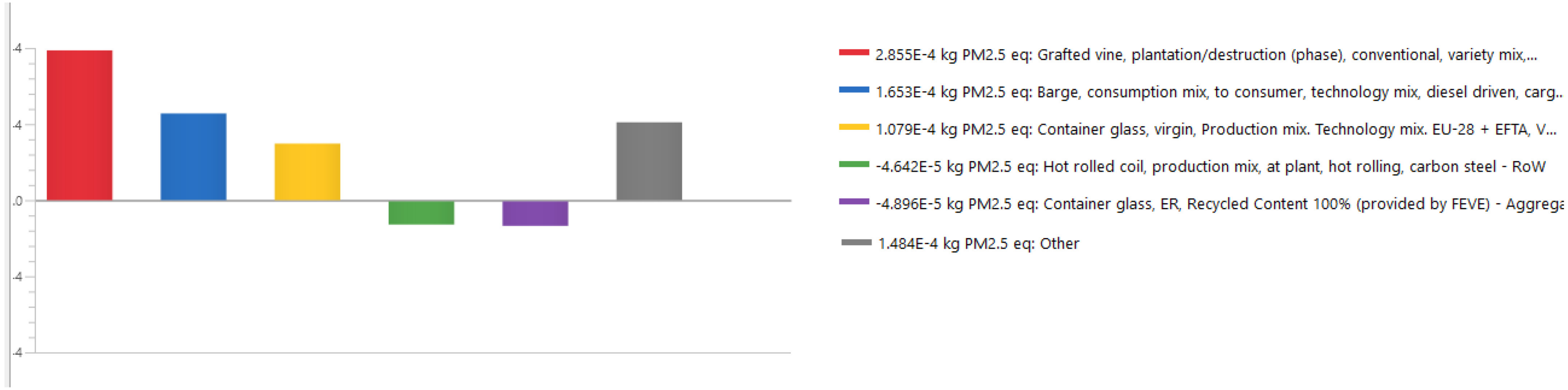


FIGURE 19: PHOTOCHEMICAL OZONE FORMATION – MOST RELEVANT PROCESSES – STILL WINE

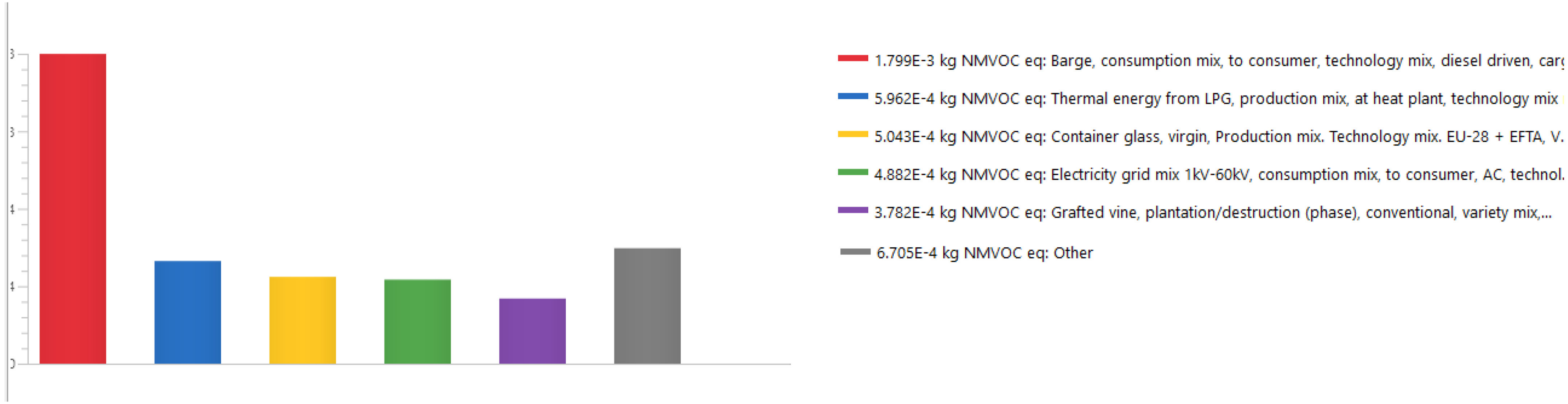
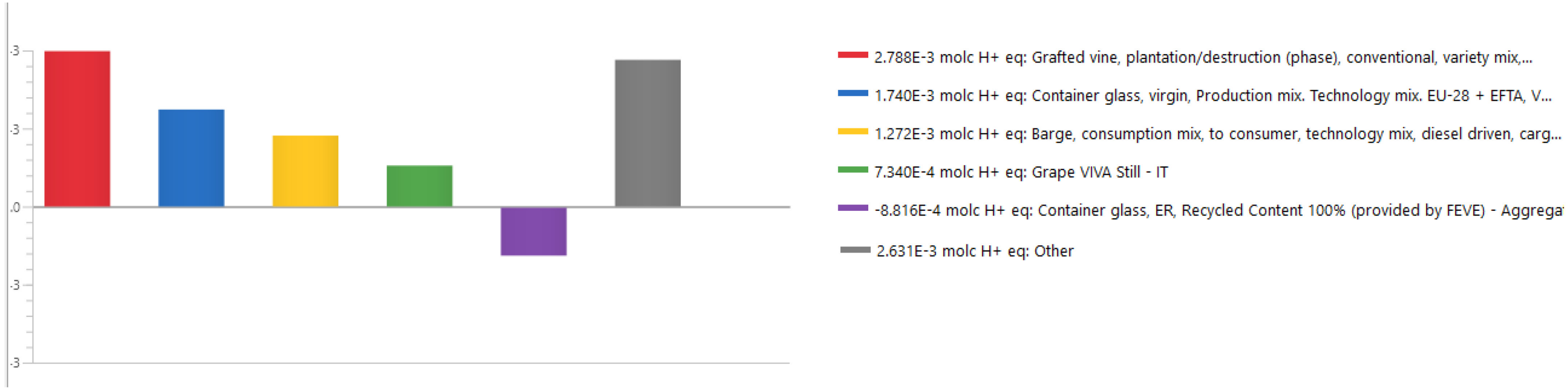



FIGURE 20: ACIDIFICATION – MOST RELEVANT PROCESSES – STILL WINE



Observing the graphs of the most relevant impact categories (citation), we see how the processes that most influence the final result are:

For Sparkling Wines:

i. Container Glass Virgin Production;
ii. Electricity Grid Mix;
iii. Grafted vine, Plantation/Destruction;
iv. Sugar from Sugar Cane (abnormal value to be checked).

For Still Wines:

i. Container Glass Virgin Production;
ii. Thermal Energy from LPG and Natural Gas;
iii. Grafted vine, Plantation/Destruction;
iv. Barge Transport, Consumption mix to consumer.

The production of Glass, as Italy has repeatedly pointed out in Europe, is a substantial process that largely influences the final result not only with regard to Climate Change, but also the cultivation of the rooted vines and the establishment of the vineyard them have a significant effect. For a more accurate study it will be useful in the future to collect primary data about this particular phase.

### 6.3.3. Data quality Assessment

As reported in the section 5.6 of the Commission Recommendation 2013/179/UE (European Commission, 2013d), data quality requirements shall be met by PEF studies intended for external communication, i.e. B2B and B2C. For PEF studies (claiming to be in line with this PEF Guide) intended for in-house applications, the specified data quality requirements should be met (i.e. are recommended), but are not mandatory.

The overall data quality shall be calculated by summing up the achieved quality rating for each of the quality criteria, divided by the total number of criteria (four). The Data Quality Rating (DQR) result is used to identify the corresponding analysis quality level:

- TeR: Technological Representativeness;
- GR: Geographical Representativeness;
- TiR: Time-related Representativeness;
- P: Precision/uncertainty.

$$DQR = \frac{TeR + GR + TiR + P}{4}$$

The Data Quality Rating (DQR) shall correspond to a data quality level defined as follows:

- overall data quality rating (DQR) from 1.6: excellent quality;
- overall data quality rating (DQR) from 1.6 to 2.0: very good quality;
- overall data quality rating (DQR) from 2.0 to 3.0: good quality;
- overall data quality rating (DQR) from 3.0 to 4.0: fair quality;
- overall data quality rating (DQR) > 4.0: poor quality.

To be PEF compliant, the score of P cannot be higher than 3 while the score for TiR, TeR, and GR cannot be higher than 2 (the DQR score shall be ≤1.6).
As already mentioned this report is for in-house application, the DQR analysis is shown below

TABLE 51: DATA QUALITY ASSESSEMENT – SPARKLING WINES

| Activity data | TiR-AD | P-AD | TeR-SD | Gr-SD | TiR-SD | DQ | %LCIA | DQ final |
|---|---|---|---|---|---|---|---|---|
| ***Vineayard*** | | | | | | | | |
| **Grape production** | 3.15 | 3 | 1 | 2 | 1 | 1.77 | 29.23% | 0.5170056 |
| ***Winery*** | | | | | | | | |
| **Wine production** | 3.15 | 3 | 2 | 2 | 1 | 2.02 | 28.25% | 0.5702969 |
| **Packaging** | 3.15 | 3 | 2 | 2 | 1 | 2.02 | 33.79% | 0.6821356 |
| **Total** | | | | | | | | **1.7694381** |

TABLE 52: DATA QUALITY ASSESSEMNT – STILL WINES

| Activity data | TiR-AD | P-AD | TeR-SD | Gr-SD | TiR-SD | DQ | %LCIA | DQ final |
|---|---|---|---|---|---|---|---|---|
| ***Vineayard*** | | | | | | | | |
| **Grape production** | 3.15 | 3 | 1 | 2 | 1 | 1.77 | 53.14% | 0.9399138 |
| ***Winery*** | | | | | | | | |
| **Wine production** | 3.15 | 3 | 2 | 2 | 1 | 2.02 | 18.64% | 0.376295 |
| **Packaging** | 3.15 | 3 | 2 | 2 | 1 | 2.02 | 17.06% | 0.3443988 |
| **Total** | | | | | | | | **1.6606075** |

## 6.4. Comparison of VIVA products with the European benchmark

In the tables below are reported the table with the comparison between the VIVA average product, the VIVA wines and the European Benchmark.

TABLE 53: SPARKLING WINE COMPARISON

| | | Unit | QUALITY | A | CC | EF | IR-HH | LU | EM | MF&RRD | OD | PM | POF | ET | WRD | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | P5W7SPARK | Pt | HQ | 9.70E-04 | 7.47E-03 | 2.30E-04 | 2.16E-03 | -9.98E-06 | 2.40E-04 | 5.23E-02 | 8.77E-06 | 1.90E-03 | 3.58E-03 | 5.70E-04 | 8.36E-06 | **6.94E-02** |
| 2 | Benchmark PEF | Pt | | 1.02E-03 | 6.73E-03 | 5.78E-05 | 4.90E-03 | 6.15E-06 | 3.70E-04 | 3.08E-02 | 1.57E-05 | 1.18E-03 | 3.50E-04 | 4.90E-04 | 2.15E-06 | 4.59E-02 |
| 3 | P1W1SPARK | Pt | MQ | 5.20E-04 | 6.15E-03 | 8.11E-05 | 1.30E-03 | -1.04E-05 | 9.73E-05 | 3.17E-02 | 2.85E-05 | 7.60E-04 | 2.03E-03 | 2.90E-04 | -2.90E-04 | **4.26E-02** |
| 4 | P1W2SPARK | Pt | MQ | 5.60E-04 | 6.13E-03 | 7.64E-05 | 1.28E-03 | -1.04E-05 | 1.40E-04 | 2.99E-02 | 2.74E-05 | 7.70E-04 | 2.01E-03 | 3.30E-04 | -2.90E-04 | **4.10E-02** |
| 5 | Benchmark VIVA | Pt | | 6.90E-04 | 5.67E-03 | 9.58E-05 | 1.51E-03 | -1.15E-05 | 2.00E-04 | 2.64E-02 | 1.81E-05 | 1.45E-03 | 2.84E-03 | 4.20E-04 | 1.58E-05 | 3.93E-02 |
| 6 | P4W6SPARK | Pt | MQ | 4.30E-04 | 4.14E-03 | 5.00E-05 | 1.44E-03 | -1.42E-05 | 7.50E-05 | 3.01E-02 | 1.06E-05 | 6.70E-04 | 1.33E-03 | 2.50E-04 | 5.30E-04 | **3.90E-02** |
| 7 | P2W4SPARK | Pt | MQ | 5.90E-04 | 4.93E-03 | 9.80E-05 | 1.23E-03 | -1.39E-05 | 1.80E-04 | 2.04E-02 | 1.98E-05 | 6.80E-04 | 2.35E-03 | 4.30E-04 | 2.10E-04 | **3.11E-02** |
| 8 | P2W3SPARK | Pt | MQ | 5.20E-04 | 4.84E-03 | 9.95E-05 | 1.59E-03 | -1.39E-05 | 1.40E-04 | 2.02E-02 | 1.98E-05 | 6.90E-04 | 1.60E-03 | 3.20E-04 | 2.50E-04 | **3.02E-02** |
| 9 | P3W5SPARK | Pt | MQ | 5.00E-04 | 4.51E-03 | 9.95E-05 | 1.43E-03 | -9.83E-06 | 1.30E-04 | 2.01E-02 | 1.98E-05 | 6.60E-04 | 1.52E-03 | 3.00E-04 | 2.30E-04 | **2.95E-02** |

In Table 53 and Table 54 the FEW, HT-CE, HT-NCE and IR-E impact categories have a weighting factor equal to 0 and so as reported in the PEFCR to ensure consistency were excluded from this table.

