POLITECNICO
DI TORINO

Dipartimento di Architettura
e Design (DAD)

Combined analysis of rice and wine value chains in Piedmont Region.

Exploiting processing and transformation by-products throgh the Systemic Design approach

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INTRODUCTION

The rice and wine production in Piedmont, Italy is widely recognized because of its traditional quality and outstanding performance within the market. Over the years, the production of wine and rice has been increased, thus, the process has been changed and activities have been modified in order to respond to the national and international market demand. Therefore, this project presents the individual analysis of the current rice and wine production chains as the clue to finding common processes and agricultural by-products with similar potentialities worthy to be handled.

Currently, it cannot be ignored that people is getting more aware about the origin of the products they are buying. When users acquire these "transparent" products they pay more than the standardized products of the same category, these because through the years the quality that represented such products was taken out as a priority and replaced by the idea that producing –and buying- cheaper was correct.

Indeed, the appropriate technology to produce and register these traceable goods is expensive because of the low amounts required by the market. Why should healthy and quality products need to be part of unique certifications that small businesses cannot invest in? Because the market demands low-cost products without really having in mind the implications in the environment as well their society; this is the reason why a holistic perspective has to be adopted.

Understanding the global and local reality, it is easier to compare and reorganize the current situation by developing processes able to find the natural value of, if possible, the 100% of the raw material used for their main activities. Thus, not only the main value chain's final product will generate the companies' income, but the remaining substances obtained from its activities. As well, the improvement of society and environmental impact.

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Scrutinizing the literature and understanding the by-product potentialities allowed the suggestion for new applications in the local industries. The great percentage of matter that is being wasted today is presented in this project as a valuable resource capable of been transformed and generate new profitable products from the pharmaceutical to the food industry.

In the pursuing of the Circular Economy principles, every stage of the process, not only the final product, should be controlled and register in order to continuously generate strategies that improve the know-how of the principal value chain (sold wine and milled rice in the market) without leaving apart the potential of by-products as resources available deprived of additional investment cost.

On the contrary, these new inputs will increase the industries yields due to the creation of a diversified market introducing products that optimize their highest utility the own biological and, of course, technical properties. The systemic approach adoption is the most valuable self-certification linked to the territory's reconfiguration and traceability requirement that new products must provide and communicate to consumers and involved actor.

Also, the systemic procedure reveals the importance of the interdisciplinary background as the principal developer of these new by-product uses. These new applications firstly look forward to improving critical conditions or activities performed during the transformation and processing of rice and wine. After identifying, studying and evaluating the critical and noncritical issues in the individual chain analysis, it was possible to compare and identify in which phase of the production chain wine and rice could generate common, similar or complementary substances able to be introduced in the Piedmont Region industrial reality, marked by the interest of improved their processes and evaluate new possible investments. The different stages of this study are individualized in Figure 1.

For the analysis of how could one chain be related with the other one, it was done a multidisciplinary study, where it was analyzed not only the connections possible design view but also from other disciplines and industries perspectives, such as biology, chemistry, physics, agronomy, gastronomy, and some other that will be deepen during this analysis.

Now, taking into account the two chains that are being studied, there are some characteristics that make them suitable for this choice. The starting point is that they share one territory and are main productions of it, but furthermore there are some reasons that make them fit together on this approach.

Rice is a hub for biodiversity embracing ecosystems such as fish, wildlife, livestock, plants and micro-organisms. (FAO, 2003) on the other hand, this production could be improved by a better and more efficient use of water, land and labor while reducing the losses incurred during production, transportation and processing. In this way, Improving the productivity of rice systems would contribute to hunger eradication, poverty, alleviation, national food security and economic development. Also, it would be able to increase dietary diversification through the promotion of complementary crops and livestock or fisheries activities.

In the case of wine, the systemic approach will help protect the soil, water and air, safeguarding the health of the local land, the surrounding communities and the industry. This taking into account that other countries are getting stronger on wine production

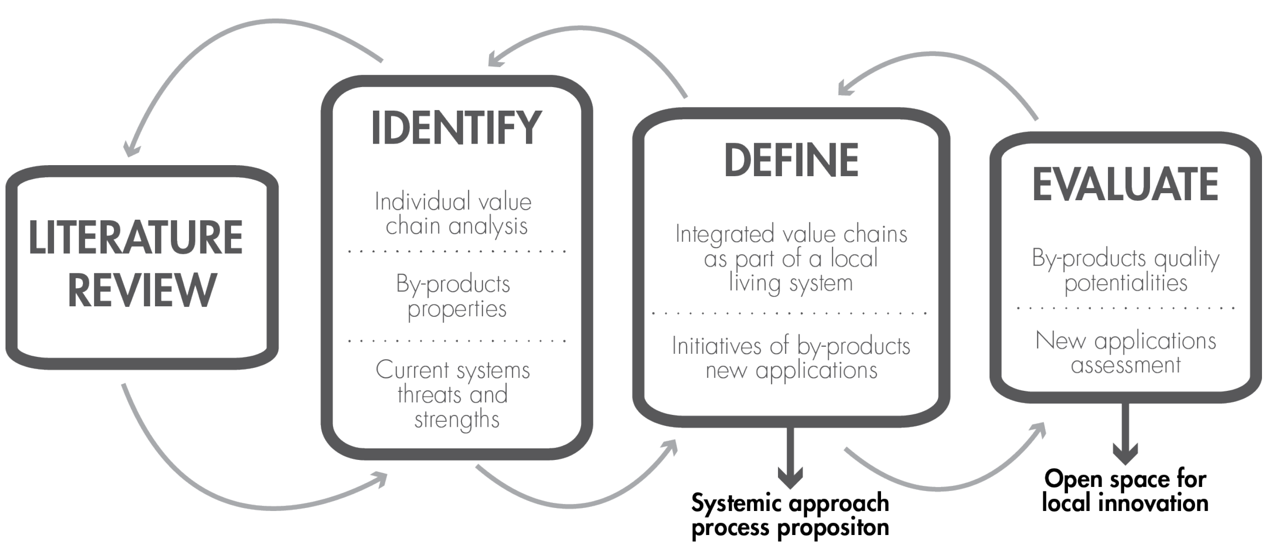

Figure 1: Study iterative process stages

because of marketing advantages, then, being competitive and responsible since the cultivation and production will potentiate the value of the industry and will help Piedmont's winegrowers to re-position in the market not only by the wine types that are already worldwide known, but also for the sustainable activities done for the production if it.

OBJECTIVES

GENERAL OBJECTIVE

Propose new applications from the by-products of milled rice and wine making through a systemic approach capable of linking both Piedmont's industries.

SPECIFIC OBJECTIVES

- Recognize the potential of innovative uses of the rice and wine by-products for promoting the zero-waste industrial development.

- Contribute to the local economy growth when perceiving by-products as useful raw material.

- Stand out the territory's new activities valorized by the traceability and quality of novel products.

- Support the InnovaEcoFood project in its research and material selection based on the reuse of local agro-activities.

1. RESEARCH METHOD

It is necessary the examination of an organized way able to plan the possible changes made to the rice and wine production industries in order to reconstruct the value of their specific context, not only contemplated at the financial level, but the natural, social and human as well. The selected procedure for the analysis and generation of the final outcome came from two emerging methodologies. These are the Systemic Design and the Circular Economy; both are holistic postulates immensely preoccupied for revalorize the quality of a territory.

In first place, the analysis of the value chains was done by the Systemic Design guidelines, which was useful for the understanding of each phase and the reasoning about how could one process help other and how would they mutually benefit. Lately, the creation of the system process presented in this document, was generated by the parameters and constraints that follow the principles of the Circular Economy.

1.1. Systemic Design

Basically, this methodology introduces a change in perspective by looking at the development of a specific territory and its identity value through the creation of a network that connects the local actors and their environment. Only by recognizing and managing the resources of the place one lives in, the understanding of complex living systems will be possible. In other words, through real knowledge of the complete environment functioning, the production of rice and wine in Piedmont will be optimized by finding value in what nowadays is treated as waste.

In this order of ideas, it is possible to mention that the systemic approach involves a total rethinking of the current linear economic model. In particular, the analysis of how outputs -as matter and energy- of a process can be reused as inputs to another reducing the leftovers produced and creating synergies between different production systems (Bistagnino, 2009).

A systemic approach assures a long-term resilience in living systems flows because it is based on a series of autopoietic relations generated between the local actors involved (environment is a protagonist) looking for a common and proportionate welfare. The autopoiesis notion reveals the autonomy of the systems; a system will find independently, in the management of its own matter or energy flows, the required resources to complete its natural cycles.

As mention before, the systemic approach always gives value to the quality of each new input or resource (another reason to recognize why the processes should be changed) coming from a specific activity. Therefore, there is a conscious use of the material characteristics capable of reducing industrial or agro-industrial waste almost to zero.

Systemic processes shape a strong net between different productive realities, in this case the milled rice and the wine, giving the opportunity to establish the former multi-productive and organic management of agro-factories in a modern context where small, medium or large-scale companies seeks to be competitive in the market. Even so, the market cannot still be understood as the main variable that prohibits the creation of this flexible but complex network.

The importance of studying food and agro-activities chains is accepting that human health should not be left apart from the origin of the products they are consuming.

It is important to embrace diversified dietary habits through the adoption of complementary crops. Hence, yield-enhancing will be made by managing quality and not submitting the territory to exaggerated physical stresses and empowering the community action from the center of every initiative.

1.2. Circular Economy

The current ways of production, either for agricultural or manufactured products have been responding to the market's demand in an economical efficient way, leaving apart the relation with the environment and the fair treatment of direct workers –and consequently costumers- whose interactions are affected by these industries. The results of the mentioned before are widely illustrated in natural resources' depletion, labor shortages, gender-based conflicts, environmental pollution and other (FAO, 2003).

So, by conceiving the benefits of understanding complete systems and not its individual components, it is possible to acknowledge the importance of scientific develop applied to current value chains, yet effectively supported by the traditional practices established as quality markers. Thus, Circular Economy refers to the controlled management of a functional service since the beginning of it, willing to optimize systems rather than individual components. Then, the "make-take-and-dispose" (Bompan & Brambilla, 2016) thought is vanished by the sense that growth could be obtained by really appreciating the biological and the technical nutrients of a specific cycle.

When dividing the matter and energy used in a process as shown in Figure 2, this methodology contemplates the safe reinsertion of useful biological components into natural cycles contributing to the increase of natural capital and by the other hand, allowing man-made materials to circulate in processing cycles at a high quality without being extremely noxious or damaging ecosystems. As Webster (2015) stablished:

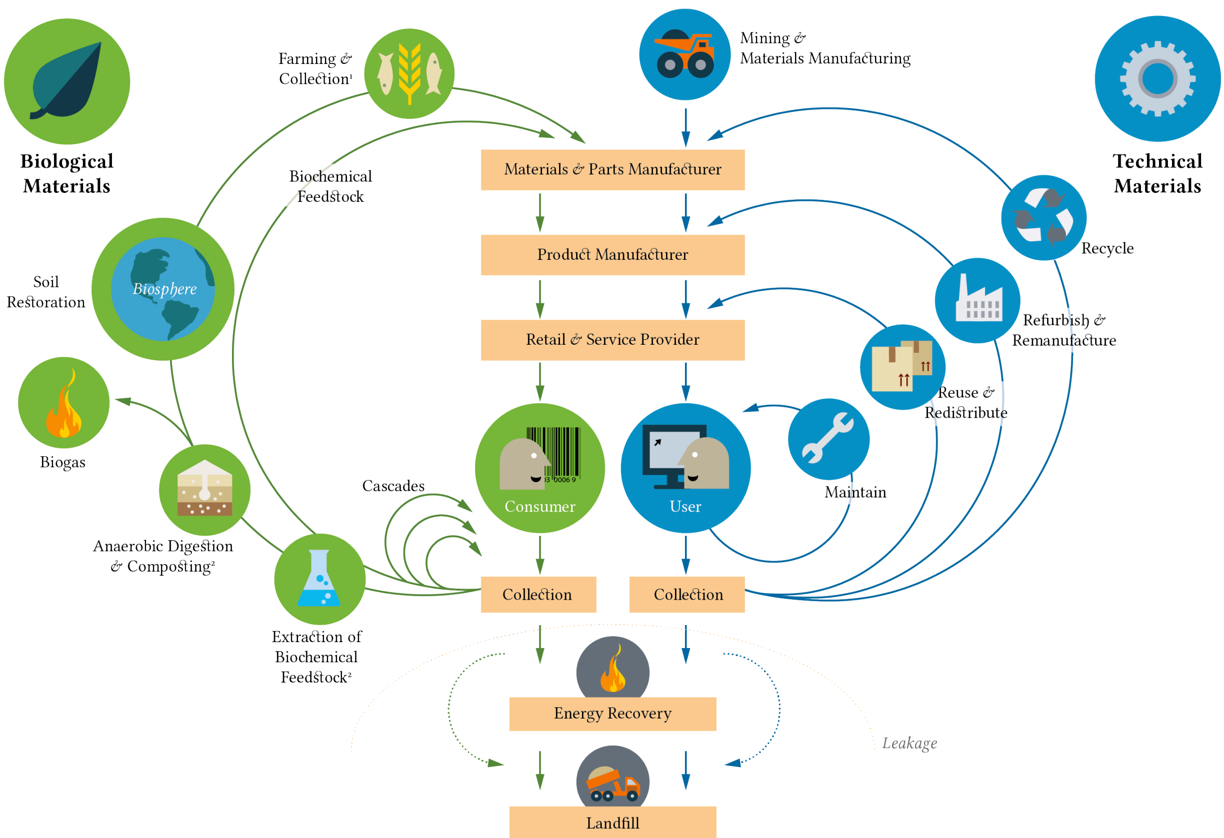

Figure 2: Circular economy flowchart. *Source: Ellen MacArthur Foundation*

> "The Circular Economy refers to an industrial economy that is restorative by intention; aims to rely on renewable energy; minimizes, tracks and hopefully eliminates the use of toxic chemicals; and eradicats waste through careful design. The term goes beyond the mechanics of production and consumption of goods and services, in the areas that it seeks to redefine"

This strategy was applied in order to further understand how could value be generated from the resources of the chains themselves, and trying to get the needed resources from their specific context and not from external non-local actors that would mean an unnecessary expense.

The generation of organic synergies offers high-yield crops, if the know-how is well understood. Also, creates new positions in small-local industries giving value to the territory and its remarkable resources – formerly treated as waste.

The systemic process of wine and rice Piedmont's industries will be respond to the five main principles exposed by the Ellen MacArthur Foundation (Webster, 2015), one of the main supporters of this aware transition for valorized products and services:

Design out waste. Either biological (non-toxic, compostable matter) and technical components (man-made materials) are used, as part of a whole system, until their cycles do not allow another application.

Build resilience through diversity. There are three main characteristics which need to be prioritized in today's perception of be competitive; modularity, versatility and adaptability.

Work towards using energy from renewable sources. Changing the perspective and adopting integrated processes make easier the management of resources and recognizing their limitations, as the energy needed for a determined task.

Think in systems. Creating valuable connections between different components of a system embraces the flexibility need to administer a whole complex system that changes circumstances in a natural way, even if these have to be well comprehended by a larger number of actors. As Webster (2015) explained, "systems that are increasingly efficient have fewer nodes, fewer connections, and greater throughput but also become increasingly brittle".

Currently, production responds to a volatile market in constant change and is supported by counted suppliers. Meanwhile, the generation of a network with multiples nodes (or connections) responds to the human activities that give value to the proper territory relying on a huge range of quality suppliers.

Think in cascade. Biological and technical components have a quality which value is found in new applications. Promoting a zero-waste philosophy, is not disappearing the by-products of the processes, is evaluating the quality and performance of these as respected and useful raw material in new activities.

2. RICE

2.1. General overview

Rice is a semi-aquatic plant, commonly related to Asian origins, that grows annually in every continent of planet Earth but Antarctica. As an agricultural commodity, rice is the second leading grain crop in the world as shown in Figure 3, only overcame by maize (Muthaya et al., 2014). During the years, since humankind can refer to history of rice, two main species are important for societies consumption: *Oryza Sativa* known as Asian rice and *Oryza Glaberrima* better called African rice.

As in this order of ideas, *Oryza Sativa L.* is the most cultivated rice around the world, from almost 15 000 years ago –finding crops in one-hundred thirteen countries belonging to Asia, North and South America, European Union, Middle East and Africa. In other hand, for the second one, it is possible to have in mind its presence since approximately 3 000 years ago as a descendant of *Oryza Barthii* present in the Sub-Saharan Africa (Muthaya et al. 2014).

During world's history, so many cultures have created their dietary habits based on rice consumption, therefore this cereal grain tends to be not only produced but consumed in the same place where it has grown (International Rice Research Institute [IRRI], 2015), turning itself as one of the biggest products when talking about food security (specially in economically challenged countries).

In consideration of the mentioned before, the whole productive chain of this commodity, from the soil's preparation until its processing phase, means the main source of employment (FAO, 2003) and decent well-being in many regions where poverty is a critical factor.

In general, it is important to understand the role given by rice consumption around the world; firstly because of the nutritional contribution among different societies (FAO, 2003) and also because of its adaptability to different kinds of soil, climate conditions and subjected height.

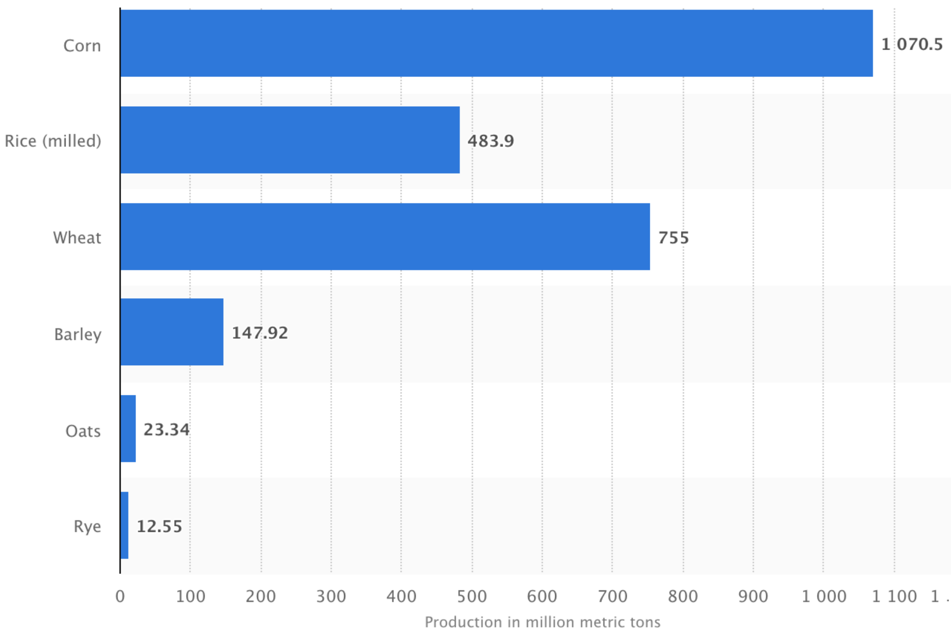

Figure 3: Worldwide production of grain in 2016/2017 by typology. *Source: statista.com*

RICE THROUGH TIME

Over the years, rice has granted nearly 20% of the daily calories to the world population. Even though there is a lack of some nutrients and vitamins (Muthaya et al. 2014) in its nutritional content, rice varieties are present in many kitchens around the world. Where does rice come from? An interesting question to be answered, unfortunately, it has been hard to tell the exact moment in history when rice appeared.

There are two well diffused hypotheses inclined to describe the very beginning and domestication of this grass specie. The first one declares that rice migrated from the Eastern Himalayas foothills and the second states the idea of a wild rice born in India and slowly spread to China, Korea, Philippines close to the 2 000 BCE and a thousand years later to Japan and Indonesia (All India Rice Exporters Association [AIREA], 2012).

Evaluating the data related to the first hypothesis and looking at recent studies made from 2004 to 2007 in Tianluoshan, China make scientists understand the origin of domesticated rice crops as part of a process developed in the Lower and Middle Yangtze, China (Fuller et al., 2009).

It could be said that even though there is an information gap about rice story before the year 6 000 BCE, the study of the spikelets bases revealed the cultivation of the grain as part of the social organization of the society between the 6 000 and the 4 000 BCE. Also, in this excavation, Fuller et al. (2009) mentioned the domestication of rice as a key transition of the major economic and ecological changes from the 4 000 BCE.

Being an autogamous wild grass, rice is a plant present all around the territory. At the very moment in which ancient cultures started to improve its quality conditions, the combination of crops and original seeds changed. Definitely, the domestication brought a total new way of conceiving the agro-activity like a human controlled system.

Taking into account the meaningful presence of the seed over the territory, the evidence shows the starting point of puddling soil and transplanting seedlings in this Chinese territory; so that, the creation of different structures and techniques truly helped to domesticate the plant (All India Rice Exporters Association [AIREA], 2012).

According to all new methods and techniques apparently used by these communities, the transformation of the seed allowed new varieties creation. Therefore, it is possible to recognize the most widely spread variety around the world: *Oryza Sativa L.*

When talking about *Oryza Sativa L.* people normally are mentioning the 440 000 years variation of the *O. Rufipogon*, which in accordance to Garris et al. (2005) started having its value in the trader ancient societies; definitely a good reason to improve the quality and start being economically competitive.

Over the years, the authenticity of rice seed has helped scientists and agronomists creating research laboratories in order to improve the performance of the grain-cereal within the current market necessities. Contemplating the importance in the world's dietary habits, these crops are under constant control because of the high number of plagues that could attack them. Also, science is seen as an associate in the duty of generating new rice varieties with a higher nutritional content.

In the past years, the International Research Rice Institute (IRRI) has been working on characterizing rice "for its traits and genetic makeup to find useful versions of genes" (International Research Rice Institute [IRRI], 2016). Getting to know rice along the years have let professionals to protect those traditional varieties which are vulnerable of disappearing because of genetic erosion.

As the IRRI's research tries to eradicate hunger and improving living conditions in the Asian territory, the creation of the International Rice

Genebank (Figure 4) takes an important global role where all countries around the world could send its own seeds to be preserved. At January 2017, the Genebank counted with 126 916 traditional, modern and wild rice varieties where almost 40 000 are *Oryza Sativa* variations.

RICE THROUGH TIME

Rice is an annual plant commonly sown in spring and harvested in fall with a 150 to 180 days cycle in order to reach its maturity. The plant morphology (Figure 5a) depends on the soil's quality and content of four main nutrients: nitrogen, carbon, calcium and phosphoric acid. So, if the plant grows in optimum conditions it would reach a higher level to receive the wind-pollination. The edible seed, also called caryopsis, is a grain (Figure 5b) commonly known as kernel. After the harvest, the kernel is treated, giving birth to milled white rice.

For the correct development of every grow stage of the rice plant (Figure 6), substrates present in soil are not the only important factor influencing the plant's growth and yield potential (Haifa Chemicals, 2014); the water is another unnegotiable actor in this project because of the huge quantities rice needs not only to be hydrous, but protected from the thermal changes.

In a study realized by Haifa Chemicals (2014), it was expressed that "about the 75% of the global rice production comes from irrigated rice systems because most rice varieties express their full yield potential when water supply is adequate". Then, the former statement refers to the specific location of rice crop around the world.

Even though rice is found in a wide range of land surface, the grain yield will depend only of the variety and the growing method, even dry or wet as shown in Figure 7.

Figure 4: Rice varieties archive open to those who want to cultivate or recover any specific rice variety. *Source: IRRI*

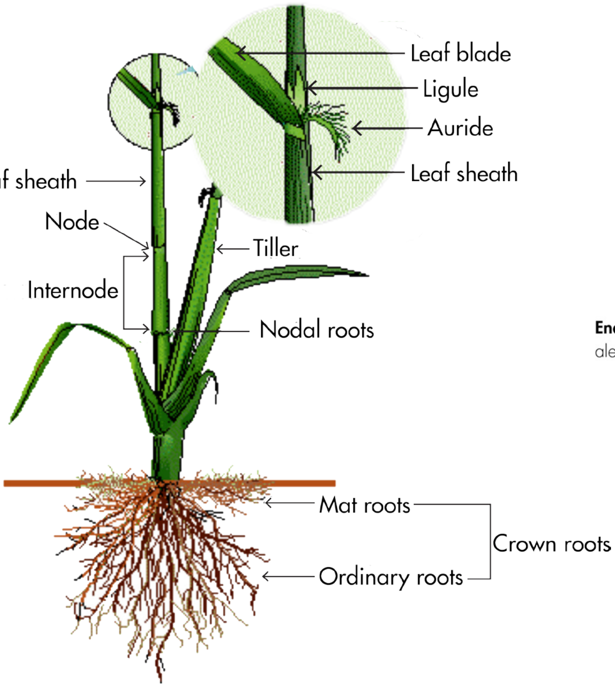

Figure 5a: Rice straw and root morphology. *Source: Haifa Chemicals Ltd.*

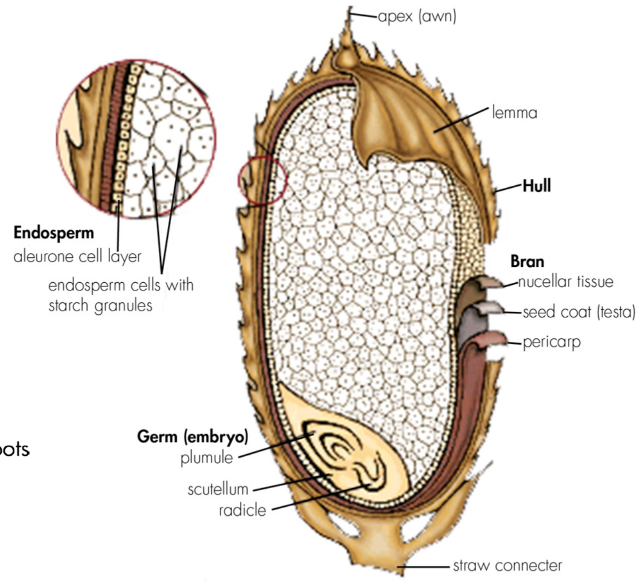

Figure 5b: Rice grain cross sectional view. *Source: Encyclopedia Britannica, Inc.*

Dry growth location is characteristic of the upland and the rain-fed growing methods. On the other hand, the wet methods are integrated by the irrigation and deep-water environments.

In this order of ideas and knowing that three quarters of world's rice production come from irrigated crops, Figure 8 illustrates the highest density of irrigated systems in Asia and its surroundings. In line with S.M Haefele (2014), irrigated crops are more productive if well managed than rain-fed upland and deep-water lowland. The average yield of irrigated plantations goes in the range from 3 to 5 t/ha contrasting with the 1 t/ha given by rain-fed upland and deep-water growing crops (Haefele, Nelson, & Hijmans, 2014).