Table 53 shows the results of sparkling wines, the analysed wines and the average sparkling wine are very well positioned compared to the European average. The possible explanations are that the impact related to the vineyard stage is lower compared to the European average for W1, W2, W3, W4, W5 and W6. That because the vineyard yields are really high (between 113 q and 184 q) compared to bibliographic data.

As we can see product W7, classified as High Quality Wine (HQ) have significantly lower yields (84.7 q) and it is a wine that has higher energy consumption in the cellar due to longer storage with a considerably heavier bottle (833 grams). This product perform the worst compared to the others.

Another important issue is related to the use of glass as packaging. Even if VIVA Still products use heavy bottles, the average European product use also glass packaging therefore a comparison is fair.

Looking the result of the 2 benchmark reported the European one performs particularly worst on A, IR-HH, and EM. Value related EM are probably related to the higher yields of the VIVA analysed sparkling wines. While results of IR-HH are related to the lower presence of Nuclear Energy in the Italian Mix.

TABLE 54: STILL WINE COMPARISON

| | | Unit | QUALITY | A | CC | EF | IR-HH | LU | EM | MF&RRD | OD | PM | POF | ET | WRD | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | P8W17STILL | Pt | MQ | 2.48E-03 | 1.37E-02 | 2.70E-04 | 1.76E-03 | 1.63E-06 | 8.90E-04 | 1.11E-01 | 1.85E-05 | 4.53E-03 | 1.61E-02 | 2.10E-03 | 2.30E-04 | **1.53E-01** |
| 2 | P10W19STILL | Pt | MQ | 3.47E-03 | 5.50E-02 | 9.30E-04 | 2.57E-02 | -6.80E-04 | 7.20E-04 | 4.72E-02 | 8.99E-06 | 4.20E-03 | 2.30E-02 | 1.82E-03 | 2.70E-04 | **1.62E-01** |
| 3 | P6W15STILL | Pt | HQ | 8.50E-04 | 4.90E-03 | 2.10E-04 | 1.56E-03 | 9.94E-07 | 1.90E-04 | 7.24E-02 | 1.23E-05 | 1.33E-03 | 2.75E-03 | 4.80E-04 | 4.10E-05 | **8.48E-02** |
| 4 | P12W27STILL | Pt | PQ | 8.80E-04 | 5.21E-03 | 1.10E-04 | 1.40E-03 | 9.76E-07 | 1.90E-04 | 6.98E-02 | 1.76E-05 | 1.50E-03 | 3.06E-03 | 5.90E-04 | 9.42E-05 | **8.28E-02** |
| 5 | P12W26STILL | Pt | HQ | 9.20E-04 | 5.45E-03 | 1.10E-04 | 1.40E-03 | 9.48E-07 | 2.10E-04 | 6.75E-02 | 1.73E-05 | 1.65E-03 | 3.91E-03 | 6.40E-04 | 9.59E-05 | **8.19E-02** |
| 6 | P5W9STILL | Pt | HQ | 1.00E-03 | 7.48E-03 | 2.80E-04 | 1.88E-03 | 7.91E-07 | 2.50E-04 | 5.94E-02 | 9.98E-06 | 1.61E-03 | 4.14E-03 | 6.40E-04 | 3.17E-05 | **7.67E-02** |
| 7 | P5W11STILL | Pt | HQ | 1.04E-03 | 7.57E-03 | 2.70E-04 | 1.82E-03 | 7.75E-07 | 2.70E-04 | 5.84E-02 | 9.79E-06 | 1.69E-03 | 4.63E-03 | 6.90E-04 | 2.41E-05 | **7.64E-02** |
| 8 | P11W20STILL | Pt | HQ | 8.20E-04 | 4.15E-03 | 9.64E-05 | 1.17E-03 | 9.02E-07 | 1.90E-04 | 6.47E-02 | 1.06E-05 | 1.36E-03 | 3.19E-03 | 5.90E-04 | 4.23E-06 | **7.62E-02** |
| 9 | P6W14STILL | Pt | HQ | 1.14E-03 | 5.48E-03 | 2.00E-04 | 1.57E-03 | 7.72E-07 | 3.30E-04 | 5.71E-02 | 9.67E-06 | 2.15E-03 | 7.00E-03 | 8.00E-04 | 6.81E-05 | **7.58E-02** |
| 10 | **Benchmark VIVA** | **Pt** | | **9.80E-04** | **6.89E-03** | **1.70E-04** | **1.34E-03** | **7.94E-07** | **2.60E-04** | **5.94E-02** | **1.24E-05** | **1.54E-03** | **4.46E-03** | **6.60E-04** | **3.43E-05** | 7.57E-02 |
| 11 | P12W22STILL | Pt | PQ | 9.80E-04 | 5.49E-03 | 1.00E-04 | 1.38E-03 | 8.44E-07 | 2.50E-04 | 6.03E-02 | 1.65E-05 | 1.68E-03 | 4.28E-03 | 7.00E-04 | 9.99E-05 | **7.53E-02** |
| 12 | P5W10STILL | Pt | MQ | 8.80E-04 | 6.72E-03 | 2.70E-04 | 1.78E-03 | 7.68E-07 | 2.10E-04 | 5.69E-02 | 9.61E-06 | 1.28E-03 | 3.16E-03 | 5.50E-04 | 5.86E-05 | **7.18E-02** |
| 13 | P12W21STILL | Pt | PQ | 8.20E-04 | 5.30E-03 | 9.45E-05 | 1.35E-03 | 7.82E-07 | 1.90E-04 | 5.62E-02 | 1.58E-05 | 1.46E-03 | 3.70E-03 | 5.60E-04 | 1.00E-04 | **6.98E-02** |
| 14 | P12W24STILL | Pt | PQ | 9.50E-04 | 5.47E-03 | 1.10E-04 | 1.41E-03 | 7.48E-07 | 2.40E-04 | 5.44E-02 | 1.61E-05 | 1.64E-03 | 4.26E-03 | 6.60E-04 | 1.00E-04 | **6.93E-02** |
| 15 | P5W12STILL | Pt | MQ | 8.20E-04 | 7.19E-03 | 2.30E-04 | 1.91E-03 | 6.68E-07 | 1.80E-04 | 5.24E-02 | 8.80E-06 | 1.22E-03 | 2.75E-03 | 4.90E-04 | 1.35E-05 | **6.72E-02** |
| 16 | P6W13STILL | Pt | HQ | 7.40E-04 | 4.92E-03 | 1.20E-04 | 1.65E-03 | 7.01E-07 | 1.90E-04 | 5.47E-02 | 9.60E-06 | 1.12E-03 | 2.99E-03 | 4.60E-04 | 8.49E-05 | **6.70E-02** |
| 17 | P12W23STILL | Pt | PQ | 1.07E-03 | 5.05E-03 | 8.84E-05 | 1.26E-03 | 7.19E-07 | 3.00E-04 | 5.30E-02 | 1.54E-05 | 1.48E-03 | 3.29E-03 | 8.10E-04 | 9.65E-05 | **6.64E-02** |
| 18 | P12W25STILL | Pt | PQ | 8.90E-04 | 5.37E-03 | 8.39E-05 | 1.34E-03 | 7.05E-07 | 2.30E-04 | 5.15E-02 | 1.51E-05 | 1.56E-03 | 4.17E-03 | 6.50E-04 | 1.00E-04 | **6.59E-02** |
| 19 | P5W8STILL | Pt | HQ | 7.30E-04 | 6.31E-03 | 2.20E-04 | 1.71E-03 | 6.03E-07 | 1.70E-04 | 4.59E-02 | 7.75E-06 | 1.04E-03 | 2.53E-03 | 4.40E-04 | 4.39E-05 | **5.91E-02** |
| 20 | P9W18STILL | Pt | MQ | 5.80E-04 | 2.62E-03 | 1.70E-04 | 1.03E-03 | 6.36E-07 | 1.20E-04 | 4.81E-02 | 8.01E-06 | 9.60E-04 | 1.42E-03 | 3.40E-04 | -8.23E-05 | **5.52E-02** |
| 21 | **Benchmark PEF** | **Pt** | | **9.40E-04** | **4.73E-03** | **6.48E-05** | **3.85E-03** | **7.14E-06** | **4.10E-04** | **3.46E-02** | **1.79E-05** | **1.10E-03** | **3.80E-04** | **4.90E-04** | **1.36E-06** | 4.66E-02 |
| 22 | P7W16STILL | Pt | MQ | 5.60E-04 | 3.12E-03 | 8.07E-05 | 4.80E-04 | 3.63E-07 | 1.10E-04 | 3.60E-02 | 6.44E-06 | 9.20E-04 | 2.37E-03 | 3.40E-04 | 1.92E-03 | **4.59E-02** |

Table 54 shows the results of still wines, in this case the analysed wine and the representative VIVA still wine have higher impacts compared to the Still wine benchmark PEF. The analysed still wines are in prevalence premium and high quality wines (6 PQ and 9 HQ), with less medium quality wines (6 MQ). Looking at the results the most performing products from an environmental point of view are PQ products. This result is interesting because those products made all by the same producer have a greater position in this ranking compared particularly to average HQ. This is a sign of how quality can also have environmental benefits, despite the fact that these companies are disadvantaged in terms of yields and weight of the packaging. Trying to explain this phenomenon, we can say that the company, being able to economically enhance its products, has invested in energy-efficient structures, investing heavily in the man work, thus containing the energy consumption related to farm and wine production.

MQ wines have in average a similar performance to PQ wines, and the less average performing are HQ wines, with an average lower position compared to the other 2 classes.

Referring to the individual products, W16 and W18 are the closest wine to the PEF benchmark, they are the 2 wines with the highest yields, respectively of 110q and 97 q, all the other wines has a yields per ha between 52q and 78 q. Contrary to the PEF still benchmark, all VIVA still wines are bottled in glass and the bottles used have, except for W19 (390g) a weight between 440 and 740 grams (equal to sparkling wines).

It is strange that wines with low packaging weight and high yields (in ex W18) have higher impacts compared to the European average. Unfortunately, it is not possible to verify this assumption due to the fact that average European inventories are not available, but I believe that this difference is due to the fact that the average European packaging considering cardboard and bag in box is particularly more performing than a glass bottle, even if it is a light one.

Looking the result of the 2 benchmark reported the European one performs particularly better on CC, MF&RDD, PM and POF. All those impact categories are affected by energy consumption and the vineyard stage and by the glass packaging.

## 6.5. The Italian solution - MADE GREEN IN ITALY

On 29 May last, Ministerial Decree no. 56 of 21 March 2018 was published in the Italian Official Gazette, containing the Regulation for the implementation of the voluntary national scheme for the assessment and communication of the environmental footprint of products, called “Made Green in Italy”, pursuant to Art. 21, paragraph 1, of Law 221/2015. (MATTM, 2018).

The Made Green Italy scheme represents a tool to increase the competitiveness of the Italian production system in a context such as the national and international one where there is a growing demand for products with a high environmental qualification.

The regulation provides for the use of the Product Environmental Footprint (PEF) methodology to determine the environmental footprint of products defined in the Recommendation 2013/179/EU of the European Commission of 9 April 2013.

The PEF methodology is the result of an experimental programme conducted by the European Commission and called the “Single Market for Green Products initiative” created to counter the proliferation of methodologies for assessing the environmental impact of products.

Compared to PEF, “Made Green in Italy” brings important innovations:

1) The product categories defined for the “Made Green in Italy” scheme are taken into account by the emerging indications in the development process of the PEF method, but may include additional categories relating to specific peculiarities of Italian domestic production.
2) The RCP (Product Category Rules in Italian) should contain the additional mandatory requirements and may contain the additional optional requirements.
    a. Mandatory additional requirements: product traceability, indication of the three impact categories considered most significant for the product category in question; value of the benchmark, for each representative product, the two thresholds that delimit three performance classes established as the differential with respect to the benchmark of the same representative product.
    b. Optional additional requirements: qualitative information relating to the impact of the product in terms of landscape quality and social sustainability; information relating to the environmental quality of the products; for products subject to minimum environmental criteria adopted by decree of the Minister for the Environment and Protection of Land and Sea within the framework of the Plan for the environmental sustainability of consumption in the public administration sector, where considered applicable and relevant for the specific product, the RCP may include the environmental criteria listed in the "technical specifications" section of the CAM (minimum environmental criteria) documents, to be demonstrated with the means of verification provided for therein.