From the expressed above, is worth to notice the extremely important participation of countries like China, India, Indonesia, Bangladesh, Vietnam, Myanmar, Thailand, Philippines, Japan and Pakistan as hometown

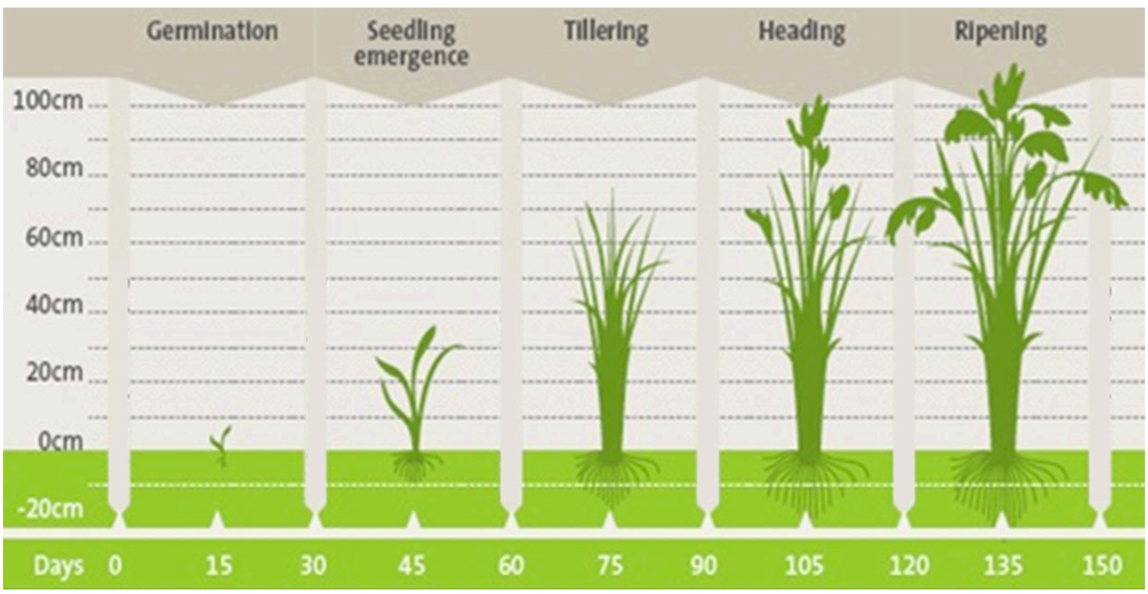

Figure 6: Rice plant growth stages from 0 to 150 days. *Source: Haifa Chemicals Ltd.*

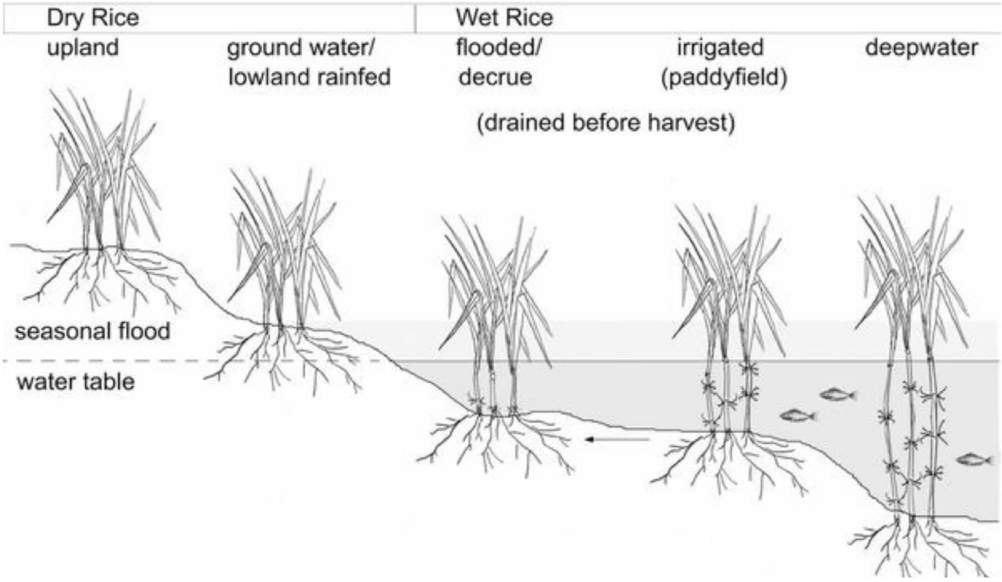

Figure 7: Dry and wet growing methods depends of the territory. *Source: University College London*

of the 90% of produced rice around the world without ignoring the other meaningful 5% of countries like Brazil, United States of America, Egypt, Madagascar and Nigeria (Muthaya et al. 2014).

With so many varieties of the grain, there come along different kinds of flavors, cooking methods and ways of integrating rice as part of the cultural develop of a specific nation as declared by the IRRI (2015). Therefore, it is easier to understand the classification depending on grain length, width, nutritional value and chemical characteristics as the common denominators to analyze rice subgroups.

There are five subgroups: Indica, Japonica, Tropical Japonica, Glutinous and Aromatic (FAO, 2003). However, there are two primary domesticated types around the world's market, these are the Indica and the Japonica subspecies; the biggest differences between both of them are the geographic region where they grow and the unique characteristics when cooked.

Taking into account these two varieties are the most demanded in the market, their characteristics should be understood as a whole in Figure 9.

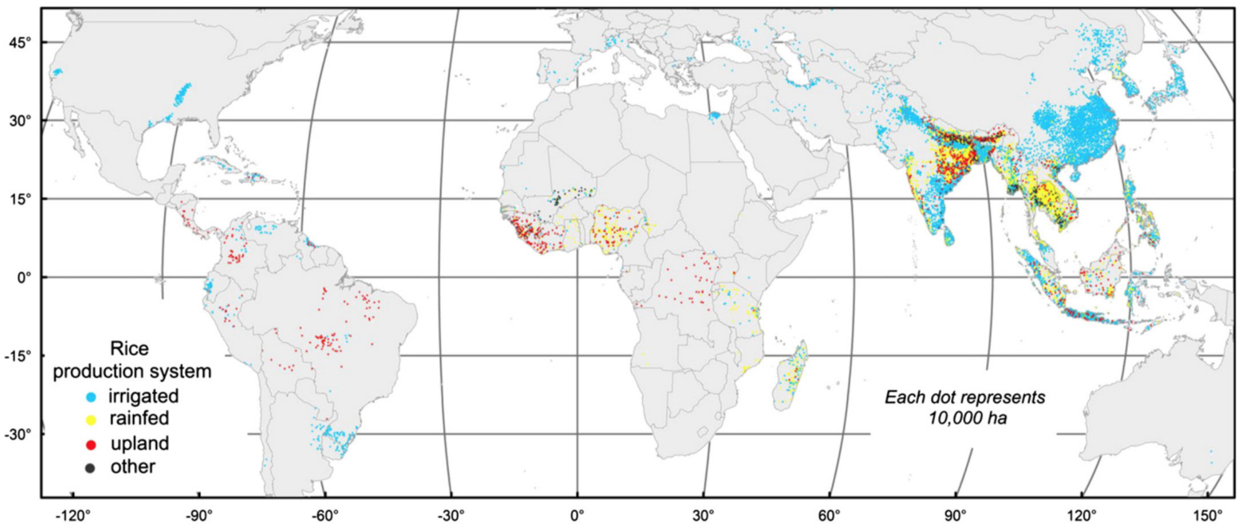

Figure 8: Rice production system. *Source: Haefele, Nelson, & Hijmans, 2014*

Japonica usually grows in temperate environments and the short, medium or long kernels get sticky when cooked (Beigthley, 2010); on the other hand, the Indica varieties are produced on Southern Asia Americas and generally the long kernels do not get sticky when cooked. Thus, from these different traits, each culture embraces the rice management in different ways.

JAPONICA	TRAIT	INDICA
Narrow, dark green	Leave shape and color	Large, light green
Wide	Corner between flag leaf and roots	Narrow
Reduced	Stem length	High
Luthe and hard to break	Stem hardiness	Rigid and easy to break
Hard lodging	Tendency to lodging	Easy lodging
Tends to circular section	Kernel's shape	Long, narrow, slightly plain
Reduced	Tendency to ginning	High
Low varieties	Aristation	Normally present, variable length
Dense and short	Trichomes number-lenght (glume)	Scattered, relatively long
<2,5	Kernel lenght/wide ratio	>2,5
Slow	Germination	Fast
Negative	Phenolic reaction	Positive
High	Potassium choride tolerance	Low
High	Low temperature tolerance	Low
Low	Drought resistance	High
Low	Endosperm resistance to alkalis	High

Table 1: Principal characteristics of main rice varieties. *Source: Beightley,2010*

CURRENT SITUATION AS A COMMODITY

As mentioned before, rice is a staple food present in every continent around the world, therefore analyzing its current trade situation stands out the actual drop of the per capita demand (FAO, 2003). Though, the increasing population maintains the consumption patterns active as shown in Figure 9.

Because rice varieties are no substitutable one to another –as shown previously, separately forms a proper market reason why it is common to perceive different behaviors in the grain daily prices and exchange.

Equally important are the legal norms that every country has to follow in order to be competitive in the market and introducing these kind of commodities as merchandise. So, the variety availability is not the only reason why rice market is volatile there are other factors explained by Muthaya et al. (2014) listed below:

In the period 2016-2017, India and Thailand were considered the major traders of rice in the world. In 5th position was the USA with almost a third of the total exportation rate bounded by India; nevertheless, the North and South America performance is growing in the exportation, this has started balancing their contemporary situation as importers.

Having in mind all the managed milled rice tons during the year and its high consumption, seems reasonable to think about not only the economic impact of these agro-activity, but the environmental. Consequently, reaching out to optimize the sustainability and production systems will be the focus of this study as an action to improve the ecosystem's welfare.

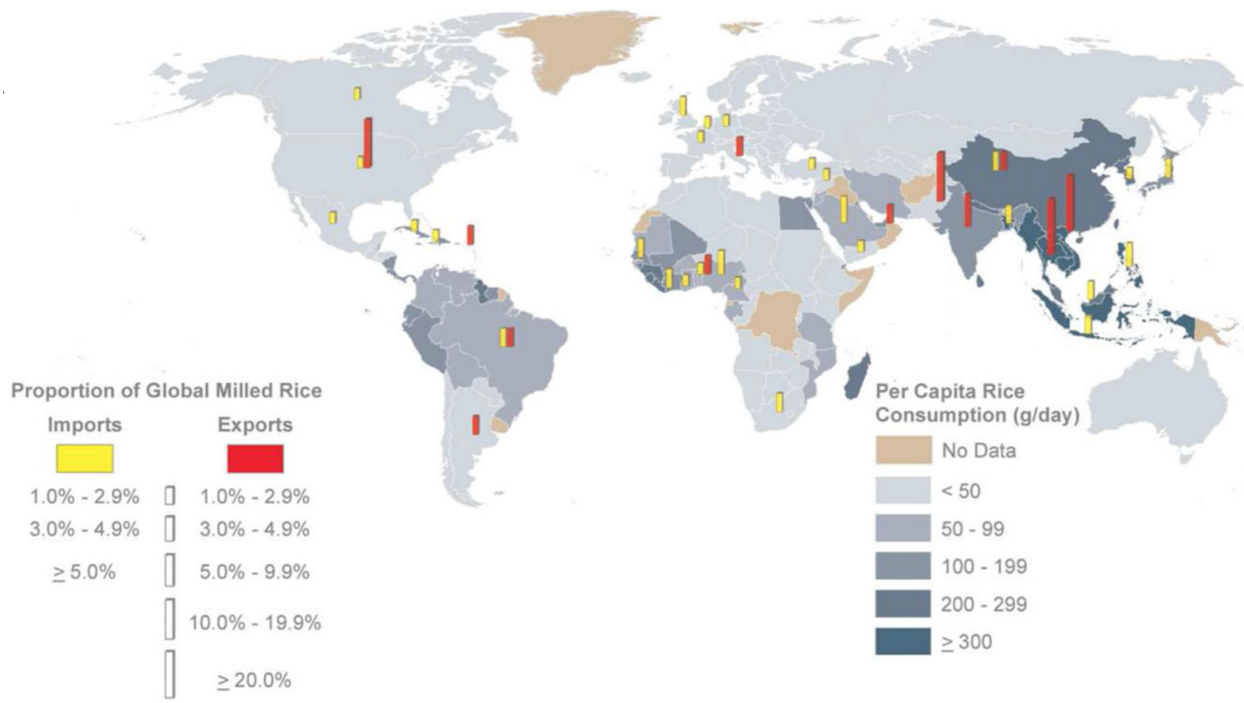

Figure 9: Global milled rice consumption, importation and exportation [2009-2010]. *Source: Muthaya et al., 2014*

2.2. The rice in Europe and Italy

Although the Italian rice cultivation is a traditional agro-activity, rice was firstly considered a paid good because of its cosmetic and pharmaceutical uses in the Greek culture and the Roman Empire (Accademia Italiana della Cucina, 2014). From there, it goes through the south of Mesopotamia (Tigris and Euphrates rivers) and over the Red Sea coastline close to Armenia.

Other historical data shows that there is evidence in Spain of rice crops around the eighth century; it seems to be incorporated as part of the Arabic invasion with the Damascus caliphate.

Nevertheless, rice history has been hard to be documented because of the different evidence and seeds varieties found in Portugal, France and Spain before it arrived in Italy. Eventually, the grain arrived in the fifteenth century with its gastronomic application taught by the Arabian conquerors.

Figure 10: Italian pioneers in rice farming. *Source: Own elaboration*

According to the Rice National Entity, rice could reach the Italian territory by four different ways shown in Figure 10 and by the sixteenth century, there were already 50 000 hectares dedicated to rice "Nostrale" variety (Ente Nazionale Risi, 2012). Even though the rice culture started to be well spread in some areas of the territory, especially in the northern part, it was until 1839 when the Jesuit priest Calleri brought forty-three new varieties from Philippines.

With the new rice varieties in the territory, the experiments and empiric learning about the grain started with Camillo Benso, Cavour's count, who encourage some farmers in cultivating these new seeds and the creation of the "Stazione Sperimentale di Risicoltura di Vercelli" (Vercelli's Experimental Station for Rice Growing).

Another big initiative from the Cavour's Count was the construction, from 1862 to 1866 (Accademia Italiana della Cucina, 2014), of one of the most efficient irrigation systems in the Po's Valley called "Canale Cavour". This canal goes through the Po river, Chivasso and disembogues in the Novara's Ticino River.

In the first years of the twentieth century, Italy bought the first technologies that supplied mechanized help to the whole process. Formerly, farmers were used to manage the land manually; straightaway, came the new labor normative which enforced collective contracts and an eight-hour working day.

In general, it could be said that from the last half of the nineteenth century, the Italian rice production was seen as a very promising activity for the national development. The more land was adapted to rice crops, the more people started migrating close to these areas, so, not only the landscape began to be modified by the domesticated crops, but the social structure towards the field processing.

Over the years, more than 60 000 hectares were cultivated with paddies -as rice is known after it has been harvested and before its threshing and drying, multiple experiments were done and an apparently growing economy was emerging in Italy. However, the Great Depression turned out as the biggest problem the rice sector (Ente Nazionale Risi, 2012) had to face in the 30s of the past century.

With the crisis, the Rice National Entity was created in 1931 to focus in the main areas of the production chain, as shown in Figure 11. Under the creation of this new entity, the former research and experimental analysis was enhanced in order to offer better quality milled rice and intensify its presence within the country.