The solution described in point 1) allows the technical tables set up in Italy to create additional product categories to better represent the national reality. This for example in the specific case of wine would allow the creation of additional representative product categories such as "Still wine DOCG" which could have average characteristics different from the average European product with a packaging exclusively in glass.

The innovations mentioned in points 2) and 3) make it possible to enhance national products with respect to the import of raw materials from abroad and include the possibility of integrating aspects of "product quality" seen as requirements for access to the brand.

The choice of these criteria will be left to the sectoral technical roundtable established at national level under the supervision of IMELS.

## 6.6. Trying to answer to some pending question

LCA studies have proven to be useful methods to account the environmental burdens associated with different products and life cycle stages. However, the holism and comprehensiveness of LCA also present disadvantages related to stakeholders and consumers communication (Weidema et al., 2008). Consequently, the development of single issue indicators, such as WATER and AIR indicator used in the VIVA project, has proliferated in LCT domain.

Although the European Commission has not yet formally expressed its opinion on what will be the regulatory instruments that will use the PEF methodology, the future development of specific public policies using PEF is supported by the publication of strategic documents like the bioeconomy strategy, the council conclusion on Eco-innovation and the EU product policy framework contributing to the circular economy (Council of the European Union, 2017; European Comission, 2018; European Commission, 2018c), that clearly mention the PEF/OEF methodology.

Different questions are therefore spontaneous:

*The PEF or MGI future schemes may replace the VIVA protocol and its indicators?*

No, at the moment the PEF only considers environmental aspects, some issues such as the impact on biodiversity, on social and cultural aspects can be measured with other protocols and sustainability schemes and then included in the PEF report as additional information. PEF or MGI can replace the assessment of some indicators like AIR and WATER indicators of the VIVA protocol, but the other sustainability pillars must be analysed with other indicators.

*However, can the Life Cycle Thinking model in the future hypothetically replace the system proposed by the VIVA protocol?*

Yes, the LCSA is a framework for future LCA suitable for integrating the three dimension of sustainability. Assuring the compliance with specific requirements, LCSA is the combination and the integration of three life cycle techniques (Kloepffer, 2008; Sala et al., 2013; UNEP/SETAC, 2011; Zamagni et al., 2012):

- Environmental Life Cycle assessment (ELCA) used to iteratively estimate ad evaluate the environmental impact of a product (Baumann and Tillman, 2004).
- Life Cycle Costing (LCC), used to assess cost related to the life cycle of a product (Rebitzer and Hunkeler, 2003).
- Social Life Cycle assessment (SLCA), used to evaluate real or potential socio-economic impacts that may positively or negatively affect stakeholders involved along the entire life cycle (SETAC/UNEP, 2009).

*Why LCSA cannot be directly implemented in the PEF method?*

Despite the recent methodological development, there is a further need for structuring the different LCA approaches in the LCSA, meeting also specific user needs such as simplified LCA or LCA tools (Guinée et al., 2011).

On the other hand, regarding simplified LCA and LCA tool some study reports interesting consideration for the agri-food sector. Arzoumanidis et al., (2017) has analysed several simplified LCA tools. Simplifications may occur at the level of Life Cycle Inventory (LCI) and LCIA. Strategies at the former level aim at simplifying the modelling and/or reducing data collection efforts, whilst ones at the latter level at reducing the set of impact categories and facilitating the communication of results (Arzoumanidis et al., 2013b; Nicoletti and Notarnicola, 1999).

The study reports that despite the fact that the tools are quite suitable for the agri-food sector, several limitations still persist and the tool should be improved to make them more robust in the implementation of specific sectors.

The work that is developing in the PEF area is shedding light on how, starting from the representative products developed in the PEF area, it is possible to adapt tools to specific sectors. A great example is the yucan app (yukan, 2017), where the basic structure of the tool remains the same, but the app is adapted from time to time to the specific sector in order to structure the flow chart. The user is then left free, based on the purpose of the study, to enter more or less data of the supply chain; the data not entered is completed by the information of the representative product PEF. Simplification of such specific sectors thus becomes an intrinsic procedure in the study and can help to facilitate its application and certification. The complexity arises from the fact that the tool must be previously adapted to each sector and an initial collection of representative data of the specific sector must be carried out.

## 7. Conclusions

EU agro-food products, both as agricultural raw materials and final products, enjoy an undisputed and envied reputation of the highest quality on the world market, especially for Italian products. The good reputation of European production at global level is also due to the respect of minimum requirements set at technically high levels (protection of health and the environment and animal welfare) compared to production by international competitors, which help to give European agro-food production an added value. However, compliance with the minimum requirements is no longer sufficient, especially for European consumers, and the interest in products with “credence” characteristics is constantly growing. The market is increasingly subject to consumer demand for detailed information on the production criteria and origin of products, especially in relation to specific themes or issues of high media interest (e.g. environmental statements such as: Programme for the Endorsement of Forest Certification schemes - PEFC, Forest Stewardship Council - FSC, Dolphin Safe the international dolphin safe scheme for the protection of dolphins in tuna fishing, products with sustainable palm oil, and products of animal origin without antibiotics). This leads companies to differentiate themselves from their national and international competitors, creating or embracing programmes, specific for product categories, which provide direct information to the final consumer. But consumers, being flooded with environmental information and a multitude of programmes, struggle to choose or understand which programme is the most reliable and best responds to their needs, causing a distrust of certifications and environmental declarations.

As mentioned in the previous paragraph, the only quality programmes that are free of this confusion are PDO and PGI products and Organic Farming products, precisely because of their ability to evoke a multiplicity of positive “emotions” in the final consumer. Unfortunately, however, the sustainability performance of these products are often not assessed. The production specifications and the regulations for organic farming do not provide for a company commitment to more sustainable production, while the consumer is also aware of social and environmental quality aspects for these products. This means that the companies producing EU tradition and quality products and organic products are not stimulated to make their production system more sustainable, but aim at maximising production in compliance with the limits of their specifications.

It is therefore clear that the European Commission has not yet been able to find a successful synthesis between the different quality cores. It has only recently started thinking about regulations on voluntary aspects of integration between quality and sustainability (see The Product Environmental Footprint (PEF) of the European Commission), but at present the existing programmes are not consistent and in some cases overlap with some objectives (i.e. ecolabel and PEF).

Individual member states, already some years ago, have started to develop national programmes in this direction (i.e. HVE, SQNPI and VIVA). A concrete example that is trying to integrate the quality of a product such as wine, strongly linked in Italy to PDO and PGI productions, with sustainability requirements is the VIVA programme for sustainability in Italian wine-growing. VIVA is one of the first attempts in Europe to focus on a specific sector, identifying the most sensitive issues at national level and of interest to the final consumer, placing them as requirements for access to the scheme through the territory indicator. The programme is therefore an optimal combination of environmental performance analysis and implementation of mitigation strategies and actions, with minimum access requirements evolving over the years. The project is not limited to identifying wines with better environmental performance, but promotes and directs the Italian wine sector to a path of innovation and improvement.

Italy now, through the establishment of the MGI scheme, intends to develop the VIVA experience in a national scheme that integrates the PEF methodology of the European Commission with additional information and/or will establish minimum criteria for programme access to enhance sustainability aspects related to traceability, landscape quality and social sustainability. The definition of specific Product Environmental Footprint Category Rules (PEFCR) adopted by the PEF programme (and by the MGI) is well integrated with what has been discussed, as the structure makes it possible to address and understand the specific problems of each sector analysed.

In the definition of PEFCR at European level, some stakeholders have come together under a single technical secretariat in order to define specific rules for the assessment of environmental impacts in accordance with the PEF methodology. In the same way, therefore, it will be possible to define critical aspects of social and landscape sustainability that the product category will have to respect and any additional information, which can be integrated in the sustainability declaration attached to the study. The development of "broadened" participatory processes involving companies, consumer associations and stakeholders in the supply chain gives greater legitimacy to the standard developed, while at the same time raise the bar of voluntary legislation.

The European production system fits well with this type of scheme and must aim to develop it. To confirm this, it is enough to look at the data regarding farms, which in the last decade have focused extensively on multifunctionality. Italy, with an average of 4,6 billion €, ranks first in the EU for support service activities, followed by France (4,2 billion €) and Germany (2,1 billion €). In the field of support activities, labour subcontracting, first processing of products and maintenance of the territory are emerging. These aspects are also interesting in order to enhance secondary activities such as the production of renewable energy and the spread of agritourism. Italy is in first place with 27,5% of European production, followed by France (14,2%) and the United Kingdom (9,9%). (ISTAT, 2017).

The last point that has not yet been dealt with, but which is certainly of interest to companies in the European agricultural and agro-food sector, concerns the predominantly economic limits that such complex schemes may have. Until now, in fact, the main difficulties that these schemes, which integrate more aspects of sustainability, had to deal with were higher costs related to the costs of carrying out studies and certification, as well as having to define optimal strategies of communication to the consumer in order to avoid being compared to scientifically unsound schemes.

Surely the evolution of methodologies is making this type of study more competitive from the point of view of the cost that companies have to bear. PEF for how it is structured, and consequently the MGI, allows consortia or groups of companies to merge with the objective of building tools that simplify the application of LCA studies, significantly reducing the costs associated with analysis and certification and allowing small and medium-sized enterprises (SMEs) to make these studies affordable (Famiglietti et al., 2018).

The European Commission is already funding research in this area (LIFE TTGG, 2018), although national and local authorities have a key role to play, as they will need to encourage and support the development and implementation of these sustainability schemes through calls for proposals for agricultural funding and future policies.

It is clear that only the generalised entry on these issues of public institutions as managers and innovators in regulatory matters, with a central role for the European institutions, which have always been progressive in this area, can guarantee a fair mediation between the collective interests and the interests of companies, putting consumer protection at the centre.

The fundamental objective of quality is to inform the final consumer about the specific characteristics of the product. Satisfaction with consumer expectations is one of the cornerstones of the ISO definition of quality, which presupposes a conscious and well-informed purchase.

The process of reforming the quality of agricultural and agro-food production cannot and must not stop. It is still necessary for both public institutions and voluntary private-sector schemes to achieve four objectives:

1. improve communication between producers, buyers and consumers on the quality of agricultural and agro-food products;
2. making EU quality policy instruments more coherent;
3. simplify label wording. The European Commission has not yet been able to find a proper synthesis between the different quality cores, investing also in consumer understanding;
4. integrating sustainability schemes more directly with CAP policies.

There is therefore an urgent need to enhance the value of these quality products with more consistent approaches, which include cross-cutting provisions with shared levels of quality with civil society and verification instruments and regulations that are suitable for preventing abuse and that support the correct information of the consumer.

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# ANNEX I:

## Check list used for data collection in the VIVA companies

| **GENERAL** | **U.M.** |
|---|---|
| Producer | |
| Name of the product | |
| Vintage | |
| Still/Sparkling | |
| White/Red/Rosé | |
| Parcels Surfaces | ha |
| Average Yield | kg/ha |
| Quantity of grape | kg |
| Wine Yield | % |
| Cultivation Density | Vine/ha |
| **VINEYARD** | |
| N in Fertilizer | kg/ha |
| P in Fertilizers | kg/ha |
| K in fertilizers | kg/ha |
| Organic Fertilizer | |
| Quantity of Organic Fertilizer | kg/ha |
| Organic Fertilizer | |
| Quantity of Organic Fertilizer | kg/ha |
| N in Organic Fertilizer | kg/ha |
| P in Organic Fertilizer | kg/ha |
| Specific phytosanitary product used in the vineyard | Kg of active ingredient/ha |
| **PHYTOSANITARY PRODUCT SHALL BE DIVIDED IN THE FOLLOWING GROUPS** | |
| [sulfonyl]urea-compounds at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Acetamide-anillide-compounds at plant, aggregated inputs per kg of active ingredient | kg/ha |
| copper oxide production technology mix production mix, at plant 100% active substance | kg/ha |
| Cyclic N-compounds at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Folpet at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Fosetyl-Al at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Glyphosate at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Mancozeb at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Organophosphorus-compounds at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Pyrethroid-compounds at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Pyridine-compounds at plant, aggregated inputs per kg of active ingredient | kg/ha |
| Sulphur (elemental) at refinery from crude oil production mix, at refinery 2.07 g/cm3, 32 g/mol | kg/ha |
| Water for Pesticide application | mc/ha |
| Water for Irrigation | mc/ha |
| Steel Wire for tying | kg |
| Diesel Consumption (0.83752 kg/l) | kg/ha |
| Electricity Consumption | kWh/ha |
| CER150106: Packaging waste mixed material | kg/ha |
| CER170403:waste steel and iron | kg/ha |

| | |
|---|---|
| CER130205:waste engine oil density (0.9kg/l) | kg/ha |
| CER150110:packaging waste containing residues of or contaminated by dangerous substances | kg/ha |
| CER150102: Packaging Waste Plastic | kg/ha |
| **VINERY - MUST PRODUCTION** | |
| Grape Transport | kg*km/kg of grape |
| Grape Transport | km |
| Produced wine | liters |
| Produced Lees | kg |
| Produced Grape Pomace | kg |
| Allocation to wine | % |
| Electricity Consumption: Grape Pressing (default 0.0056kWh/kg) | kWh/kg of grape |
| Electricity Consumption: Wine Making and storage | kWh/kg of grape |
| photovoltaic electricity produced and consumed in the vinery | kWh/kg of grape |
| Diesel consumption | kg/kg of grape |
| PLG consumption (0.52854 kg/l) | kg/kg of grape |
| Natural Gas consumption | mc/kg of grape |
| Groundwater | mc/kg of grape |
| Well water | mc/kg of grape |
| Waste water | kg/kg of grape |
| Refrigerant gas leaks R134a | kg/kg of grape |
| Refrigerant gas leaks R404a | kg/kg of grape |
| Refrigerant gas leaks R407a | kg/kg of grape |
| Refrigerant gas leaks R410a | kg/kg of grape |
| **DIRECT EMISSIONS** | |
| R134a | kg/kg of grape |
| R125 | kg/kg of grape |
| R143a | kg/kg of grape |
| R32 | kg/kg of grape |
| **VINERY - WINE PRODUCTION AND AGING** | |
| Ammonium bisulphite | kg/liter of wine |
| Ammonium sulphate | kg/liter of wine |
| Calcium Tartrate | kg/liter of wine |
| Enzymes | kg/liter of wine |
| Yeast | kg/liter of wine |
| Sugar | kg/liter of wine |
| Tannins | kg/liter of wine |
| Thiamine hydrochloride | kg/liter of wine |
| Yeast mannoproteins | kg/liter of wine |
| Wood oak barrel | kg/liter of wine |
| Transport input material | kg*km/liter of wine |
| WINE PACKAGING | |
| Electricity consumption - bottling | kWh/liter |
| Glass | kg/FU |
| Paper label | kg/FU |
| Cork stopper for still wine | kg/FU |
| Cork stopper for sparkling wine | kg/FU |
| Aluminium overcap | kg/FU |

| | |
|---|---|
| Aluminium screw cap | kg/FU |
| Plastic cork stopper | kg/FU |
| Glue | kg/FU |
| Plastic film | kg/FU |
| Cardboard | kg/FU |
| Wood | kg/FU |
| Wooden Pallet | kg/FU |
| Plastic Pallet | kg/FU |
| Lorry: mass transported | kg/FU |
| Lorry: transport distance | km/FU |
| Train: mass transported | kg |
| Train: transport distance | km/FU |
| Barge: mass transported | kg |
| Barge: transport distance | km/FU |
| CER150106: Packaging waste mixed material | kg/KG of grape |
| CER150110: Packaging waste containing residues of or contaminated by dangerous substances | kg/KG of grape |
| CER150102: Packaging Waste Plastic | kg/KG of grape |
| CER150103: Packaging waste wood | kg/KG of grape |
| CER150101: Packaging waste paper | kg/KG of grape |
| CER170403: Waste steel and iron | kg/KG of grape |
| CER170202: Waste glass | kg/KG of grape |
| CER020705: Sludges from on-site effluent treatment | kg/KG of grape |
| CER161002: Non-hazardous aqueous waste solutions | kg/KG of grape |
| CER020103: Plant waste | kg/KG of grape |
| **DISTRIBUTION** | |
| Lorry: mass transported | kg |
| Lorry: transport distance | km/FU |
| Train: mass transported | kg |
| Train: transport distance | km/FU |
| Barge: mass transported | kg |
| Barge: transport distance | km/FU |
| CER150106: Packaging waste mixed material | kg/FU |
| Packaging Waste Plastic | kg/FU |
| Packaging waste wood | kg/FU |
| Packaging waste paper | kg/FU |
| CER170403:waste steel and iron | kg/FU |
| Packaging waste glass | kg/FU |
| % Central Europe | |
| % USA and Canada | |
| % Italy | |

# ANNEX II:

## Proposal for a Wine Product Category Rules

### Table of Content
### List of Figures
### List of Tables
### Abbreviations, acronyms and units
### Glossary
### Geographic region
This PCR is the result of years of Carbon footprint and LCA study about Wine produced in Italy. These rules could however be applied globally.

### Methodological inputs and compliance
The PCR has been prepared in conformance with the following documents:

1. ISO TS 14067:2013 – Greenhouse gases - Carbon footprint of products - Requirements and guidelines for quantification and communication (ISO, 2013).
2. PCR International EPD System – UN CPC 24211 – Sparkling wine of fresh grapes (International EPD System, 2014).
3. PCR International EPD System – UN CPC 24212 – Wine of fresh Grapes, except sparkling wine (International EPD System, 2010).
4. Disciplinare VIVA 2014/1.1 (MATTM, 2014).
5. ISO 14040:2006 - Environmental management -- Life cycle assessment -- Principles and framework (ISO, 2006b).
6. EU PEF Guidance for the implementation of the EU PEF during the Environmental Footprint pilot Phase – Version 5.2 - February 2016 (European Commission, 2016).
7. Product Environmental Footprint Category Rules Wine (Pilot Phase) – Version 02 – February 2016 (CEEV, 2016).
8. General Programme Instruction for the International EPD System – Version 2.5 – 11 May 2015 (International EPD System, 2015).

### Scope
The product category for this PCR is:

This PCR apply to wine from fresh grapes, regardless of variety in colour, sugar content or age.

The grape can be produced using all existing agricultural practices and the wine can be made with different production processes, and presented in different packaging formats (primary, secondary, tertiary).

## Functional Unit

The functional unit is 0.75 litres of wine, including packaging, consumed at home as final product without cooling.

## Product Classification

The CPA/NACE class corresponding to wine product category is “11.02 – 192 manufacture of wine from grape”

## System boundaries, life-cycle stages and processes

The system boundaries considered include all significant material and energy flows associated with grape production, wine making, bottling, distribution, retail, consumption, and end of life of wine. Thus, it will consider:

- Energy and water consumption;
- Emissions;
- Waste management and valorization;
- Auxiliary materials for grape production (propagating material, fertilizers, pesticides, etc.);
- Auxiliary materials for wine making (oenological practices, cleaning agents, primary, secondary and tertiary packaging, etc.);
- Transport/distribution of grapes;
- Transport/distribution of wine (in bulk and packaged intended to not only “Business to Business”, but also “Business to consumers”);
- Energy, refrigerants and maintenance of the cooling equipment needed for cooling the wine (at home cooling, bars and restaurants);
- Packaging management after consumption of the wine (re-use, recycled, landfilling or incineration).

## Data collection reference period

Wine production can include an ageing phase prior to the sale and this could be an element difficult to manage for firms. Set out below are two different approaches:

1. **Standard Approach:** it specifies the approach to be followed according to this scheme;
2. **Extraordinary Approach:** it specifies the approach to be followed for the wines for ageing where is not possible to apply the standard approach.

## Standard Approach

In a CFP study the primary activity data must be collected respecting the time representativeness, for example:

1. Production and selling of young wines, for example 2014 grape harvest, sold in 2015 and consumed over the year:

    a. Grape Production and Harvest: it is necessary to collect the agricultural phase data of the 2013-2014 years, taking into account the ground preparation activities (fertilization, phytosanitary products treatments) from the end of the preceding harvest (2013) to the reference harvest (2014).

    b. Grapes Transport, Wine Production and Bottling: in these phases it is necessary to collect primary data, from the harvest phase to the wine bottling (for example from the 2014 harvest to the wine bottling and labelling in April 2015).

    c. Wine Distribution and Packaging End of Life: it is necessary to collect the distribution data of the specific product and of the specific distribution of that product in that specific year for example from April 2015 to April 2016).

2. Production and selling of wines for ageing, for example 2010 grape harvest, sold bottled in 2015 and in case consumed over several years since set aside for bottle-ageing as well.

    a. Grape Production and harvest: it is necessary to collect the agricultural phase data of the actual production year taking into account the ground preparation activities (fertilization, phytosanitary products treatments) from the end of the preceding harvest (2009) to the 2010 harvest.

    b. Grapes Transport and Production: it is necessary to collect primary data according to these phases, respecting the time representativeness (for example year 2010 grapes transport and years 2010 and 2011 production data till the barrique-ageing phase).

    c. Barrique-ageing: it is necessary to collect data related to wine preservation in the barrique (for example the winery energy consumption) and a mass allocation of the analyzed product compared to the whole wine kept in the winery related to the analyzed wine ageing years.

    d. Bottling: it is necessary to collect specific data concerning the bottling phase.

    e. Bottle-ageing: it is necessary to collect data related to bottled wine preservation (for example winery energy consumption) and a mass allocation of the analyzed product compared to the whole wine kept in the winery related to the analyzed wine ageing years till the labelling and distribution phases.

    f. Labelling, Distribution and End of Life: it is necessary to collect primary data concerning the labelling and distribution phases. In relation to the distribution phase, if a share of the product is not distributed in the course of the year because reserved to further preservation, the firm must provide a representative scenario of the same product bottles distribution, taking into account the different previous years sold bottles and ensuring to relate the case to the number of bottles produced in the specific year.

## Extraordinary approach

The standard approach poses many difficulties as regards the wines for ageing. The main problem area is connected to the data collecting of vintage wines, particularly if the firm has to work in close contact with grape-growers or if it has been not finalized a data collection system allowing the firm to obtain substantial and time representative data. Basing on the assumption that the production process, as regards the technological level, has not incurred substantial variations, and every possible variation must be defined and related in the wines for ageing study report, it is possible to proceed as follows:

1. Production and selling of wines for ageing, 2010 grape harvest, sold bottled in 2015 or in case consumed over several years since set aside for bottle-ageing as well.
    a. *Grape Production and Harvest:* it is possible to collect the agricultural phase data, working out the average of the last two production years, taking into account the ground preparation activities (fertilization, and phytosanitary products treatments from harvest to harvest). In the case of a wine, 2010 grape harvest, sold in 2015 it is necessary to work out the 2013-2014 years' average (this choice must be duly described in the study report).
    b. *Grapes Transport and Production:* in these phases it is necessary to collect primary data working out the average of the last two production years. In the case of a wine, 2010 grape harvest, sold in 2015 it is necessary to work out the 2013-2014 years' average.
    c. *Barrique-ageing* it is necessary to collect data related to wine preservation in the barrique (for example the winery energy consumption) and a mass allocation (look at standard approach) considering the previous year energy consumption. In the case of a wine, 2010 grape harvest, sold in 2015, it is necessary to consider the 2014 energy consumption and to multiply it by the ageing years.
    d. *Bottling*: it is necessary to collect specific data concerning the bottling phase.
    e. *Bottle-ageing:* it is necessary to collect data related to bottled wine preservation (for example the winery energy consumption) and a mass allocation (look at standard approach) considering the previous year energy consumption. In the case of a wine, 2010 grape harvest, sold in 2015, it is necessary to consider the 2014 energy consumption and to multiply it by the ageing years.
    f. *Labelling, Distribution and End of Life:* it is necessary to collect primary data concerning the labelling and distribution phases. In relation to the distribution phase, if a share of the product is not distributed in the course of the year because reserved to further preservation, the firm must provide a representative scenario of the same product bottles distribution, taking into account the different previous years sold bottles and ensuring to relate the case to the number of bottles produced in the specific year.

**For both standard and extraordinary approach, the study reference year (written on the label) is the year of the grape harvest.**

*Note 1: if the firm chooses the extraordinary approach, the assumptions made and the approach choice must be specified in the final report".*

*Note 2: if it is necessary to modify one of the approaches, this variation must be duly explained in the Final Report.*

*Note 3: the firm who chooses the extraordinary approach must finalize a data collection system to allow the realization of the standard approach for the next grape harvests, for this reason the extraordinary approach choice is only accepted during the initial phase of adhesion to the project.*

## Cut-off and exclusions

The following general cut-off rule will be applied: those energy and material flows that represent less than 1% of the total energy or mass, respectively, that enter or leave each of the modules of the life cycle may be excluded from the study. The sum of the excluded flows may not exceed 5% of the energy and the total materials used in the entire life cycle of the product.

This cut-off rule may not be used to exclude input or output flows that are dangerous to human health or ecosystems according to legislation, regulations or existing scientific evidence or that cause relevant environmental impacts.

During the application of these cut-off rules in the LCA studies in which these PCR are based, it was found that the following transport processes for wine production may be excluded due to the negligible impact in the context of the life cycle:

- Internal transportation, with the exception of that related to cultivation and tillage operations.
- Transport of raw materials to the winery, with the exception of packaging materials.
- Transport of waste generated in the winery to the treatment plant.

The production of infrastructure (such as power or waste treatment plants, the construction of the winery and the machinery used, etc.) may also be excluded.

Following the recommendations of the Intergovernmental Panel on Climate Change (IPCC), CO2 emissions from biological sources are considered neutral. For example, the atmospheric C that is fixed during the growth of the grape (through photosynthesis) or the CO2 emissions from fermentation or biological decomposition of organic waste, will not be included in the inventory. CO2 emissions from fossil fuels will be included in the inventory.