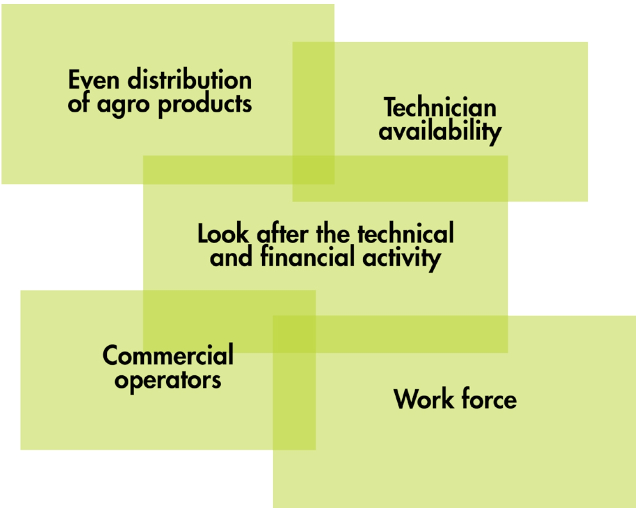

Figure 11: Rice National Entity main tasks. *Source: Own elaboration*

It is worth to mention the importance of the grain as a social actor in the years after the depression and the Second World War (Accademia Italiana della Cucina, 2014). Because of the conflict, people, especially low-income families, started consuming rice because of its nutritional characteristics and was in that moment when rice preparations and recognition of hybrid varieties became part of Italian culture and cuisine.

Different experimentations continued to be part of the improving rice industry during the years and in 1952 (FAO, 2003) there was a breaking point in the way rice growing was executed. As a grass, rice is vulnerable to many diseases and plagues; thus, scientists started diffusing the application of pesticides and chemical agro-products for protecting the crops.

Therefore, farmers started spreading these substances among the fields until the 2000s (Perosino, 2002). The abusive usage of chemical products brought with it considerable biodiversity loss and migration, growth inhibition of surrounding crops, hydric sources contamination and last but not least, the raise of human illness associated with high toxicity levels.

Keeping in mind the position of rice growing nationwide, Italian norms were adjusted forbidding some pesticides, herbicides and fungicides. From 2002, the integrative production chain was included in almost the 25% of the total cultivated area. As Perosino (2002) explained, it was necessary to conduct alternative strategies like the controlled fertilization, crops rotation and green manure.

At the present time, Italy depends on more advanced technology and chemical products, nevertheless, changing to a greener production system has been difficult because the activity is developed by small farmers who sell their paddies to bigger companies whose purpose is to transform the rice.

With such an organized structure, Italy is the largest producer in Europe. As shown in Figure 12, Italy produce almost the 50% of the total milled rice in Europe (Ente Nazionale Risi, 2014). So, from the entire production, Italy exports 65% -from which 12% goes to Extra-EU countries like Turkey, Switzerland, United States, Lebanon, Syria and Jordan, of the total amount of rice produced nationally, even though the farms have disappeared in a 40% since 1980.

The major percentage of rice is grown and produced in Piedmont and Lombardy, in the region known like Po Valley. As seen in Figure 13, only the 6,8% of the cultivated area is distributed in other regions of the country. Moreover, the investments for the north maintenance are regularly higher because of the disposition of rice irrigated portions of land.

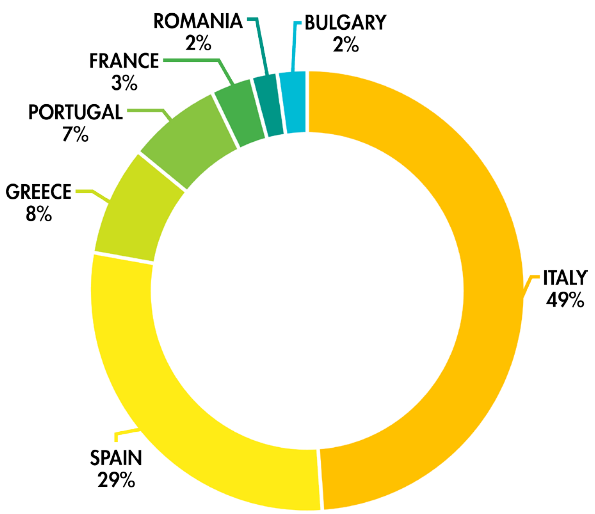

Figure 12: European rice producers. *Source: Ente Nazionale Risi, 2014*

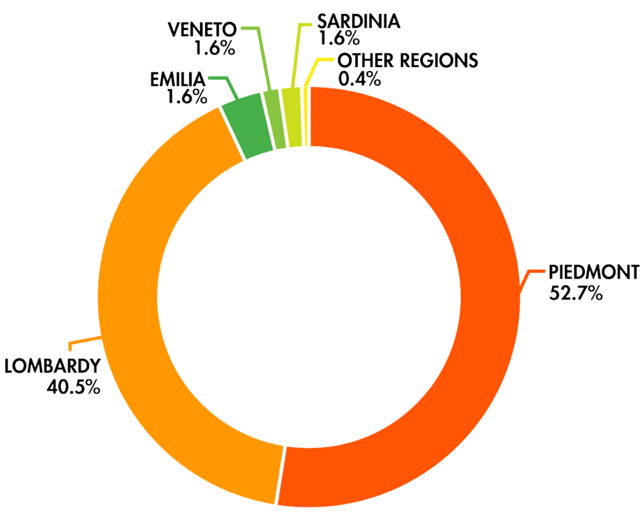

Figure 13: Cultivated area by region. *Source: Ente Nazionale Risi, 2014*

ITALIAN RICE VARIETIES

After the Rice National Entity was created, the Common Market Organizations appeared as supporting bodies in charge of settle the market according to the Common Agricultural Policy, guarantee a fair trade and increase the agricultural productivity of the agro activities.

Studying the data from 2016, it is possible to appreciate that the most consumed presentation is the polished and milled rice with a 69% of national preference followed by the parboiled with a 29% and finally, there is a growing portion of people who are eating brown also recognized like integral rice which represents the 2% of the country's consumption.

Italian varieties are classified in four main groups depending of its grain length, width and shape. The classification determines the specific usage and cooking behaviors of each variety. Figure 14 synthesizes the principal characteristics of the four groups.

The data of the cultivated area in 2016 (shown in Appendix 1) reveals all the grain varieties treated in Italy. With almost 150 kinds and some experimental seeds, the strong experimentation in the paddy fields is visible.

At the moment of the data collection, there was a total of 234 135 cultivated hectares (Ente Nazionale Risi, 2014); clearly, more than the half of the total land dedicated to rice crops corresponds to the Lungo-A group, represented in the Volano and the Luna CL varieties. Subsequently, the rounded grain is the second preferred by Italy's demand with a 30% of the total planted soil followed by the Lungo-B (occupying the 14% of the total) and finally the medium with a 4% represented in the majority by the Vialone Nano variety.

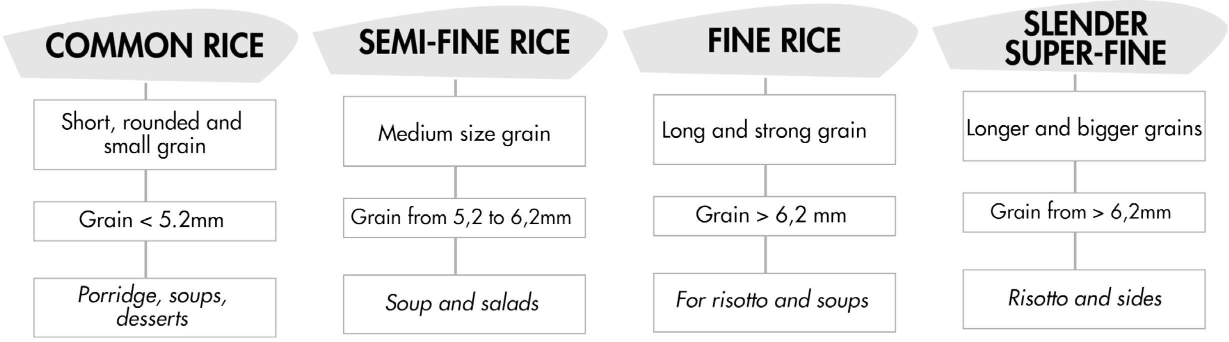

Figure 14: Rice varieties classified by group cultivated in Italy. *Source: Own elaboration*

2.3. Piedmont's rice background

Definitely the better soil for rice growing is located in the Piedmont and Lombardy regions. Because of the width land extension dedicated to this agro-activity, farmers are able not only to produce high quality grains, but experimentation is a common denominator that focus on improving seeds' quality at the same time that allows preserve the traditional varieties locally.

When talk about locally, this document is referring to five main provinces in charge of growing and caring about the 90% of the national rice production and where 74 rice transformation and milling industries (ISMEA, 2015) have their headquarters.

These provinces, delimited in Figure 15, have converted the territory in an important superficial ecosystem by introducing a "squared sea" that covers the flat lands (Accademia Italiana della Cucina, 2014). For understand the importance in the total surface designated to rice growth, Appendix 2 show the total rice obtained by group and variety in every region –conformed by different provinces; Vercelli's performance is wide higher than the rest in every category.

Rice growing not only have changed the landscape of the zone and its organization, the activity also changed the local eating habits, people's lifestyle, the evolution of human settlements and mostly, it could be considered the pillarstone of the social and cultural structure.

In order to appreciate better the current importance of rice crops in the territory, it would be fair to recognize the medieval application of rice according to the Savoia registers in 1253 (Accademia Italiana della Cucina, 2014); the grain was sold like a condiment for desserts preparations. Only after 1500 the Cistercian monks started cleaning and deforesting small pieces of land in order to create the first "granges". After multiple experimentations with different rice selections brought from Philippines, each grange was composed by a three-thousand hectares area in which these varieties where tested.

When talking about deforesting, it is important to emphasize the potentiality of this argillaceous soil for giving a different value in a natural way. Furthermore, these pioneers were proving their hypothesis in an apparently hard to plant soil represented by swamps and moors.

Years past and more land was cleaned and prepared for planting rice. With the increasing demand of the paddies fields maintenance, help was need. So, people living in Rivolta di Mondovì who could not afford taxes payment decided to migrate and make the rice fields their new home.

During the 1600s, rice crops where incorporated to other kinds of grain cultivation. However, the social believe that grain was "food for poor" (Accademia Italiana della Cucina, 2014) and the constant presence of health diseases were crucial for creating a blur prospective of rice nutritional benefits added to the depopulation of those who decided to move to the surroundings.

At the same time, while rice production was being more accepted, the period of wars arrived. When people could not found food in the former places they bought it, rice was seen as a dietary alternative. Then, the planted surface expanded along the territory and more rice need to be produces, and more farmers were needed to labor the soil.

By 1800, cooked rice preparations were more accepted and spread within the region. In this way, the local administration initiative of creating the Canale Cavour was supported. After 152 years, this canal is still in use (Borgia, 2015) and have been complemented with other irrigation passages fed by hydric sources coming from Valle D'Aosta and Mount Rosa massif.

Being the most productive region in the whole country for rice production is a valid reason that justify the tireless attempts of the research centers in the zone for be at the forefront of rice technologies, techniques and quality improvement.

Since 1980, another paradigm change was experienced. Italy had studied the European preferences obtained from the costumes and cooking methods in their eastern colonies. In other words, more varieties not only from Japonica but Indica where introduced to Po Valley's rice crops.

Figure 15: Main Italian rice producer provinces and natural hydric sources for fields irrigation. *Source: Own elaboration*

PROTECTED DESIGNATION OF ORIGIN

The Protected Designation of Origin (PDO) certification responds to the Council Regulation (EEC) No. 2081/92. This guideline looks forward in the protected designations of origin and geographical indications for products created by the agricultural sector.

So, this regulation tries to balance the supply and demand of foodstuff products designated for human consumption defending the statement that "consumers must, in order to be able to make the best choice, be given clear and succinct information regarding the origin of the product".

There are four indispensable conditions for being considered a protected indication. The first one is the seriousness at the moment the farmer or consortium follow the local normative. Secondly, it is possible to talk about the traceability, showing the actual place in which the product was grown and transformed. Traceability is directly connected with the third one, link with the territory.

Maintaining the real link of local rice varieties means considering the local climate, geology, agronomic features as fundamental and unchangeable factors that influence in the grain's quality. Finally, there is the tradition as the controlling agent that tries to optimize and make cleaner the production chain and the raw matter utilization.

Although there are two protected geographical indications areas in Italy, the Rice from Baraggia's Biella and Vercelli area represents the quality from Piedmont's territory. Only the rice that was seed, harvested and transformed in the Nord-East part of the Piedmont can be presented with the DOP seal as shown in Figure 16 on the retail store.

Figure 16: DOP signature printed of the product's packaging for communicate its origin. *Source: Terre d'Italia*

The Piedmont's area enclosing the Monte Rosa massif and the northern Vercelli's periphery has been the place where twenty-eight communes (Figure 17) have had united their working organization into the Consorzio di Tutela del Riso di Baraggia biellese e vercellese; the consortium created for the protection of Baraggia's rice. Baraggia is the geographical area where Biella and Vercelli PDO rice crops are located.

It is worth to mention the proximity to the 4.500 hectares of natural reserves (Consorzio di Tutela del Riso di Baraggia Biellese e Vercellese, 2011). The zone holds some castles and fortified buildings that protected people from possible attacks, this is why there are some structures where rice could be stock under low humidity levels.

The consortium is responsible of about 44.000 hectares –around the 50% is dedicate to rice farming. The agro activity must register every single stage of the process, reason why the certified seeds are previously evaluated by the Ente Nazionale Sementi Elette (National Entity for Selected Seeds).

Everything has to be executed in the less harmful procedure –for the environment and the workers. Thus, the usage of nitric fertilizers or those with heavy metals is forbidden; additionally, combustible contamination should be reduced in every stage of the process.

Holding the Council's Regulation, farmers take advantage of the winds by producing a lighter and less dense grain capable to optimize its productivity in soil rotations at maximum every eight years.

In sum up, the vegetal development of the rice plant is reached in the reproductive stage, in other words, by collecting the rice panicles in 112 days, farmers got a fulfilled maturity compared with the same varieties grown in other regions. The leading cultivated varieties are Arborio, Baldo, Balilla, Carnaroli, Gladio, Loto and S. Andrea.