## Allocation

There are processes shared with other product systems that are not included in the analysis (for example marcs production reserved for distilleries).

*Note: agri-food systems give rise to products and by-products frequently reused in other processes or sold to the firm. In this case is not always possible to split single processes and it is necessary to rely on specific allocation criteria that are likewise employed in reuse and recycling processes.*

When it is not possible to split single processes in two or more sub-processes it is necessary to divide system inputs and outputs by different products or functions in accordance with the allocation principle taking into account the physical relations (mass, ideally). **The only exception is represented by the allocation of production, transport and grapes pressing: in this case the impacts must be allocated as follows: 96% wine, 4% lees and marcs.**

### Allocation Procedures in Case of Reuse and Recycling

As regards the allocation procedures in case of reuse and recycling, within this specification it is employed the "Polluter-Pays Principle (PPP)".

This principle links together different product systems in which the system by-products or waste, after having been processed or transported, become raw materials for other systems (for example lees and marcs become part of the spirits production). Making use of this principle the limit between the systems is determined by the point in which by-products and waste reach the "lower of the market value". This implies that the system generating waste is responsible for its impact until the waste or by-product start a new processing phase. The succeeding system is responsible for the impact connected to the waste or byproduct processing, but it does not answer for the "previous" life cycle phases.

## Data quality requirements

All data must be relevant, complete, consistent, coherent, accurate and transparent as defined in ISO TS 14067:*2013 Clause 5.*

According to ISO /TS 14067 data are classified in primary and secondary.

1. Primary data: quantified values of a process unit or an activity derived from direct surveys or original data source direct surveys and can be divided up in:

   a. specific data collected *in situ:* all data concerning processes under the financial or operational supervision of the organization that is carrying out the study must be collected in the original place;

   b. Non site-specific primary data: all data that do not directly refer to the analysed production system, but to a different and comparable production system.

2. Secondary data: it is necessary to make use of these data for processes of lesser importance or when primary data are not traceable. These data are indirectly derived and based on bibliographical sources (previous studies, databases, published in the scientific literature and verified by a third party).

Environmental data (matter and energy flows exchanged by the system) must be as more specific as possible because they are illustrative of the analysed process. Secondary data source must be cited in the study report.

## Other Methodological Features

### Greenhouse Gases Emissions and Removal (Biogenic Carbon)

To draw the biogenic carbon balance it is necessary to adopt the following hypothesis:

1. the $CO_2$ included in the product and the $CO_2$ emitted as a consequence of product consumption are not considered. It is assumed that the carbon included in the product oxidizes at the end of life, so the absorbed and emitted carbon balance is at a zero level.

2. are considered only the methane biogenic emissions, because methane has a higher potential greenhouse effect compared with absorbed carbon dioxide.

3. methane emissions due to organic fertilizers employment are not considered, because at the time of distribution fertilizers are substantially stable.

### Land Use Change

The emissions connected to land use change must be considered if the land use change has taken place no more than 20 years from the reference year.

### Soil Carbon Content Variation

Carbon emissions and removals must not be considered if depending on soil organic substance variations.

# ANNEX III: Direct emission of active ingredient used in the vineyard

| Product Code | Abamectina | Acetamiprid | Ametoctradin | Benthiavalicarb isopropyl | Boscalid | Bupirimate | Buprofezin | Chlorpyrifos Methyl | Cicloxidim | Clofentezine |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P1W1SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.56E-01 | 0.00E+00 | 9.43E-02 | 0.00E+00 | 0.00E+00 |
| **P1W2SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.56E-01 | 0.00E+00 | 9.43E-02 | 0.00E+00 | 0.00E+00 |
| **P2W3SPARK** | 0.00E+00 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 6.87E-01 | 0.00E+00 | 0.00E+00 | 5.25E-01 | 3.10E-01 | 0.00E+00 |
| **P2W4SPARK** | 0.00E+00 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.25E-01 | 3.10E-01 | 0.00E+00 |
| **P3W5SPARK** | 0.00E+00 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 6.87E-01 | 0.00E+00 | 0.00E+00 | 5.25E-01 | 3.10E-01 | 0.00E+00 |
| **P4W6SPARK** | 1.00E-03 | 6.00E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.30E-02 | 9.70E-02 | 0.00E+00 | 0.00E+00 |
| **P5W7SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W8STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W9STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W10STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W11STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P5W12STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W13STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.00E-01 | 6.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W14STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.00E-01 | 6.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W15STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.00E-01 | 6.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P7W16STILL** | 9.40E-02 | 0.00E+00 | 0.00E+00 | 4.25E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.81E-01 | 0.00E+00 | 5.00E-02 |
| **P8W17STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P9W18STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P10W19STILL** | 4.70E-03 | 0.00E+00 | 1.50E-02 | 2.28E-01 | 9.00E-02 | 1.37E-01 | 0.00E+00 | 1.15E+00 | 0.00E+00 | 2.50E-03 |
| **P11W20STILL** | 0.00E+00 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W21STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.77E+00 | 0.00E+00 | 0.00E+00 |
| **P12W22STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.77E+00 | 0.00E+00 | 0.00E+00 |
| **P12W23STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.77E+00 | 0.00E+00 | 0.00E+00 |
| **P12W24STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.16E+00 | 0.00E+00 | 0.00E+00 |
| **P12W25STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W26STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.39E+00 | 0.00E+00 | 0.00E+00 |
| **P12W27STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.39E+00 | 0.00E+00 | 0.00E+00 |

| AVERAGE SPARKLING | Abamectina | Acetamiprid | Ametoctradin | Benthiavalicarb isopropyl | Boscalid | Bupirimate | Buprofezin | Chlorpyrifos Methyl | Cicloxidim | Clofentezine |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 1.43E-04 | 8.57E-04 | 1.29E-01 | 0.00E+00 | 1.96E-01 | 1.23E-01 | 7.57E-03 | 2.66E-01 | 1.33E-01 | 0.00E+00 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.70E-02 | 0.00E+00 | 0.00E+00 |
| **MAX VALUE** | 1.00E-03 | 6.00E-03 | 3.00E-01 | 0.00E+00 | 6.87E-01 | 5.47E-01 | 5.30E-02 | 5.25E-01 | 3.10E-01 | 0.00E+00 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.43E-02 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 0.00E+00 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 3.43E-01 | 1.56E-01 | 0.00E+00 | 5.25E-01 | 3.10E-01 | 0.00E+00 |
| **POSITIVE DELTA** | -1.43E-04 | -8.57E-04 | 1.71E-01 | 0.00E+00 | 1.47E-01 | 3.29E-02 | -7.57E-03 | 2.59E-01 | 1.77E-01 | 0.00E+00 |
| **NEGATIVE DELTA** | -1.43E-04 | -8.57E-04 | -1.29E-01 | 0.00E+00 | -1.96E-01 | -1.23E-01 | -7.57E-03 | -1.72E-01 | -1.33E-01 | 0.00E+00 |

| AVERAGE STILL | Abamectina | Acetamiprid | Ametoctradin | Benthiavalicarb isopropyl | Boscalid | Bupirimate | Buprofezin | Chlorpyrifos Methyl | Cicloxidim | Clofentezine |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 4.94E-03 | 0.00E+00 | 1.58E-02 | 2.39E-01 | 9.45E-02 | 1.44E-01 | 0.00E+00 | 1.21E+00 | 0.00E+00 | 2.63E-03 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **MAX VALUE** | 9.40E-02 | 0.00E+00 | 3.00E-01 | 4.25E+00 | 6.00E-01 | 5.47E-01 | 0.00E+00 | 7.16E+00 | 0.00E+00 | 5.00E-02 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.50E-02 | 0.00E+00 | 2.39E-01 | 0.00E+00 | 2.39E+00 | 0.00E+00 | 0.00E+00 |
| **POSITIVE DELTA** | -4.94E-03 | 0.00E+00 | -1.58E-02 | -2.14E-01 | -9.45E-02 | 9.57E-02 | 0.00E+00 | 1.19E+00 | 0.00E+00 | -2.63E-03 |
| **NEGATIVE DELTA** | -4.94E-03 | 0.00E+00 | -1.58E-02 | -2.39E-01 | -9.45E-02 | -1.44E-01 | 0.00E+00 | -1.21E+00 | 0.00E+00 | -2.63E-03 |

| Product Code | Copper Hydroxide | Neutralised Copper Sulphate | Copper Oxychloride | Tribasic Copper Sulphate | Cyazofamid | Cyflufenamid | Cymoxanil | Cyproconazole | Cyprodinil | Difenoconazole | Dimethomorph |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P1W1SPARK** | 0.00E+00 | 0.00E+00 | 1.28E+01 | 0.00E+00 | 1.13E+00 | 7.58E-02 | 1.82E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.93E-01 |
| **P1W2SPARK** | 0.00E+00 | 0.00E+00 | 1.28E+01 | 0.00E+00 | 1.13E+00 | 7.58E-02 | 1.82E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.93E-01 |
| **P2W3SPARK** | 0.00E+00 | 4.14E+00 | 1.25E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.51E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 1.17E+00 |
| **P2W4SPARK** | 0.00E+00 | 2.40E+00 | 1.25E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.51E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 1.17E+00 |
| **P3W5SPARK** | 0.00E+00 | 4.14E+00 | 1.25E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.51E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 1.17E+00 |
| **P4W6SPARK** | 0.00E+00 | 0.00E+00 | 2.62E+00 | 0.00E+00 | 0.00E+00 | 1.00E-02 | 4.30E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.02E-01 |
| **P5W7SPARK** | 0.00E+00 | 0.00E+00 | 6.04E+00 | 2.69E+00 | 0.00E+00 | 4.18E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.21E-01 |
| **P5W8STILL** | 0.00E+00 | 6.00E+00 | 6.04E+00 | 2.69E+00 | 0.00E+00 | 4.23E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.21E-01 |
| **P5W9STILL** | 0.00E+00 | 6.00E+00 | 5.95E+00 | 2.19E+00 | 0.00E+00 | 4.23E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.21E-01 |
| **P5W10STILL** | 0.00E+00 | 6.00E+00 | 5.95E+00 | 2.19E+00 | 0.00E+00 | 4.23E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.21E-01 |
| **P5W11STILL** | 0.00E+00 | 6.00E+00 | 6.04E+00 | 2.69E+00 | 0.00E+00 | 4.23E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.21E-01 |
| **P5W12STILL** | 0.00E+00 | 0.00E+00 | 6.04E+00 | 2.69E+00 | 0.00E+00 | 4.18E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.21E-01 |
| **P6W13STILL** | 2.90E+00 | 2.40E+00 | 3.18E+00 | 1.60E+00 | 0.00E+00 | 0.00E+00 | 4.40E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 3.15E-01 |
| **P6W14STILL** | 2.20E+00 | 4.80E+00 | 2.22E+01 | 1.60E+00 | 0.00E+00 | 5.10E-02 | 4.40E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 4.95E-01 |
| **P6W15STILL** | 1.70E+00 | 2.40E+00 | 1.58E+01 | 1.60E+00 | 0.00E+00 | 0.00E+00 | 4.40E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 3.15E-01 |
| **P7W16STILL** | 1.18E+00 | 1.42E+00 | 9.39E+00 | 4.19E+00 | 1.98E-01 | 0.00E+00 | 3.80E-01 | 1.06E+00 | 5.68E-01 | 2.30E-02 | 6.53E-01 |
| **P8W17STILL** | 1.73E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.50E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P9W18STILL** | 0.00E+00 | 0.00E+00 | 1.35E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.63E-01 | 0.00E+00 | 6.80E-01 |
| **P10W19STILL** | 4.85E-01 | 1.75E+00 | 5.54E+00 | 1.07E+00 | 9.90E-03 | 1.44E-02 | 1.47E-01 | 5.31E-02 | 8.65E-02 | 1.15E-03 | 2.88E-01 |
| **P11W20STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.67E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.98E-01 |
| **P12W21STILL** | 0.00E+00 | 0.00E+00 | 2.08E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.36E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W22STILL** | 0.00E+00 | 0.00E+00 | 2.08E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.36E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W23STILL** | 0.00E+00 | 0.00E+00 | 2.08E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.36E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W24STILL** | 0.00E+00 | 0.00E+00 | 5.37E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.51E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W25STILL** | 0.00E+00 | 0.00E+00 | 1.50E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.80E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W26STILL** | 0.00E+00 | 0.00E+00 | 1.80E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.17E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W27STILL** | 0.00E+00 | 0.00E+00 | 1.80E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.17E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| AVERAGE SPARKLING | Copper Hydroxide | Neutralised Copper Sulphate | Copper Oxychloride | Tribasic Copper Sulphate | Cyazofamid | Cyflufenamid | Cymoxanil | Cyproconazole | Cyprodinil | Difenoconazole | Dimethomorph |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 0.00E+00 | 1.53E+00 | 1.03E+01 | 3.84E-01 | 3.23E-01 | 2.91E-02 | 2.09E-01 | 0.00E+00 | 1.29E-01 | 0.00E+00 | 6.60E-01 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 1.25E+01 | 0.00E+00 | 0.00E+00 | 1.00E-02 | 1.82E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.21E-01 |
| **MAX VALUE** | 0.00E+00 | 4.14E+00 | 1.28E+01 | 2.69E+00 | 1.13E+00 | 7.58E-02 | 3.51E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 1.17E+00 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 2.62E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.02E-01 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 9.28E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.13E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.93E-01 |
| **75% PERC** | 0.00E+00 | 3.27E+00 | 1.27E+01 | 0.00E+00 | 5.66E-01 | 5.88E-02 | 3.51E-01 | 0.00E+00 | 3.00E-01 | 0.00E+00 | 1.17E+00 |
| **POSITIVE DELTA** | 0.00E+00 | 1.74E+00 | 2.41E+00 | -3.84E-01 | 2.42E-01 | 2.97E-02 | 1.42E-01 | 0.00E+00 | 1.71E-01 | 0.00E+00 | 5.10E-01 |
| **NEGATIVE DELTA** | 0.00E+00 | -1.53E+00 | -9.89E-01 | -3.84E-01 | -3.23E-01 | -2.91E-02 | -9.61E-02 | 0.00E+00 | -1.29E-01 | 0.00E+00 | -4.67E-01 |