Figure 17: DOP rice cultivated area in Piedmont. *Source: Consortium for the protection of Baraggia Biella and Vercelli rice*

HYDRIC RESOURCE

One of the biggest factors influencing the right conditions for a qualified grain production is the constant flow and purity of the hydric sources without leaving apart its indispensable usage as a thermo-regulator. Acknowledging the consequences of the crops being part of a territory with a temperate climate, farmers have managed the fields since years by irrigation systems.

Considering the presence of numerous watery bodies around the planted surface, it is possible to understand the importance of all the built canals along the years in order to preserved the seed from the very first day of its germination. These canals have contributed by having the seed submerged for almost the entire growth cycle; water is drained three times meanwhile the weeding and then forty days before the harvest.

So, contemplating that the rice seed is planted in May and the panicle is harvested in mid-September or at the beginning of October, there is a water demand through nearly six months, which equals to around 180 days. Rice is an annual plant, but if it is treat carefully, it can be harvested twice a year (Borgia, 2015); in this case, around 24.000 m^3 will be cover the total need of the plant's growth.

In this moment is important to mention the canals that constitute the irrigation network (Est Sesia, 2017). First, it is worth to talk about the Cavour's Canal functionality. The canal's path is about eighty-six-kilometer long and its maximum flow rate at the entrance is 110 m^3/s (at Sesia's east area changes to 85 m^3/s). As shown in Figure 18, the water coming from the Po River arrives to Chivasso, where from its crosspiece with a 3m constant slope until the Ticino River.

From this Canale, the flow of the water is redirected by hose adaptors like Quintino

Sella which goes from Novara's north to south not only as part of the irrigation system but as a support of the hydroelectric around it.

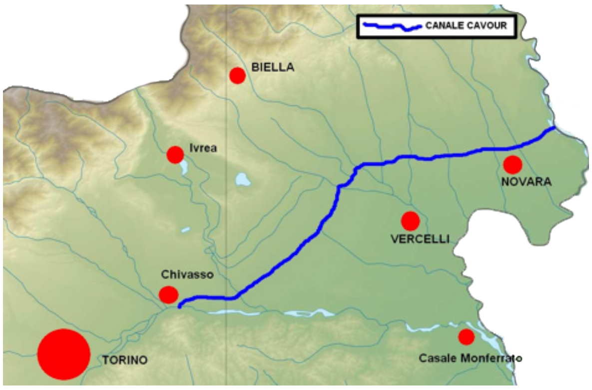

Figure 18: Canale Cavour path. It starts in Chivasso and disembogues in the Ticino River. *Source: Deniele di Stefano*

Because of the continues water deficiencies of the Canale Cavour, there is the Regina Elena canal. The most important labor for this, is support the Cavour's deficiency in moments of drought leading water from the Lago Maggiore –a lake connected to the Ticino river. The Regina Elena is supported by the Alto Novarese branch canal.

The network is completed with the irrigation ditches like Mora, Busca, Biraga, and Sartirana and the little canals represented by Langosco and Sforzesco. Consequently, with the gravitational water flow, the irrigation network does not need motor-pumps in order to drain or dry the soil. Because of the continues water deficiencies of the Canale Cavour, there is the Regina Elena canal.

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Having in mind the complexity of the irrigation system, the extreme supervision of the flow rate is needed when water goes into the rice field chambers (Figure 19). These chambers are communicated between them for potentiating the equal distribution of water over the entire surface in every stage.

Spring is the season where irrigation starts, the ideal depth for every chamber varies from 5 to 15 centimeters during the whole cycle until panicles maturity. According to Beigthley (2010), irrigated crops' yield goes from four to ten tons per hectare. Obviously, the irrigation structure and technology have helped the new rice varieties to optimize their performance in more than 50% since the canals construction.

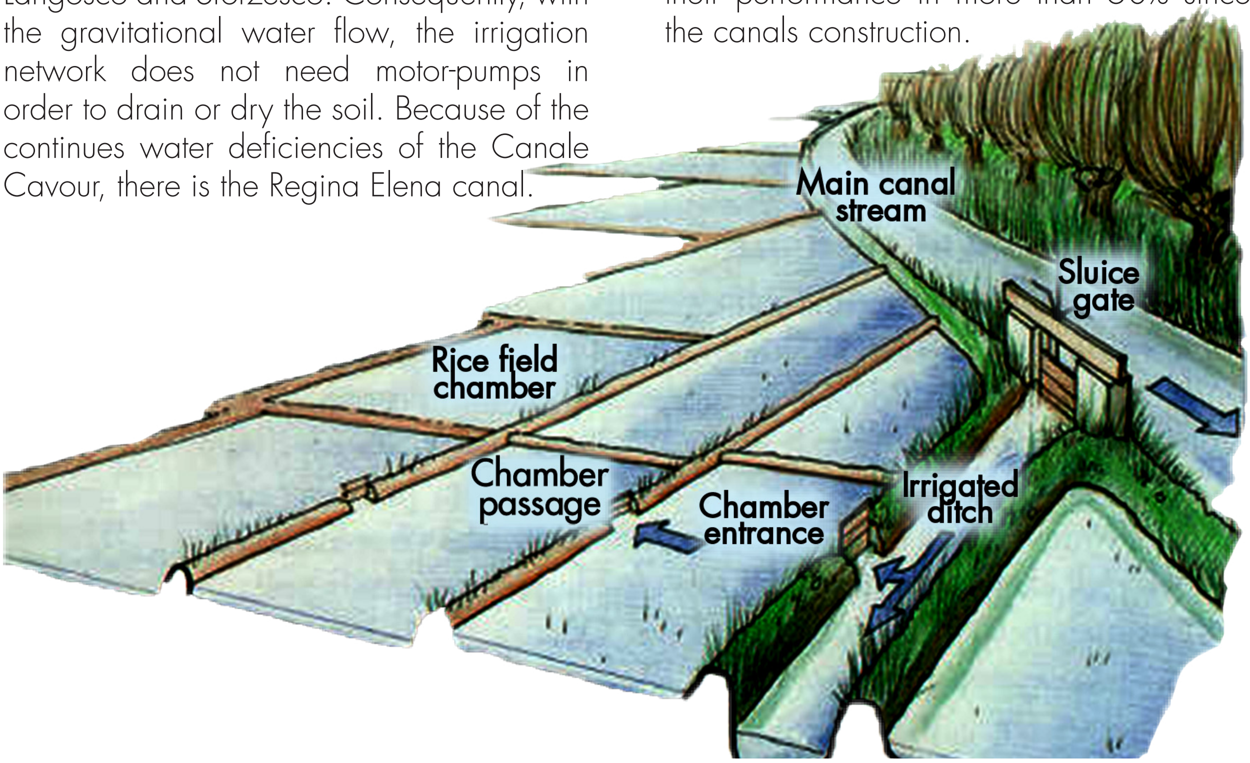


Figure 19: Irrigation system filling the interconnected chambers. *Source: Mortara, perla della Lomellina newspaper.*

3. WINE

3.1. General overview

Wine is a natural, agricultural product defined in the EU legislation as a "product obtained exclusively from the total or partial alcoholic fermentation of fresh grapes, whether or not crushed, or of grape must." There's not an exclusive recipe for its manufacturing. Instead wine characteristics and quality depend on different factors such as weather, soil, geology, the winemaking process and the type of harvest. And even so being from the same producer and terroir, each wine is unique and each harvest changes with the years (CEEV, 2016).

Entailing different processes as the cultivation, the production, and consumption, wine, is an entire sector that contributes not only to who produce it but also to its surroundings socially and environmentally. "Vineyards ensure the human presence in fragile areas that often lack other real economic value. Vines planted on hillsides help limit soil erosion and can also provide fire protection since the low density of their rootstocks helps to restrict the spread of fire" (CEEV, 2016; Goldammer, 2015).

But when talking about wine, people not only think about its production or the final beverage, is also considered its thousands of varieties, the social moments that enclose it, and the countries and cultures that produce and consume it. Indeed, the wine has been part of history for many years, being one of the most common and ancient traditions in the world.

Besides, the wine sector is also contributing economically to the territories by providing them a touristic potential. Here not only the on-site sales grow, but also it creates a more profound relationship with consumers, who get immersed in each step of the wine production; being able to learn about winemaking, how to pair wine with food, visit the vineyards, or just watching the wine landscape for some days. This options for consumers are not offered by all the wineries but by those interested in creating a long-term project engaging in a brand and connecting deeper with clients (Karlsson, 2017).

ANTECEDENTS

Before going in depth about wine characteristics and types, it should be first known where does it comes from. As said before, being wine the fermented juice of wine grapes, for its production is first necessary the growth of this fruit, and the plant in charge of generating the needed quality of it for the production of wine is called vine.

The life cycle of the grapevine is perennial, which means it blooms in spring and summer and goes into dormancy in autumn and winter (Fifure 20). This is possible and doesn't affect the life of the plant thanks to the storage of starch in the trunk. This cycle is then repeated from the rootstock the next year. For the first period, the plant is not ready for producing a good quality wine because this is the time where it gains and stores nutrients. The vine is prepared to provide a better quality by the third year of progress, and it can mature and produce for 30 years before production declines (Mercedes, 2016).

The vine is part of the family of the Vitaceae; flowering plants with a rough, short and woody trunk, which is the central upright part of the vine and it contain a layer with continually regenerating cells important form the reproduction of new vines. Reaching its height (the crown), which is determined by the pruning and training system of the plant, the trunk is divided into the arms of the vine also called cordons, and from this point, it will stop growing in, but it will continue gaining diameter (TAFE NSW Online). The quantity and height of the branches (cordons)

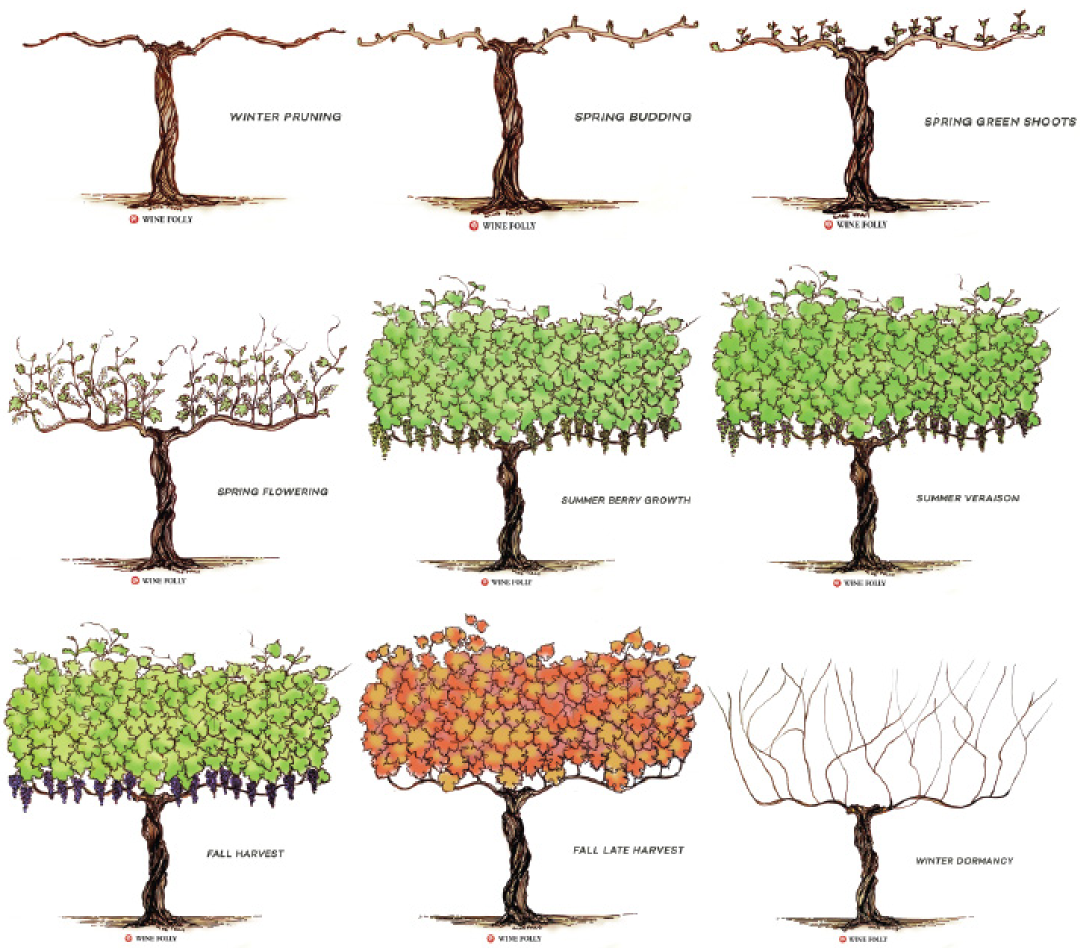


Figure 20: Life cycle of the grape vine. *Source: Wine Folly*

also depend on the pruning, an essential stage of the process for the production of grapes, which will be explained in chapter 4.

From the branches grow the lobe-shaped leaves, having up to 5 lobes, they are smooth, green, and its length is usually of the same measure than its width. Opposite from the leaves are the tendrils, supporting organs which are filaments that create a spiral shape on its base and allows it to remain altogether in one place. The tendrils act as lianas that enable the vine to be a climber bush when it has support to be anchored (Figure 21).

The flowers of the vine are gathered in panicle inflorescences, appearing first erect and while they reproduce they transform into pendulums groups. Each group is attached to the arms by the rachis, smaller branch that acts like axis for connecting the flower to the main branches through the peduncle and for supporting every single flower with the pedicels, supporting stems. The flower reproduction leads to the creation of the fruit, berries commonly called grapes which are individually attached to the pedicels (Tosti, 2017).

The cultivation of the vine is done in vineyards and is called viticulture, while the transformation of the grape in wine is called vinification process or winemaking. Since wine is consumed all across the world, some experts study different emphasis of wine production, such as the enologist, who is the person in charge of supervising the whole wine production, from the inspection of grapes and crops to the overseeing of each of the stages of the production in the winery. Also the sommelier, who is the expert in charge of wine service in restaurants and bars.