| AVERAGE STILL | Copper Hydroxide | Neutralised Copper Sulphate | Copper Oxychloride | Tribasic Copper Sulphate | Cyazofamid | Cyflufenamid | Cymoxanil | Cyproconazole | Cyprodinil | Difenoconazole | Dimethomorph |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 5.10E-01 | 1.84E+00 | 5.81E+00 | 1.13E+00 | 1.04E-02 | 1.52E-02 | 1.54E-01 | 5.57E-02 | 9.09E-02 | 1.21E-03 | 3.02E-01 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 5.46E+00 | 5.36E-01 | 0.00E+00 | 0.00E+00 | 1.26E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.02E-01 |
| **MAX VALUE** | 2.90E+00 | 6.00E+00 | 2.22E+01 | 4.19E+00 | 1.98E-01 | 5.10E-02 | 4.40E-01 | 1.06E+00 | 5.68E-01 | 2.30E-02 | 6.80E-01 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 2.01E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 6.58E-01 | 3.00E+00 | 6.04E+00 | 2.19E+00 | 0.00E+00 | 4.19E-02 | 2.01E-01 | 0.00E+00 | 1.31E-01 | 0.00E+00 | 6.21E-01 |
| **POSITIVE DELTA** | 1.49E-01 | 1.16E+00 | 2.22E-01 | 1.06E+00 | -1.04E-02 | 2.68E-02 | 4.62E-02 | -5.57E-02 | 3.97E-02 | -1.21E-03 | 3.19E-01 |
| **NEGATIVE DELTA** | -5.10E-01 | -1.84E+00 | -3.81E+00 | -1.13E+00 | -1.04E-02 | -1.52E-02 | -1.54E-01 | -5.57E-02 | -9.09E-02 | -1.21E-03 | -3.02E-01 |

| Product Code | Disodium phosphate | Emamectin Benzoate | Ethofenprox | Fenamidone | Flazasulfuron | Fluazinam | Fludioxonil | Fluopicolide | Folpet | Fosetyl-Al |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P1W1SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.28E+01 | 0.00E+00 | 4.97E+01 |
| **P1W2SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.28E+01 | 0.00E+00 | 4.97E+01 |
| **P2W3SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.22E-01 | 0.00E+00 | 9.07E+00 |
| **P2W4SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.22E-01 | 0.00E+00 | 8.03E+00 |
| **P3W5SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.22E-01 | 0.00E+00 | 9.07E+00 |
| **P4W6SPARK** | 6.50E-02 | 0.00E+00 | 2.10E-02 | 6.30E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.64E-01 |
| **P5W7SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.47E-01 | 0.00E+00 |
| **P5W8STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.47E-01 | 0.00E+00 |
| **P5W9STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.47E-01 | 0.00E+00 |
| **P5W10STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.47E-01 | 0.00E+00 |
| **P5W11STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.47E-01 | 0.00E+00 |
| **P5W12STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.47E-01 | 0.00E+00 |
| **P6W13STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.08E-01 | 0.00E+00 | 0.00E+00 | 4.00E+00 |
| **P6W14STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.00E-01 | 0.00E+00 | 0.00E+00 | 4.00E+00 |
| **P6W15STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.00E-01 | 0.00E+00 | 0.00E+00 | 4.00E+00 |
| **P7W16STILL** | 0.00E+00 | 5.10E-02 | 0.00E+00 | 0.00E+00 | 1.20E-02 | 0.00E+00 | 1.09E+00 | 0.00E+00 | 1.43E+01 | 5.28E+00 |
| **P8W17STILL** | 0.00E+00 | 1.47E-02 | 0.00E+00 | 2.75E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.71E+00 |
| **P9W18STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.78E-01 | 1.75E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P10W19STILL** | 0.00E+00 | 3.28E-03 | 0.00E+00 | 1.37E-02 | 6.00E-04 | 2.89E-02 | 1.03E-01 | 1.24E-01 | 9.15E-01 | 4.70E+00 |
| **P11W20STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 8.00E-01 | 0.00E+00 |
| **P12W21STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.07E-01 | 0.00E+00 | 9.07E+00 |
| **P12W22STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.07E-01 | 0.00E+00 | 9.07E+00 |
| **P12W23STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.07E-01 | 0.00E+00 | 9.07E+00 |
| **P12W24STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.95E-01 | 0.00E+00 | 2.35E+01 |
| **P12W25STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.22E-01 | 0.00E+00 | 6.56E+00 |
| **P12W26STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.66E-01 | 0.00E+00 | 7.85E+00 |
| **P12W27STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.66E-01 | 0.00E+00 | 7.85E+00 |

| AVERAGE SPARKLING | Disodium phosphate | Emamectin Benzoate | Ethofenprox | Fenamidone | Flazasulfuron | Fluazinam | Fludioxonil | Fluopicolide | Folpet | Fosetyl-Al |
|---|---|---|---|---|---|---|---|---|---|---|

| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
|---|---|---|---|---|---|---|---|---|---|---|
| **ARITHMETICAL MEAN** | 9.29E-03 | 0.00E+00 | 3.00E-03 | 9.00E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.76E+00 | 9.24E-02 | 1.81E+01 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.22E-01 | 0.00E+00 | 9.07E+00 |
| **MAX VALUE** | 6.50E-02 | 0.00E+00 | 2.10E-02 | 6.30E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.28E+01 | 6.47E-01 | 4.97E+01 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.11E-01 | 0.00E+00 | 4.40E+00 |
| **75% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.53E+00 | 0.00E+00 | 2.94E+01 |
| **POSITIVE DELTA** | -9.29E-03 | 0.00E+00 | -3.00E-03 | -9.00E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.77E+00 | -9.24E-02 | 1.13E+01 |
| **NEGATIVE DELTA** | -9.29E-03 | 0.00E+00 | -3.00E-03 | -9.00E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -3.65E+00 | -9.24E-02 | -1.37E+01 |

| **AVERAGE STILL** | **Disodium phosphate** | **Emamectin Benzoate** | **Ethofenprox** | **Fenamidone** | **Flazasulfuron** | **Fluazinam** | **Fludioxonil** | **Fluopicolide** | **Folpet** | **Fosetyl-Al** |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 0.00E+00 | 3.45E-03 | 0.00E+00 | 1.44E-02 | 6.30E-04 | 3.03E-02 | 1.09E-01 | 1.30E-01 | 9.61E-01 | 4.93E+00 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.00E+00 |
| **MAX VALUE** | 0.00E+00 | 5.10E-02 | 0.00E+00 | 2.75E-01 | 1.20E-02 | 5.78E-01 | 1.09E+00 | 7.95E-01 | 1.43E+01 | 2.35E+01 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.21E-01 | 2.66E-01 | 6.47E-01 | 7.85E+00 |
| **POSITIVE DELTA** | 0.00E+00 | -3.45E-03 | 0.00E+00 | -1.44E-02 | -6.30E-04 | -3.03E-02 | 1.27E-02 | 1.36E-01 | -3.14E-01 | 2.92E+00 |
| **NEGATIVE DELTA** | 0.00E+00 | -3.45E-03 | 0.00E+00 | -1.44E-02 | -6.30E-04 | -3.03E-02 | -1.09E-01 | -1.30E-01 | -9.61E-01 | -4.93E+00 |

| Product Code | Glufosinate ammonium | Glyphosate | Hexythiazox | Indoxacarb | Iprovalicarb | Mancozeb | Mandipropamid | Meptyldinocap | Metalaxil-m | Methoxyfenozide | Metiram |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P1W1SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.58E+00 | 0.00E+00 | 9.42E-02 | 2.41E-02 | 0.00E+00 | 7.47E+00 |
| **P1W2SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.58E+00 | 0.00E+00 | 9.42E-02 | 2.41E-02 | 0.00E+00 | 7.47E+00 |
| **P2W3SPARK** | 7.96E-01 | 6.48E-01 | 0.00E+00 | 4.50E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.10E-01 | 0.00E+00 | 0.00E+00 | 3.90E+00 |
| **P2W4SPARK** | 7.96E-01 | 6.48E-01 | 0.00E+00 | 4.50E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.10E-01 | 0.00E+00 | 0.00E+00 | 3.90E+00 |
| **P3W5SPARK** | 7.96E-01 | 6.48E-01 | 0.00E+00 | 4.50E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.10E-01 | 0.00E+00 | 0.00E+00 | 3.90E+00 |
| **P4W6SPARK** | 0.00E+00 | 6.80E-02 | 3.80E-03 | 0.00E+00 | 7.40E-02 | 0.00E+00 | 1.90E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.36E-01 |
| **P5W7SPARK** | 0.00E+00 | 1.31E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.10E-01 | 0.00E+00 |
| **P5W8STILL** | 0.00E+00 | 1.79E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.10E-01 | 0.00E+00 |
| **P5W9STILL** | 0.00E+00 | 1.79E+00 | 0.00E+00 | 0.00E+00 | 1.95E-01 | 4.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.10E-01 | 0.00E+00 |
| **P5W10STILL** | 0.00E+00 | 1.79E+00 | 0.00E+00 | 0.00E+00 | 1.95E-01 | 4.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.10E-01 | 0.00E+00 |
| **P5W11STILL** | 0.00E+00 | 1.79E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.10E-01 | 0.00E+00 |
| **P5W12STILL** | 0.00E+00 | 1.31E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.10E-01 | 0.00E+00 |
| **P6W13STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.50E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.76E-01 | 4.00E-01 | 0.00E+00 | 2.64E+00 |
| **P6W14STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.50E-02 | 0.00E+00 | 2.59E+00 | 2.50E-01 | 1.79E-01 | 4.40E-01 | 0.00E+00 | 3.52E+00 |
| **P6W15STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.50E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.79E-01 | 2.00E-01 | 0.00E+00 | 2.64E+00 |
| **P7W16STILL** | 0.00E+00 | 3.15E+00 | 0.00E+00 | 9.50E-02 | 0.00E+00 | 1.32E+01 | 3.85E-01 | 0.00E+00 | 5.38E-01 | 0.00E+00 | 5.57E+00 |
| **P8W17STILL** | 0.00E+00 | 1.07E+00 | 0.00E+00 | 0.00E+00 | 2.45E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.88E-01 |
| **P9W18STILL** | 0.00E+00 | 2.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.40E+00 | 0.00E+00 | 3.57E-01 | 4.00E-01 | 0.00E+00 | 2.00E+00 |
| **P10W19STILL** | 0.00E+00 | 7.34E-01 | 0.00E+00 | 1.15E-02 | 3.18E-02 | 2.94E+00 | 1.01E-01 | 1.44E-01 | 1.04E-01 | 2.76E-02 | 8.93E-01 |
| **P11W20STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.32E+00 | 0.00E+00 | 0.00E+00 | 9.70E-02 | 0.00E+00 | 1.10E+00 |
| **P12W21STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.08E+00 | 1.73E-01 | 2.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W22STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.08E+00 | 1.73E-01 | 2.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W23STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.08E+00 | 1.73E-01 | 2.47E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W24STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.37E+00 | 4.48E-01 | 6.40E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W25STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.50E+00 | 1.25E-01 | 1.79E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W26STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.80E+00 | 1.50E-01 | 2.14E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W27STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.80E+00 | 1.50E-01 | 2.14E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |