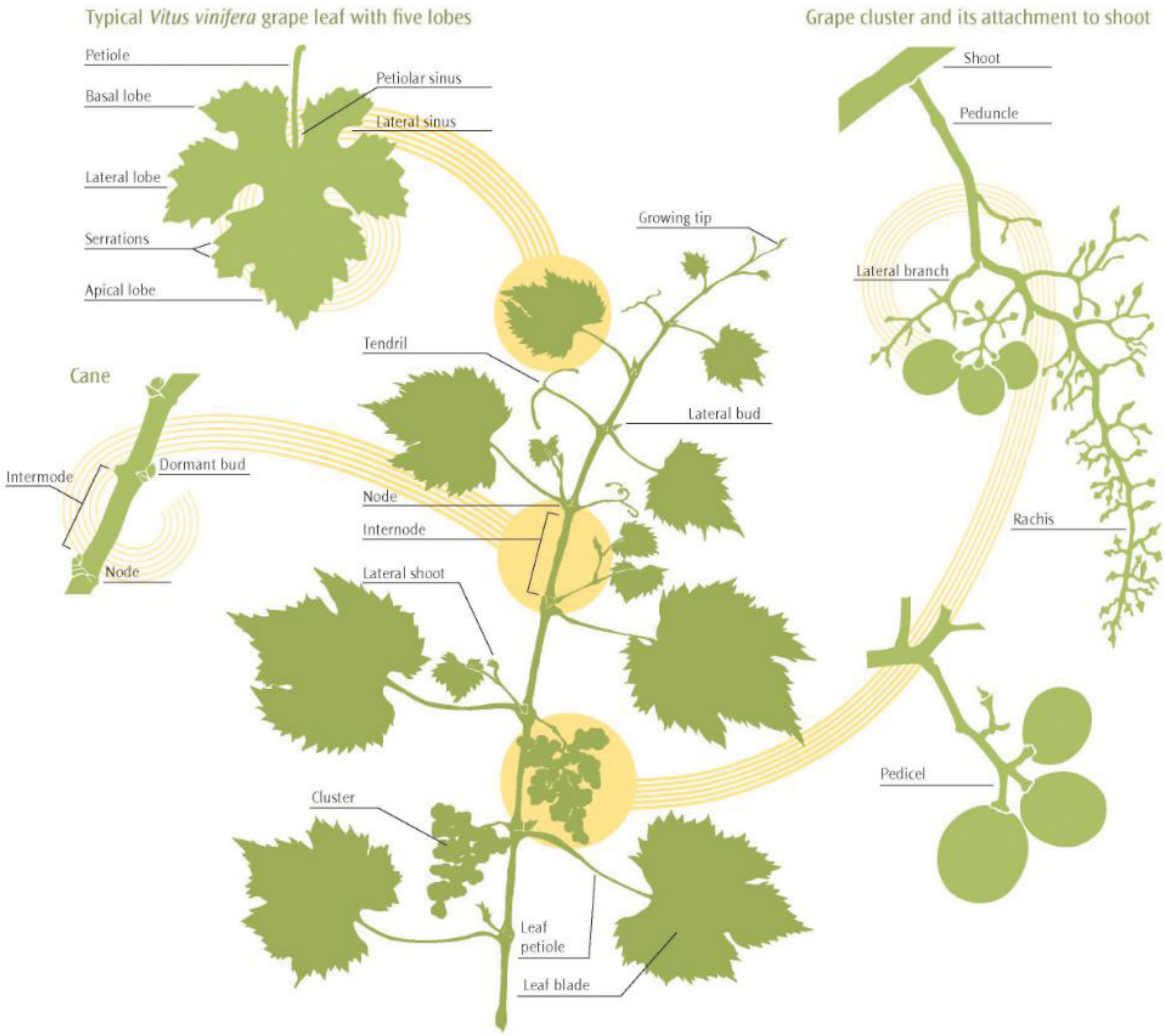


Figure 21: *Main parts of grapevine shoot. Source: Lodi winegrowers California*

VINE VARIETIES

There are a lot of varieties of vines all around the world, around 60 accepted from the about 800 recognized, each for the production of grapes but not all of them suitable for wine production. The principal uses of the grapes from this different vines are: for fresh consumption of the fruit, for transformation into dry grapes and winemaking.

For winemaking, the variety of the grape is an important factor for the quality of the wine because it is the grape the one in charge of giving specific characteristics such as flavor to the final drink. These essential factors depend not only on the vine species but also in the territory in which it is cultivated, the climate, soil, and type of cultivation.

The principal species for wine production are the following (Vinetur, 2008):

Vitis vinifera: Is the European vine species considered the winemaking grape for excellence. Native to Mediterranean Europe and Central Asia is one of the best-known strains in the world and is also produced in America in a minor quantity. Although it is the primary variety in the production of juices and wines, it is also commercialized as fresh table grapes.

Vitis labrusca: Best known North American native variety also present in Argentina, but its main production areas are the Great Lakes region, Delaware and New England. As the vinifera, the labrusca is used for winemaking and fresh fruit consumption.

Vitis riparia: Native vine from North America also known as Frost grape and distributed to Canada and England. Due to the variability of its fruit, this kind is used for experimentation and laboratory investigations.

Vitis rotundifolia: Also native from North America and distributed up to the Gulf of Mexico. It is Used not only for winemaking but also for the production of jams, juices, and gelatin.

Vitis vulpina: Eastern North America Native kind with a bad resistance to low temperatures. Its high levels of sugar and lower of acidity, allow the fermentation and elaboration of wines. Used also in natural herbal medicine.

Vitis amurensis: Asian continent native species that is very resistant to cold, surviving up to -35°C temperatures as long as it has proper and sufficient irrigation.

Species like the Vitis amurenis are considered of producing low-quality grapes, but they are still cultivated for the generation of rootstocks. Another technique is the creation of hybrids, for originating new varieties from the mix of two different species, but this activity is not allowed in many countries (FAO, 2009).

In spite of the different species of wine grapes, the one cultivated the most all over the world is the Vitis vinifera because of its already known quality of stains, as world-class wines, and being Native from some specific sectors does not restrict its cultivation in others. By the other hand, being the most significant kind of vine produced doesn't mean that the wine produced from it is the same in every place, in fact, different varieties derivate from de vinifera species (Goldammer, 2015). Each one with its particularities, defined by color, flavor, phenolic, berry size and acids of the fruit that gives life to a vast variety of wines (Figure 22).

WINE THROUGH TIME

As mentioned before, wine culture and tradition is spread all around the world, and it can be said that its history has run parallel to the history of humanity. Its name come from the Latin *vinum* that derivates from the from the Geek *oinos* and can also be from de *Sankit vêna*.

About its origins, is believed that the cultivation of the vine as wild plant known as Vitis vinifera sylvestris, and the production of juices from the grape started since the 6,000 and 5,000 B.C. But its appearance in history as beverage was since the Bronze Age in the 3,000 B.C. There is archeological evidence that the first wine harvest was done in Sumer, the land of the Tigris and Euphrates rivers in the ancient Mesopotamia. From Sumer, it arrived in Egypt where the vines were cultivated alongside the banks of the Nile river. Was in this time where they started domesticating the plant by elaborating a more industrial and laborious activity for planting and producing vines. They started the red wine production by fermenting the must in clay pots, and it was when the beverage began to gain social status; it was used for religious rites and festivities. Pharaohs were buried with jars full of wine; there is evidence of hieroglyphics on the pyramids symbolizing vine cultivation, harvest, elaboration, and the enjoyment of it on parties and religious events. Since this time, the older wine had more value than the younger, they used to save wine in amphoras for long terms and labeled them with the type and quality of must (Vinoselección, 2010).

Because of the adaptability of the plant and the contact of the Egyptians with the Phoenicians between 1,200 B.C and 539 B.C, the vine and so the wine, started spreading around the world by trading routes across the Mediterranean, crossing from North Africa and arriving in Greece and Italy. They transported wine and grapes in ceramic pots, and during the trading, they got in contact with Jews, who included wine in their religious ceremonies since then (Vinepair, 2014). Starting its expansion in Europe, wine spread rapidly reaching China.

Being introduced to wine, the Greeks began to produce more carefully the wine perfecting it. And in the 800 B.C wine was already a symbol of trading, health, and religion.

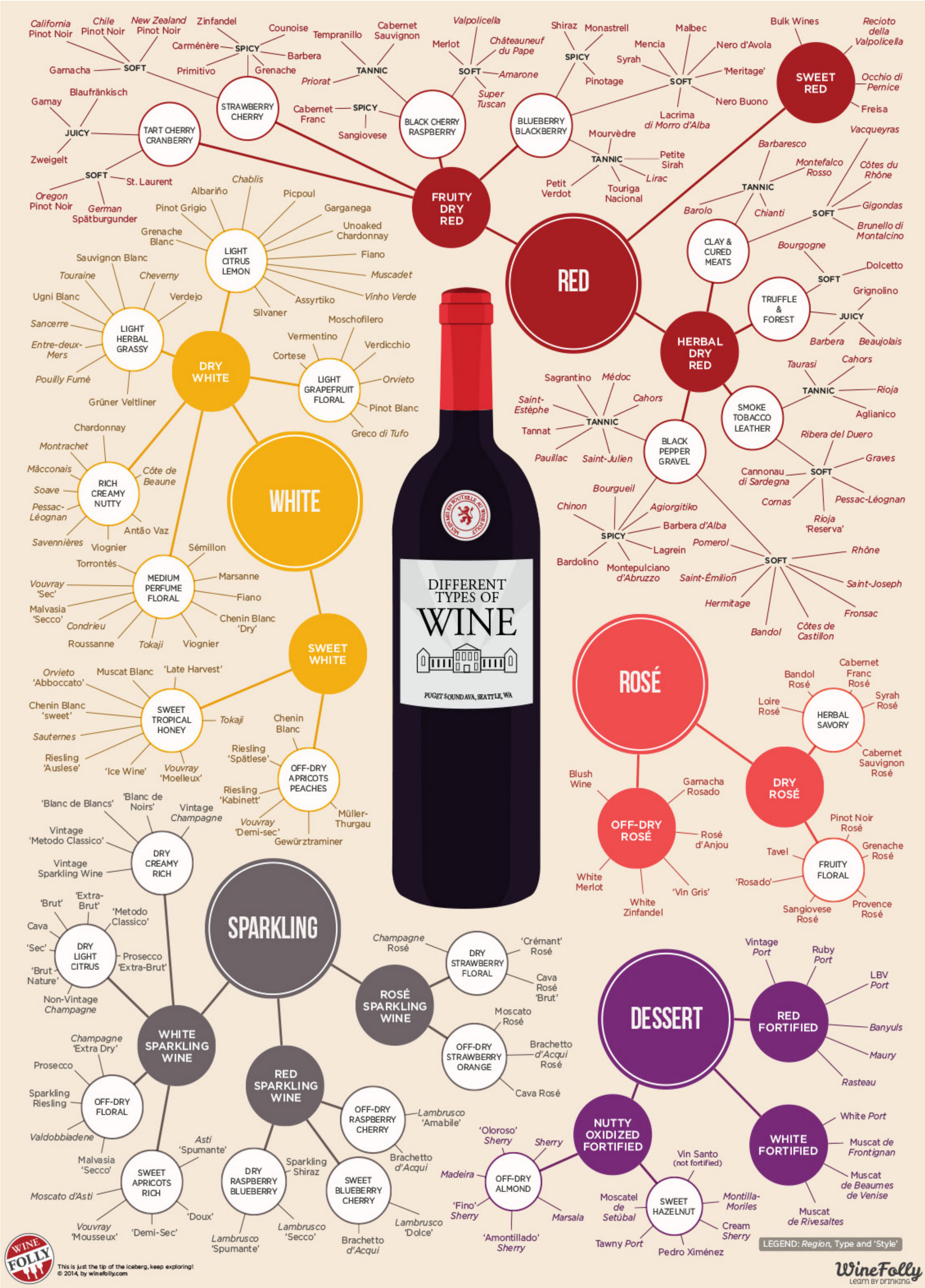


Figure 22: Types of wine. *Source: Wine Folly*

Greeks started conquering colonies and settling there not leaving behind the grapevines and was in this time when wine got to Italy, from the south, finally reaching Rome (Vinepair, 2014). Greeks also assigned to wine a god; Dionysus, who is always represented holding a glass in his hand. Lately, in the year 146 B.C, Romans make wine central part of their culture and taking it as their own they decided to change the

Greek god's name and change it to Bacchus, symbolizing the festivity associated with the consumption of wine. With the establishment of the Roman Empire, they formalize the cultivation methods gaining practicality and technological knowledge for both the cultivation and the winemaking process. They celebrated the harvest festival every year, and as it happened for the Greeks, it became a symbol of wealth, power and luxury. It also became a relevant economic activity thanks to trading and importing business, it started to be consumed not only as a beverage, but also it was included in the making of many Roman dishes (Vinoselección, 2010). Taking advantage of their expansion in Europe, Romans planted Vines in what today is known as France, Germany, Portugal, Spain, and other European nations.

For the year 380, the Roman Empire adopted Christianity and wine became part of the sacrament, reason why the Catholic Church started focusing on wine production and cultivation and monks in Italy and France worked as vintners, making more significant the wine sector as the Church grow in Europe (Vinepair, 2014).

Between 1492 and 1600 Spanish colonizers take wine to the New World, arriving in Mexico and Brazil and then spreading down to South America, where wine was traded for products such as coffee and cocoa. In this time, winemaking had gained even more perfection, glass bottles started being used, and the cork was used as the stopper. Furthermore, monk Dom Pérignon discovered how to make sparkling wine in the Champagne region of France (Vinoselección, 2010).

Meanwhile, Portuguese traveled to Japan spreading Christianity and so the wine culture, and Spanish conquerors in South America arrived in Argentina, where they planted the first grapes of the Mendoza region, a currently recognized wine area in America. But in the new continent wine was not just spread to the south, it also reached the north with French settlements in Canada around 1608. Jesuits in Quebec tried settling European grape species, but not having success they grew local north American grapes (Vinepair, 2014).

In the late 19th century, it was developed in Europe a devastating pest, the phylloxera, which spread damaging European vines in the majority of its territory. Native American strains were immune to the pest, and due to this, wild vines planted in the new continent were recovered for replantation creating hybrid varieties in order to protect the vine from the insect. But even though the recuperation was done from American vines, in this territory, the production is based on grape varieties from the Old Continent, the *Vitis vinifera*.