| AVERAGE SPARKLING | Glufosinate ammonium | Glyphosate | Hexythiazox | Indoxacarb | Iprovalicarb | Mancozeb | Mandipropamid | Meptyldinocap | Metalaxil-m | Methoxyfenozide | Metiram |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 3.41E-01 | 4.74E-01 | 5.43E-04 | 1.93E-02 | 1.06E-02 | 1.04E+00 | 2.71E-03 | 1.17E-01 | 6.89E-03 | 1.57E-02 | 3.91E+00 |
| **MIDDLE** | 0.00E+00 | 6.48E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.42E-02 | 0.00E+00 | 0.00E+00 | 3.90E+00 |
| **MAX VALUE** | 7.96E-01 | 1.31E+00 | 3.80E-03 | 4.50E-02 | 7.40E-02 | 4.14E+00 | 1.90E-02 | 2.10E-01 | 2.41E-02 | 1.10E-01 | 7.47E+00 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 3.40E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.71E-02 | 0.00E+00 | 0.00E+00 | 2.32E+00 |
| **75% PERC** | 7.96E-01 | 6.48E-01 | 0.00E+00 | 4.50E-02 | 0.00E+00 | 1.58E+00 | 0.00E+00 | 2.10E-01 | 1.21E-02 | 0.00E+00 | 5.68E+00 |
| **POSITIVE DELTA** | 4.55E-01 | 1.74E-01 | -5.43E-04 | 2.57E-02 | -1.06E-02 | 5.36E-01 | -2.71E-03 | 9.31E-02 | 5.17E-03 | -1.57E-02 | 1.77E+00 |
| **NEGATIVE DELTA** | -3.41E-01 | -4.40E-01 | -5.43E-04 | -1.93E-02 | -1.06E-02 | -1.04E+00 | -2.71E-03 | -6.98E-02 | -6.89E-03 | -1.57E-02 | -1.59E+00 |

| AVERAGE STILL | Glufosinate ammonium | Glyphosate | Hexythiazox | Indoxacarb | Iprovalicarb | Mancozeb | Mandipropamid | Meptyldinocap | Metalaxil-m | Methoxyfenozide | Metiram |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 0.00E+00 | 7.70E-01 | 0.00E+00 | 1.21E-02 | 3.33E-02 | 3.09E+00 | 1.06E-01 | 1.51E-01 | 1.09E-01 | 2.90E-02 | 9.37E-01 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.33E+00 | 5.06E-02 | 1.77E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **MAX VALUE** | 0.00E+00 | 3.15E+00 | 0.00E+00 | 9.50E-02 | 2.45E-01 | 1.32E+01 | 4.48E-01 | 6.40E-01 | 5.38E-01 | 1.10E-01 | 5.57E+00 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.72E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 0.00E+00 | 1.79E+00 | 0.00E+00 | 2.88E-03 | 0.00E+00 | 4.14E+00 | 1.73E-01 | 2.22E-01 | 1.28E-01 | 4.82E-02 | 1.33E+00 |
| **POSITIVE DELTA** | 0.00E+00 | 1.02E+00 | 0.00E+00 | -9.20E-03 | -3.33E-02 | 1.05E+00 | 6.66E-02 | 7.11E-02 | 1.89E-02 | 1.92E-02 | 3.88E-01 |
| **NEGATIVE DELTA** | 0.00E+00 | -7.70E-01 | 0.00E+00 | -1.21E-02 | -3.33E-02 | -1.37E+00 | -1.06E-01 | -1.51E-01 | -1.09E-01 | -2.90E-02 | -9.37E-01 |

| Product Code | Metrafenone | Miclobutanil | Penconazole | Pirimiphos methyl | Propineb | Proquinazid | Pyraclostrobin | Pyraflufen Ethyl | Pyrethroid | Pyrimethanil | Quinoxifen |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P1W1SPARK** | 1.94E-02 | 0.00E+00 | 6.28E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.42E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.92E-02 |
| **P1W2SPARK** | 1.94E-02 | 0.00E+00 | 6.28E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.42E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.92E-02 |
| **P2W3SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.88E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P2W4SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.88E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P3W5SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.88E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P4W6SPARK** | 1.90E-02 | 1.00E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.30E-03 | 0.00E+00 | 1.20E-02 |
| **P5W7SPARK** | 0.00E+00 | 0.00E+00 | 6.00E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.05E-01 | 0.00E+00 |
| **P5W8STILL** | 0.00E+00 | 0.00E+00 | 6.12E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.05E-01 | 0.00E+00 |
| **P5W9STILL** | 0.00E+00 | 0.00E+00 | 6.37E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.05E-01 | 0.00E+00 |
| **P5W10STILL** | 0.00E+00 | 0.00E+00 | 6.37E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.05E-01 | 0.00E+00 |
| **P5W11STILL** | 0.00E+00 | 0.00E+00 | 6.12E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.05E-01 | 0.00E+00 |
| **P5W12STILL** | 0.00E+00 | 0.00E+00 | 6.00E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.05E-01 | 0.00E+00 |
| **P6W13STILL** | 2.13E-01 | 0.00E+00 | 2.53E-02 | 0.00E+00 | 0.00E+00 | 5.13E-02 | 1.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W14STILL** | 2.13E-01 | 0.00E+00 | 5.07E-02 | 0.00E+00 | 0.00E+00 | 5.13E-02 | 1.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P6W15STILL** | 2.13E-01 | 0.00E+00 | 2.54E-02 | 0.00E+00 | 0.00E+00 | 5.13E-02 | 1.00E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P7W16STILL** | 0.00E+00 | 1.06E-01 | 1.18E-01 | 6.00E-02 | 5.14E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.06E-01 |
| **P8W17STILL** | 0.00E+00 | 0.00E+00 | 2.32E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.92E-03 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.43E-02 |
| **P9W18STILL** | 0.00E+00 | 2.80E-02 | 3.06E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P10W19STILL** | 3.16E-01 | 4.89E-02 | 2.91E-02 | 3.00E-03 | 2.57E-01 | 7.69E-03 | 1.54E-02 | 0.00E+00 | 0.00E+00 | 1.76E-01 | 3.65E-02 |
| **P11W20STILL** | 1.25E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W21STILL** | 6.92E-01 | 1.71E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.72E-02 |
| **P12W22STILL** | 6.92E-01 | 1.71E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.72E-02 |
| **P12W23STILL** | 6.92E-01 | 1.71E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.72E-02 |
| **P12W24STILL** | 1.79E+00 | 1.71E-01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.79E-01 |
| **P12W25STILL** | 5.00E-01 | 4.76E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.00E-02 |
| **P12W26STILL** | 5.99E-01 | 5.70E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.99E-02 |
| **P12W27STILL** | 5.99E-01 | 5.70E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.99E-02 |

| AVERAGE SPARKLING | Metrafenone | Miclobutanil | Penconazole | Pirimiphos methyl | Propineb | Proquinazid | Pyraclostrobin | Pyraflufen Ethyl | Pyrethroid | Pyrimethanil | Quinoxifen |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 8.26E-03 | 1.43E-03 | 2.65E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.05E-02 | 8.06E-03 | 3.29E-04 | 1.01E-01 | 1.01E-02 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **MAX VALUE** | 1.94E-02 | 1.00E-02 | 6.28E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.42E-01 | 1.88E-02 | 2.30E-03 | 7.05E-01 | 2.92E-02 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 1.92E-02 | 0.00E+00 | 6.14E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.08E-02 | 1.88E-02 | 0.00E+00 | 0.00E+00 | 2.06E-02 |
| **POSITIVE DELTA** | 1.09E-02 | -1.43E-03 | 3.49E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.04E-02 | 1.07E-02 | -3.29E-04 | -1.01E-01 | 1.05E-02 |
| **NEGATIVE DELTA** | -8.26E-03 | -1.43E-03 | -2.65E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | -4.05E-02 | -8.06E-03 | -3.29E-04 | -1.01E-01 | -1.01E-02 |

| AVERAGE STILL | Metrafenone | Miclobutanil | Penconazole | Pirimiphos methyl | Propineb | Proquinazid | Pyraclostrobin | Pyraflufen Ethyl | Pyrethroid | Pyrimethanil | Quinoxifen |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 3.32E-01 | 5.13E-02 | 3.06E-02 | 3.15E-03 | 2.70E-01 | 8.07E-03 | 1.62E-02 | 0.00E+00 | 0.00E+00 | 1.85E-01 | 3.84E-02 |
| **MIDDLE** | 2.13E-01 | 1.40E-02 | 2.53E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.83E-02 |
| **MAX VALUE** | 1.79E+00 | 1.71E-01 | 1.18E-01 | 6.00E-02 | 5.14E+00 | 5.13E-02 | 1.00E-01 | 0.00E+00 | 0.00E+00 | 7.05E-01 | 1.79E-01 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 5.99E-01 | 6.93E-02 | 6.03E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.98E-03 | 0.00E+00 | 0.00E+00 | 3.08E-01 | 6.72E-02 |
| **POSITIVE DELTA** | 2.67E-01 | 1.79E-02 | 2.97E-02 | -3.15E-03 | -2.70E-01 | -8.07E-03 | -1.42E-02 | 0.00E+00 | 0.00E+00 | 1.23E-01 | 2.88E-02 |
| **NEGATIVE DELTA** | -3.32E-01 | -5.13E-02 | -3.06E-02 | -3.15E-03 | -2.70E-01 | -8.07E-03 | -1.62E-02 | 0.00E+00 | 0.00E+00 | -1.85E-01 | -3.84E-02 |

| Product Code | Spinosad | Spirotetramat | Spiroxamine | Sulphur | Tebuconazole | Teflubenzuron | Tetraconazole | Thiamethoxam | Trifloxistrobina | Zoxamide |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **P1W1SPARK** | 4.86E-02 | 0.00E+00 | 9.05E-01 | 1.50E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.94E+01 | 0.00E+00 | 0.00E+00 |
| **P1W2SPARK** | 4.86E-02 | 0.00E+00 | 9.05E-01 | 1.50E+02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.94E+01 | 0.00E+00 | 0.00E+00 |
| **P2W3SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.71E+01 | 7.40E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.97E-01 |
| **P2W4SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.38E+01 | 7.40E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.97E-01 |
| **P3W5SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.71E+01 | 7.40E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.97E-01 |
| **P4W6SPARK** | 0.00E+00 | 0.00E+00 | 2.09E-01 | 7.89E+00 | 4.30E-02 | 0.00E+00 | 0.00E+00 | 5.80E-02 | 0.00E+00 | 4.30E-02 |
| **P5W7SPARK** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.02E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.50E-02 | 0.00E+00 |
| **P5W8STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.02E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.50E-02 | 0.00E+00 |
| **P5W9STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.02E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.50E-02 | 0.00E+00 |
| **P5W10STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.02E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.50E-02 | 0.00E+00 |
| **P5W11STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.02E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.50E-02 | 0.00E+00 |
| **P5W12STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.02E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.50E-02 | 0.00E+00 |
| **P6W13STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.40E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.44E-01 |
| **P6W14STILL** | 0.00E+00 | 0.00E+00 | 2.14E-01 | 9.60E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.44E-01 |
| **P6W15STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.40E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.44E-01 |
| **P7W16STILL** | 0.00E+00 | 8.00E-02 | 5.79E-01 | 1.50E+02 | 0.00E+00 | 3.10E-02 | 2.90E-02 | 1.86E-01 | 0.00E+00 | 0.00E+00 |
| **P8W17STILL** | 0.00E+00 | 1.80E-02 | 6.12E-01 | 4.25E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.55E-01 | 0.00E+00 |
| **P9W18STILL** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 9.38E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.00E-02 | 0.00E+00 | 0.00E+00 |
| **P10W19STILL** | 0.00E+00 | 4.90E-03 | 4.29E-01 | 3.73E+01 | 0.00E+00 | 1.55E-03 | 1.45E-03 | 3.96E-02 | 2.15E-02 | 9.17E-02 |
| **P11W20STILL** | 0.00E+00 | 0.00E+00 | 3.60E-01 | 5.47E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **P12W21STILL** | 0.00E+00 | 0.00E+00 | 8.47E-01 | 6.57E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.92E-02 | 0.00E+00 | 1.74E-01 |
| **P12W22STILL** | 0.00E+00 | 0.00E+00 | 8.47E-01 | 6.57E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.92E-02 | 0.00E+00 | 1.74E-01 |
| **P12W23STILL** | 0.00E+00 | 0.00E+00 | 8.47E-01 | 6.57E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.92E-02 | 0.00E+00 | 1.74E-01 |
| **P12W24STILL** | 0.00E+00 | 0.00E+00 | 2.19E+00 | 1.70E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.79E-01 | 0.00E+00 | 4.51E-01 |
| **P12W25STILL** | 0.00E+00 | 0.00E+00 | 6.12E-01 | 4.75E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.00E-02 | 0.00E+00 | 1.26E-01 |
| **P12W26STILL** | 0.00E+00 | 0.00E+00 | 7.33E-01 | 5.69E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.99E-02 | 0.00E+00 | 1.51E-01 |
| **P12W27STILL** | 0.00E+00 | 0.00E+00 | 7.33E-01 | 5.69E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.99E-02 | 0.00E+00 | 1.51E-01 |