Nowadays, wine is being produced in many countries around the world, but the situation of the industry has been changing with time. Countries that used to be leaders are not dominating the market as they have done before. As Aylward (2003) expressed, "New World producers such as California, South Africa, Australia and New Zealand have successfully married production, management, marketing, and innovation to emerge as a new force on the global wine landscape." This fact gives place to a new perspective in the wine industry. Where it is important the knowledge about the motivation behind the consumer's choice for the production of wine, and the implementation of sustainable practices for the cultivation and the winemaking, taking into account that the wine history has "evolved from the cottage industry to global networks of consumer-aware producers." (Linda F. Bisson, et al. , 2002).

VINE AND WINE TRADE

For understanding the wine industry and how it has evolved during time, it is essential to study its changes starting from the cultivation of the vine. As seen before in the history, this plant was widely spread around the world, and it covers a significant area contributing not only in agricultural terms but also environmental and economically. Figure 23 shows the evolution in the last 16 years of

Figure 23: World area under vines. *Source:OIV*

the vine plantation, it can be noticed how this area has decreased but still maintained a certain level over time.

The principal countries that represent the higher quantity of surface area are Spain (14%), China (11%), France (10%), Italy (9%), and Turkey (7%). These five countries all summed up constituted the 50% of the world vineyard cultivation in 2016. (refer to appendix 3).

The surface area mentioned before, consider the production of wine grapes, table grapes or dried grapes, on its formal stage of production or its dormant awaiting production (International Organisation of Vine and Wine, 2017).

In regard specifically to world wine production, Figure 24 shows how by the years this activity has been more than anything a constant action with some fluctuations but that don't have significant positive or negative peaks.

On the other hand, contrasting the data of vine plantation and wine production its evidenced that being a country leader on vine surface does not mean being the leader on production, this, taking into account the fact that there are different types of grape for various uses. Countries that are on the higher level of wine production are (appendix 4): Italy (50.9 mhl), France (43.5 mhl), Spain (39.3 mhl), USA (23.9 mhl), and Australia (13.0 mhl). Remaining on the top are France,

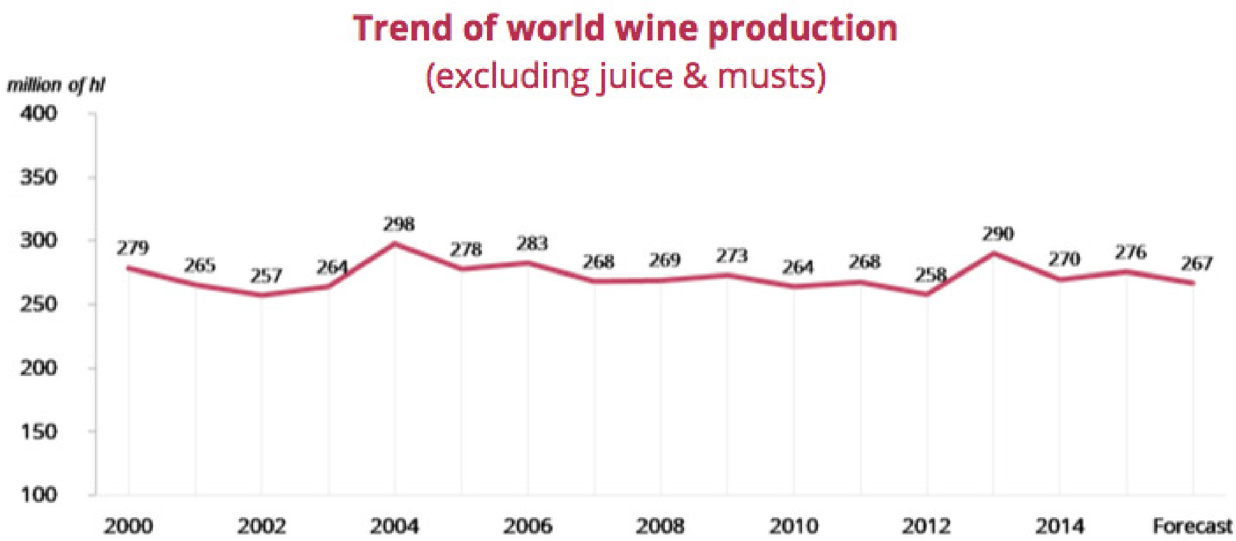


Figure 24: World wine production. *Source:OIV*

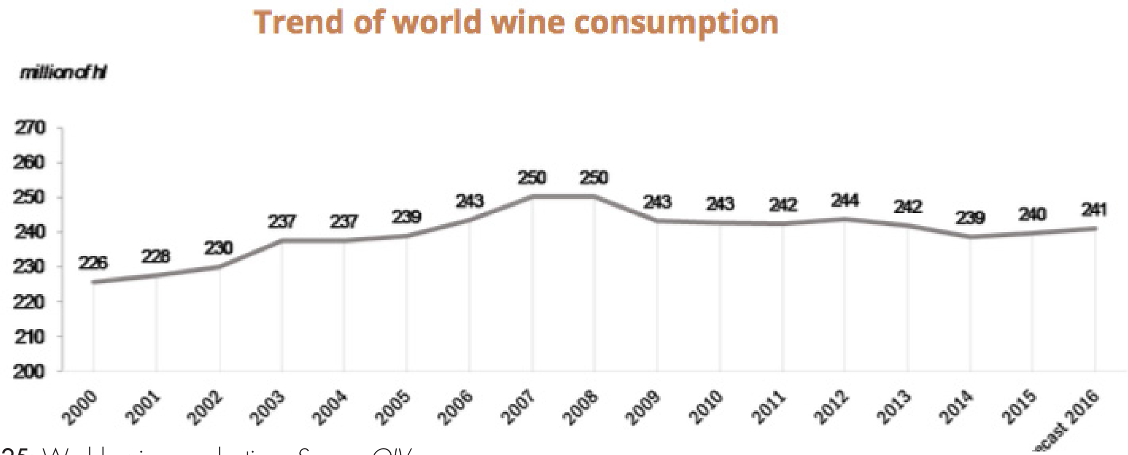


Figure 25: World wine production. *Source:OIV*

Italy, and Spain, but Turkey and China, which where big grape producers, are not anymore on the top of the winemakers, this is because they are predominantly producers of fresh grape and not of wine grape. Instead, the United States of America and Australia are not at the top of grape production, but the quantities they produce are the majority for winemaking. The same contrast can be made by analyzing the world wine consumption, which have been gradually growing (Figure 25)

Being 241mhl the global wine consumption in 2016. Placing the USA as the higher wine consumer with 13.2%, followed by France (11.2%), Italy (9.4%), Germany (8.1%) and China (7.2%). Once again, as in the vine surface are the first five countries the ones representing the half of the wine consumption in the world (appendix 5).

The fact that the trend of wine consumption has been growing does not mean that this phenomenon has occurred in all the countries.

Figure 26: Wine consumption by areas since 2008. *Source:OIV*

The overall data shows this growth, but taking a look at the single territories Figure 26, can be noticed how there are some areas in which wine consumption decreased in time.

Wine consumption in some non-producer's territories is able thanks to trading and exporting from those who are active producers. Globalization and modernization have made trading easier, reason why there is a significant and constant growth in wine trading. In volume as well as in value, the principal traders as exporters are Spain, Italy, France, Chile, and Australia (Figure 27)

While the countries importing the most are Germany, USA, UK, China and Canada as shown in Appendix 6 and 7. This precisely corresponds to the places that are leaders in consumption but that are not mainly producers.

It is evident how through time the concern for the production of wine has been transferred to other countries on all continents that have gradually acquired increasing recognition in their national as well as international market. Indicating how the wine industry and viticulture are being through different stages, allowing the rise of new spaces and societies in charge of the grape care and transformation (Portela, 2013).

Figure 27: Wine consumption by areas since 2008. *Source:OIV*

3.2. The wine in Europe and Italy

Vineyards, as well as cereals, are one of the essential crops for the agrarian economy of some European countries. Precisely, for the rural development, wine industry and viticulture represent an economic engine for many municipalities of the Old Continent, which during the time have been gaining recognition as wine producer territories. Even though the production of wine in the European Union was reduced in the last 20 years, they still have a significant distinction of some wines over others thanks to the constitution of the Designation of Origins, impulse with which they changed their way of producing wine and gain great recognition (Portela, 2013).

The vineyard has had a strong influence on the European agrarian landscape since the Middle Ages, and it is still in use today, providing these countries with distinctive signs of identity among the rest of the world's crops and spaces. Europe has always been the largest producer of wine in the world and has been characterized by periods of increase and others of decline. Besides the historical recognition, another difference between European wine and the one produced in new countries is the conception of quality over quantity. In this way, Europe manages to provide the most famous and unique wines in the world with prestigious wineries that place their wines in a tiny market even when some of its bottles reach astronomical values (Portela, 2013).

European production of wine is represented by the triangle of France, Italy, and Spain as leaders in production, with about the 73.49% of the total produced in Europe in 2006 (Portela, 2013) and being France and Italy the countries among which have been alternating the first place. Taking into account that the focus of this study has been analyzed in Italy, this country will be explained regarding wine production.

As mentioned before, wine production developed in Italy around the 800 B.C arriving from the south and gradually spreading all around the country.

As wine grape growing area, Italy is the fourth country with 642.000 ha of vine land in 2016. From this area, the main vine's types cultivated are the Sangiovese with 53.000 ha, and the Trebbiano with 37.000 ha, followed by Montepulciano with 72.000 ha. Moreover, the region with the most significant vineyard areas cultivates is Sicily with 100.000 ha, followed by Puglia with 86.000 ha and Veneto with 81.000 ha. Instead, the areas that lead in the production of wine are Veneto, Emiligia Romagna, and Puglia, contributing to the total wine production in Italy for 2016 which was of about 48.5 mhl (Italian Trade Agency, 2017). This data makes evident that the wine industry is a crucial component for the agri-food sector in Italy, being one of the most appreciated excellences of the "made in Italy" products not only nationally but also internationally (Sementa, 2014).

Regarding structure, about 80% of Italian production is made up of small companies, which contribute to 1,5% of the total production in the country. On the other hand, the large industries, which represent the 0,2% of the sector, make up more than 40% of the production, and contributing for more than the 50% are the emerging cooperative structures (Italian Trade Agency, 2017). Looking to the economic aspect of the wine industry is evident how it is a fundamental activity (concerning invoicing), corresponding the 7,2% on its agricultural phase and the 8% on the industrial stage, from the estimated total of 132 billion euros of the agri-food sector (Sementa, 2014).

Nowadays wine production is present in the 20 regions of Italy being the most extensive and most diversified wine producer country, thanks to the climate and microclimates of the different regions along the territory. There can be identified 377 unique native wine grapes. Not leaving behind the biotypes and sub-varieties, which are meant to be grape with the same genes but with physiological and morphological variations, which gives place to lots of different wine stains Figure 28. Added to this number, are the wines labeled with a designation of origin which are estimated to be 408 (Puckette, 2016). This large number of wines with Appellation of Origin is because there are different types of classifications (Federdoc, 2016):

"Table Wines" (Vini da Tavola): Are the ones that don't have any reference from the territory in which they were produced. They don't have unique characteristics, but they're still of quality.

Figure 28: Types of wines by regions in Italy. *Source: Wine Folly*

I.G.T: Italian acronym for Typical Geographical Indication wines, which are the ones that refer to the region and the vine they come from, and the year of harvesting. For a type of wine to meet his classification, it has to respond to specific characteristics such as the minimum natural alcohol content, and the best performance on the transformation from grape to wine.

D.O.C: A.O.C in English, which means Appellation of Controlled Origin, are wines produced in a delimitated area of territory and with specific chemical and organoleptic characteristics that are defined in the production regulations. On this control is also determined the type of wine that will be produced, the quantity and variety of grapes that can be obtained for each hectare of vineyard, the yield of transformation of such grapes into wine, the alcohol content and the aging duration. All the cycle is determined and regulated, and this is qualitatively controlled before the wine goes into the market to ascertain their compliance with the parameters imposed in the production disciplinary.

D.O.C.G: Wines labeled with the Appellation of Controlled and Guaranteed Origin are of particular value and have acquired renown and commercial value at national and international level. Its production rules are stricter than the other denominations, and they have to be labeled as D.O.C wines for at least five years before being able to be known as D.O.C.G. the maximum capacity of bottles that can be marketed cannot be more than 5 liters.

D.O.P: Appellation of Protected Origin are wines in which is indicated the name of a region or specific place from where this product is designated, due to this, the characteristics are exclusively linked to the geographical factors of production, and its grapes have to be 100% produced and transformed in this region. This classification and labeling of wines with such strict parameters make possible the improvement of the sector and potentiate the role of wine in the international trade relations, achieving the 15,4% of the Italian agri-food exports. From the wide variety of products being exported, wine is placed on the third position with red and rosé wines labeled as D.O.P, the red and rosé I.G.P wines in the eleventh position and white wines in the fourteenth place (Sardone, 2014). Figure 29 shows the production of wines according to its appellation of origin type, and it is evident how the production changed from being first the "table wines" the most produced to a drastically change where the D.O.P are the wines leading the production in 2013.

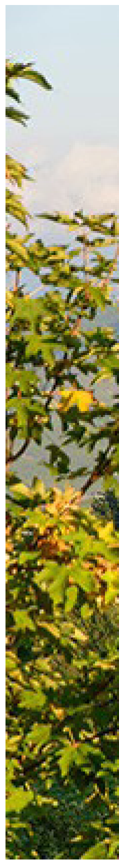


Figure 29: Wine production by typologies in Italy, 2009-13. *Source: Agriregionieuropa*

3.3. Piedmont's wine background

Historically, the origin of the territory as wine producer dates back to the pre-Roman times, when Celtics arrived to populate the hills, this resulted in the inheriting of castles, fortresses, walls, and ruins to the vines landscape. The landscape that since 2014 has been recognized as an integral part of the UNESCO World Heritage, accrediting the exceptional universal value to the Piedmonts' cultural scenery. This recognition was explicitly given to the lands of Langhe-Roero and Monferrato, making part of the 50 places in Italy obtaining this acknowledgment.