| AVERAGE SPARKLING | Spinosad | Spirotetramat | Spiroxamine | Sulphur | Tebuconazole | Teflubenzuron | Tetraconazole | Thiamethoxam | Trifloxistrobina | Zoxamide |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 1.39E-02 | 0.00E+00 | 2.89E-01 | 6.66E+01 | 3.78E-02 | 0.00E+00 | 0.00E+00 | 5.55E+00 | 7.86E-03 | 9.04E-02 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.71E+01 | 4.30E-02 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.30E-02 |
| **MAX VALUE** | 4.86E-02 | 0.00E+00 | 9.05E-01 | 1.50E+02 | 7.40E-02 | 0.00E+00 | 0.00E+00 | 1.94E+01 | 5.50E-02 | 1.97E-01 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 7.89E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.55E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 2.43E-02 | 0.00E+00 | 5.57E-01 | 1.00E+02 | 7.40E-02 | 0.00E+00 | 0.00E+00 | 9.73E+00 | 0.00E+00 | 1.97E-01 |
| **POSITIVE DELTA** | 1.04E-02 | 0.00E+00 | 2.69E-01 | 3.35E+01 | 3.61E-02 | 0.00E+00 | 0.00E+00 | 4.18E+00 | -7.86E-03 | 1.06E-01 |
| **NEGATIVE DELTA** | -1.39E-02 | 0.00E+00 | -2.89E-01 | -3.11E+01 | -3.78E-02 | 0.00E+00 | 0.00E+00 | -5.55E+00 | -7.86E-03 | -9.04E-02 |

| AVERAGE STILL | Spinosad | Spirotetramat | Spiroxamine | Sulphur | Tebuconazole | Teflubenzuron | Tetraconazole | Thiamethoxam | Trifloxistrobina | Zoxamide |
|---|---|---|---|---|---|---|---|---|---|---|
| | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha | kg of AI/ha |
| **ARITHMETICAL MEAN** | 0.00E+00 | 5.14E-03 | 4.50E-01 | 3.91E+01 | 0.00E+00 | 1.63E-03 | 1.52E-03 | 4.16E-02 | 2.26E-02 | 9.63E-02 |
| **MIDDLE** | 0.00E+00 | 0.00E+00 | 3.94E-01 | 2.71E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.98E-02 | 0.00E+00 | 1.09E-01 |
| **MAX VALUE** | 0.00E+00 | 8.00E-02 | 2.19E+00 | 1.50E+02 | 0.00E+00 | 3.10E-02 | 2.90E-02 | 1.86E-01 | 1.55E-01 | 4.51E-01 |
| **MIN VALUE** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.75E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **25% PERC** | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.35E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **75% PERC** | 0.00E+00 | 0.00E+00 | 7.33E-01 | 7.02E+01 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 6.22E-02 | 5.50E-02 | 1.51E-01 |
| **POSITIVE DELTA** | 0.00E+00 | -5.14E-03 | 2.83E-01 | 3.11E+01 | 0.00E+00 | -1.63E-03 | -1.52E-03 | 2.06E-02 | 3.24E-02 | 5.46E-02 |
| **NEGATIVE DELTA** | 0.00E+00 | -5.14E-03 | -4.50E-01 | -3.28E+01 | 0.00E+00 | -1.63E-03 | -1.52E-03 | -4.16E-02 | -2.26E-02 | -9.63E-02 |

## ANNEX IV

Valid EU regulation updated to July 2017 setting maximum levels for certain contaminants in foodstuffs:

- COMMISSION Regulation (EU) n. 2017/1237 of 7 July 2017 amending Regulation (EC) n. 1881/2006 as regards the maximum level of hydrocyanic acid in unprocessed whole, ground, ground, mololite, crushed and ground apricot seeds placed on the market for the final consumer.
- Commission Regulation (EU) n. 2016/239 of 19 February 2016 amending Regulation (EC) n. 1881/2006 as regards maximum levels for tropical alkaloids in certain processed cereal-based foods for infants and young children.
- Commission Regulation (EU) n. 1940/2015 of 28 October 2015 amending Regulation (EC) n. 1881/2006 as regards maximum levels for sclerotia of Claviceps spp. in certain unprocessed cereals and monitoring and reporting requirements.
- Commission Regulation (EU) n. 1933/2015 of 27 October 2015 amending Regulation (EC) n. 1881/2006 as regards maximum levels for polycyclic aromatic hydrocarbons in cocoa fibre, banana chips, food supplements, dried aromatic herbs and dried spices.
- Commission Regulation (EU) n. 1137/2015 of 13 July 2015 amending Regulation (EC) n. 1881/2006 as regards the maximum level of ochratoxin A in spices Capsicum spp.
- Commission Regulation (EU) n. 1006/2015 of 25 June 2015 amending Regulation (EC) n. 1881/2006 as regards the maximum levels for inorganic arsenic in foodstuffs.
- Commission Regulation (EU) n. 1005/2015 of 25 June 2015 amending Regulation (EC) n. 1881/2006 as regards the maximum levels for lead in certain foodstuffs.
- Commission Regulation (EU) n. 704/2015 of 30 April 2015 amending Regulation (EC) n. 1881/2006 as regards the maximum level of non-dioxin-like PCBs in wild spinarolo (Squalus acanthias).
- Commission Regulation (EU) n. 1327/2014 of 12 December 2014 amending Regulation (EC) n. 1881/2006 as regards the maximum levels for polycyclic aromatic hydrocarbons (PAH) in traditionally smoked meat and meat products as well as in traditionally smoked fish and fishery products.
- Commission Regulation (EU) n. 696/2014 of 24 June 2014 amending Regulation (EC) n. 1881/2006 as regards maximum levels for erucic acid in vegetable oils and fats and in foodstuffs containing vegetable oils and fats.
- Commission Regulation (EU) n. 488/2014 of 12 May 2014 amending Regulation (EC) n. 1881/2006 as regards the maximum levels for cadmium in foodstuffs.
- Commission Regulation (EU) n. 212/2014 of 6 March 2014 amending Regulation (EC) n. 1881/2006 as regards maximum levels for the contaminant citrinin in food supplements based on fermented rice with Monascus purpureus red yeast.

- Commission Regulation (EU) n. 1067/2013 of 30 October 2013 amending Regulation (EC) n. 1881/2006 as regards maximum levels for dioxin, dioxin-like PCBs and non-dioxin-like PCBs in the liver of terrestrial animals.
- Commission Regulation (EU) n. 1058/2012 of 12 November 2012 amending Regulation (EC) n. 1881/2006 as regards maximum levels for aflatoxins in dried figs.
- Commission Regulation (EU) n. 594/2012 of 5 July 2012 amending Regulation (EC) n. 1881/2006 as regards maximum levels for ochratoxin A, non-dioxin-like PCBs and melamine in foodstuffs.
- Commission Regulation (EU) n. 1259/2011 of 2 December 2011 amending Regulation (EC) n. 1881/2006 as regards maximum levels for dioxin-like PCBs and non-dioxin-like PCBs in foodstuffs.
- Commission Regulation (EU) n. 1258/2011 of 2 December 2011 amending Regulation (EC) n. 1881/2006 as regards maximum permitted levels for nitrates in foodstuffs.
- Commission Regulation (EU) n. 835/2011 of 19 August 2011 amending Regulation (EC) n. 1881/2006 as regards maximum levels for polycyclic aromatic hydrocarbons in foodstuffs.
- Commission Regulation (EU) n. 420/2011 of 29 April 2011 amending Regulation (EC) n. 1881/2006 setting maximum levels for certain contaminants in foodstuffs.
- Commission Regulation (EU) n. 165/2010 of 26 February 2010 amending Regulation (EC) n. 1881/2006 setting maximum levels for certain contaminants in foodstuffs as regards aflatoxins.
- Commission Regulation (EU) n. 105/2010 of 5 February 2010 amending Regulation (EC) n. 1881/2006 setting maximum levels for certain contaminants in the products of the product concerned

# ANNEX V

| Name | Description | Established in | Managing body | Regulatory process | Implementation | Geographic perimeter | Control | Target |
|---|---|---|---|---|---|---|---|---|
| Regulation (CE) n. 396/2005 | Plant Protection products maximum residue level | 2005 | EU Institution | Mandatory | Effective | All products sold in EU | Guaranteed by the national state | B2B |
| Council Regulation (CEE) n. 315/93 | Contaminants in foods | 1993 | EU Institution | Mandatory | Effective | All products sold in EU | Guaranteed by the national state | B2B |
| Commission Regulation (EC) n. 1881/2006 | Setting maximum levels for certain contaminants in foodstuffs | 2006 | EU Institution | Mandatory | Effective | All products sold in EU | Guaranteed by the national state | B2B |
| Regulation (EU) n. 1169/2011 | Provision food information to consumers | 2011 | EU Institution | Mandatory | Effective | All products sold in EU | Guaranteed by the national state | B2C |
| Regulation (EU) n. 1151/2012 | quality schemes for agricultural products and foodstuffs (PDO, PGI, TSG, mountain product, product of EU's outermost regions) | 2012 | EU Institution | Voluntary | Effective | Worldwide | Guaranteed by the national state | B2B<br>B2C |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Organic farming | biological or ecological agriculture that combines traditional conservation-minded farming methods with modern farming technologies | 1924* | National public Institution and NGO's | Voluntary | Effective | Worldwide | Independent Certification | B2B<br>B2C |
| Label Rouge - French Law n. 2006-11 | products which by their terms of production or manufacture have a higher level of quality compared to other similar products usually marketed | 2006 | French public institution | Voluntary | Effective | Worldwide | Independent Certification | B2C |
| SNQPI - Italian Law n. 4 of the 3rd February 2011 | Provides for the adoption of the regional integrated production specifications approved by the Ministry of Agricultural and Forestry Policy | 2011 | Italian public Institution | Voluntary | Effective | Italy | Independent Certification | B2C |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Haute valeur environnementale French certification issued by Grenelle Environnement conference | Approach accessible to all the sectors concerned by four themes: biodiversity, fertilization management, phytosanitary strategy and water resource management | 2012 | French public institution | Voluntary | Effective | France | Independent Certification | B2C |
| VIVA Sustainability and Culture | Programme to assess the sustainability performance of the wine sector in Italy | 2011 | Italian public Institution | Voluntary | Effective | Italy | Independent Certification | B2C |
| PEF-OEF Product and organisation environmental footprint Commission recommendation 2013/179/EU | environmental footprint impact assessment methodology based on Life Cycle Assessment | 2013 | EU Institution | Voluntary | experimental phase open for a 2 year test from mid-2018 | All products sold in EU for which a PEF-OEF Category Rules has been drawn up | Independent Certification | B2B<br>B2C |
| MADE GREEN IN ITALY - Ministerial Decree no. 56 of 21 March 2018 | environmental footprint impact assessment methodology based on PEF | 2018 | Italian public Institution | Voluntary | Effective | All product “Made in Italy” for which there is an active RCP. | Independent Certification | B2B<br>B2C |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| EU Ecolabel - Regulation (EC) n. 66/2010 | Ecological labelling scheme to promote and make recognisable products with a reduced environmental impact | 1992 | EU Institution | Voluntary | Effective | All products sold in EU for which a EU Ecolabel criteria has been drawn up | Independent Certification | B2C |
| The Global GAP standard (IFA Standard V5) | Integrated Farm Assurance standard for agriculture, aquaculture, livestock and horticulture production | 1997 as Eurepgap | Private | Voluntary | Effective | Worldwide | Independent Certification | B2B |
| The British Retail Consortium (BRC) global standard | Four industry-leading technical standards that specify production, packaging, storage and distribution requirements to guarantee safe food and consumer products | 1992 | Private | Voluntary | Effective | Worldwide | Independent Certification | B2B |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| International Featured Standard - IFS 6.1 food | Global Food Safety standard for auditing food manufacturers, focussed on food safety and quality of processes and products | 2003 | Private | Voluntary | Effective | Worldwide | Independent Certification | B2B |
| ISO 22000 - Food safety management | food safety management system certification using HACCP | 2005 | Private | Voluntary | Effective | Worldwide | Independent Certification | B2B |
| Safe Food Quality institute – SQF code | food safety and quality management system HACCP based | 2009 | Private | Voluntary | Effective | Worldwide | Independent Certification | B2B |
| Environmental labels and declarations – Type I - ISO 14024:2001 | requirements for operating an ecolabelling scheme | 2001 | Private | Voluntary | Effective | Worldwide | Independent Certification | B2C |
| Environmental labels and declarations - Type II - ISO 14021:2016 | Standard for self-declared environmental claims | 2001 | Private | Voluntary | Effective | Worldwide | Independent Certification | B2C |
| Environmental labels and declarations – | specifies procedures for issuing quantified environmental | 2006 | Private | Voluntary | Effective | Worldwide | Independent Certification | B2B<br>B2C |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Type III - ISO 14025:2010 | information about products, based on life-cycle assessment | | | | | | | |

*developed in 1924 with the Biodynamic agriculture of Rudolf Steiner