One characteristic of Piedmont's vineyards is their small size (compared to the extension of vineyards of other regions). Is because viticulture, has been an activity that is inherited during the time from one family generation to another. Due to this, an interlacing landscape is created in the form of a mosaic, specifically on the UNESCO recognized areas (Zahuranec, 2015).

The characteristics of the territory that gave place to the achievement of the UNESCO (2014) recognition were:

Land as a testimony of historical tradition on vine cultivation and winemaking process.

Social, rural and economic context based on wine culture and production.

Presence of ancient architecture and artifacts related to the vines cultivation.

Example of human interaction with its territory, by the evolution of techniques and know-how of viticulture.

The territory is a fundamental factor for the identity of wine, being at the "foot of the mountain" gives Piedmont specific characteristics that differentiate its wines from the rest of Italy. The Alps create a shield-effect on the region, making the climate of winter

Figure 29: Wine production by typologies in Italy, 2009-13. *Source: Agriregionieuropa*

less rainy than at the same latitude as Bordeaux, and hotter and humid in summer. In fact, the variety of hilly conformations, gentle at the south, steep and at the north and flattened at the east, contributes to the type of soil and microclimates. Due to this characteristics, is possible the production of a varied collection of wines: from the single Nebbiolo grapes derive 14 different D.O.C certified wines (Zahuranec, 2015).

With 45,000 hectares of vineyards, Piedmont is one of the most famous wines producing regions in Italy. Recognized for its excellence in wine-lands, vines are located in the hills, including the alpine and pre-alpine areas, where producers prefer working manually, looking forward to achieve and enhance the best quality of their products. Annually are produced about 3 million of hectoliters from the 20,000 wineries in the territory and being derived from at least 20 indigenous vines capable of producing 17 DOCG and 42 DOC types of wines that are recognized as Piedmont's products (Regione Piemonte, 2012).

In spite of being an essential region in Italy for wine production, the regional vineyard areas have decreased in the last years. Areas that were of excellent vine concentration such as Cuneo, Asti and Alessandria presented a significant reduction in the previous decades. Instead, the regional export performance in 2011have increased. Bottled DOC red wines have undergone a positive rise towards all the primary markets: growing 14.8% in value towards European countries, and 25% towards the USA (IRES Piemonte, 2012).

Even though the vine is a plant able to adapt to any type of soil, Piedmont's hills and characteristics are an advantage for the quality of wine. Taking into account that the vine gives better grapes when cultivated in mountain than in plane areas, inclination benefit the crop in terms of drainage, and amount of sun impact. Another benefit of Piedmont's territory characteristics for the vine is the climate, which being cooler will give as result more mature grapes. Additionally, the presence of mountains (the alps), rivers and lakes protect the vineyard from cold and hard winds and by the other hand, in summer helps as thermoregulation due to the reservoir of humidity (Ariano & Sabella, 2015).

PIEDMONT'S WINES AND AREAS

The principal red wines produced in Piedmont are Barolo, Barbaresco, Barbera, and Dolcetto, whose grape type are respectively Nebbiolo, Barbera, and Dolcetto. On the other hand, primary white wines are Moscato d'Asti, Asti Spumante and Arneis, whose grapes corresponds to vines of Arneis and Moscato.

Form these varieties, the most cultivated is the Barbera (Figure 30), which is also the most consumed in the territory and generally the more accessible, not meaning this that it can't be found of excellent quality. In contrast, Nebbiolo is the is the noble grape of the Piedmont area, from which the two most valuable, and elegant wines are produced: Barolo and Barbaresco.

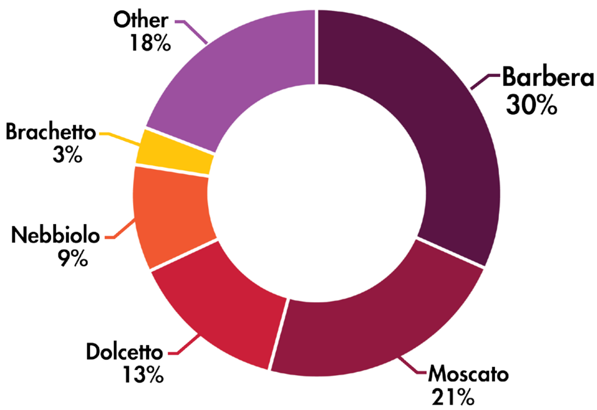


Figure 30: Grape varieties by surface cultivated. *Source: I Numeri del Vino*

The principal areas where these wines are produced (Figure 31) are in the territories of Langhe, Roero, and Monferrato, in central and southern Piedmont. Just in the Cuneo Province, the Langhe region, it is cultivated one-third of Piedmont's wine growing. In this same part can be found the two recognized areas of Barolo and Barbaresco, where the Nebbiolo grape grows and from where is given the label local denomination to this wine.

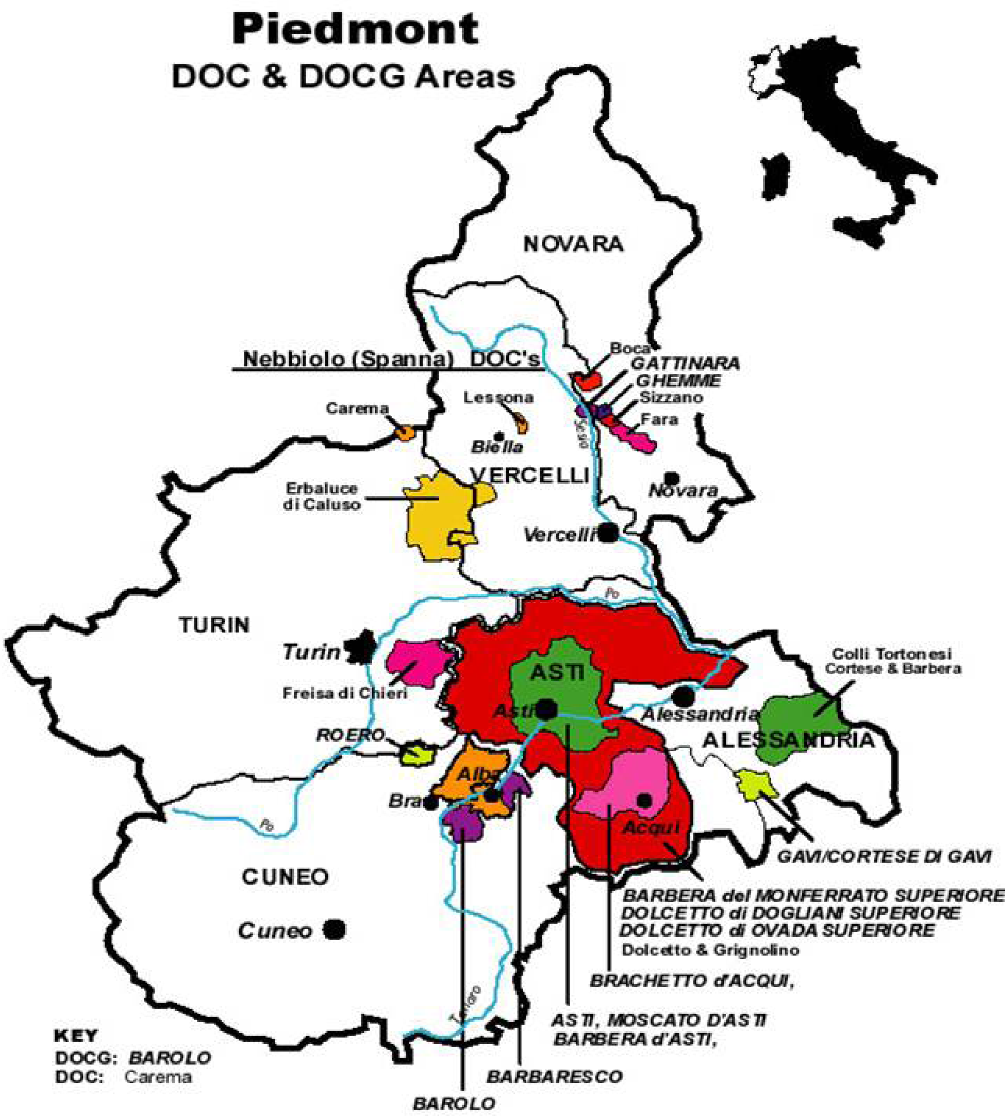


Figure 31: Piedmont's wine map. *Source: Wine, Wit and Wisdom*

On the other hand, Asti and Moscato are the hub of sparkling piedmont's wine, in the city of Canelli the principal wines that can be found are, Asti DOCG, the best known and sweet Moscato d'Asti, the Dolcetto and, the Barbera (Zahuranec, 2015).

Moreover, Piedmont has not only a based production of local grapes, but there are also excellent international varieties. In fact, in this region Pinot Nero, Sauvignon, Riesling and Chardonnay are cultivated and enjoy the denomination of controlled origin: they can fall under the DOC of the LANGHE DOC, MONFERRATO DOC, or under that of the Region, the PIEMONTE DOC (Zahuranec, 2015).

4. Current production chains

4.1. Piedmont's current rice production

The rice production in Piedmont has changed in the last years. As part of a volatile market, farmers have found trouble when presenting their merchandise in a competitive and remarkable way, therefore, Piedmont's rice quality is not perceived as a valuable piece of the local culture. Rice growing can be recognized like the number one commodity produced in the territory, but its traditional role is not being valued or well spread.

Over the years, the number of little farms that produced rice have been diminished because they have found hard to potentiate their product. So, the best way to start controlling the situation was to join their workforce and give birth to different associations.

The associations or consortiums understood the sense of collaboration and cooperation as the biggest feasible strategy in order to start changing rice production paradigm. Producing almost the half of the national production, the territory has lost its sense of authenticity and has replaced it with the production of a more efficient seed (in terms of grain yield and cost control) forgetting in some ways the quality that characterized the Po Valley staple food.

It seems that the only way in which a farmer would control and register the progress of the rice chain is by acquiring the DOP certification, however, the high costs and investment that this initiative entails are not enough motivations to convince local farmers of giving value and reposition Piedmont's seed as a quality competitor in the national market.

Consequently, the local administration has tried to bind the emerging associations with the awareness of requalifying Piedmont's rice production. In November 2017, the press communicated the release of "Piemondina" Figure 32 a regional campaign. The initiative looks forward to reconnecting the semi-mechanical production and processing methods currently used with the tradition; all the enrolled actor must believe that these indispensable variables would be capable of recovering the value that the rurality had once.

According to Giorgio Ferrero, Regional Council's assessor, the campaign not only will respond to the mandatory indication of the origin on the rice label decree – proclaimed in July 2017- but conceives "a reality that, with its more than 1800 producers, represents an excellence not only for quantity, but also for product quality, for the attention to the environment in the crops, for the history and the cultural tradition that embodies" (Riso Italiano, 2017).

Figure 32: Piedmont's rice fields" brand set rice quality effective communication. Source: Regione Piemonte.

Piemondina offers the information to improve the current rice production chain by taking care the correct treatment of raw materials, traceability rules, processing real impact registration and the effective communication of the process to the consumer.

In order to explain the importance of these kind of initiatives in the fulfillment of the objective of this study, it is worth to explain in detail the current reality of Piedmont's rice chain as performed in the majority of rice growing-dedicated farms.

When talking about the rice process, it is being mentioned the performance of the rice plant as the main raw material treated in the procedure. This procedure is composed of three main stages; every stage embraces a series of activities specially dedicated to managing the organic matter in its alteration.

The first stage, classified in this document as "Paddies creation", covers the very first moment in which the seed is sown until the plant has flowered and produced mature panicles to be harvested. Then, the second stage starts when the paddies are harvested and treated for being bagged, thus this stage will be understood as the "Transformation and processing" phase.

Finally, the third big step in the rice chain, expressed as "Packaging", contemplates the moment in which the milled rice is ready for being sold and distributed, or prudently storage for further purposes.

PADDIES CREATION

Rice quality starts in the way it is cultivated. Normally, the farmers are 100% in charge of this part of the process, they take care of rice plantations in order to supply the market. Even though local farmers know how rice must be treated, in the last years the growth of processing companies have divided the tasks. Nowadays, is common to observe that farmers or farmers' consortiums sell the paddies to the mentioned companies.
Paddies are the grains held by the plant panicle during the ripening phase. After being threshed, paddies become the raw material of the milling structures dedicated to rice production. Therefore, it is fundamental to preserve its development in phase of rice growth.

Rice is a very vulnerable plant and natural phenomena could be harmful for the plant's proper growth. The most delicate conditions affecting rice yield are wind, electric storms, weeds, insects, parasites and fungus. Nonetheless, if those issues are well controlled, the average number of mature panicles, grains in each panicle and the weight of the individual grain will be higher. A good harvest allows a farmer obtaining a better payment because of useful mature grains.

Soil preparation.

Soil condition is important because it is the medium in which nutrients will be absorbed by the plant. Also, the correctly fixation of the roots take place here. If a seed is not well attached to the soil since the germination phase, the plants would not grow healthy.
When preparing the soil, farmers carry out different activities. The most important activity is tilling the soil; by moving the soil, the nutrients present underneath the surface will be useful.
The macronutrients needed by the rice plant are nitrogen, phosphorus and potassium (Beigthley, 2010). The first for the culms to fit correctly in the spikelet; if this union is right, the caryopsides will have the enough protein content at the flowering phase, thus healthy and mature panicles will reach the required size and weight. Nitrogen depends directly from the phosphorus concentration, because phosphorus allows roots stretching and nitrogen absorption. Finally, potassium works improving the resistance to plagues and insects.

Piedmont's peat soil is rich in nitrogen, carbon, oxygen, hydrogen and sulfur (Jinming & Xuehui, 2009) without mentioning the high concentration of organic matter present in its chemical composition and the extraordinary water retention capacity which maintains high humidity levels in the caryopsides and clings the roots easier.

Before the tilling comes the plowing, used to breaking up the soil for deeper tillage, and the harrowing to smooth the soil bumps left by the plowing. After the harrowing Po Valley's rice fields should maintain a leveled soil with a constant slope that enables the water flow goes through all the chamber when irrigation time arrives, reason why after the terrain's levelling some farmers repass the harrows to eliminate weeds.

Simultaneously, ditches are arranged from the last season or reconstructed in order to let the irrigation water moves on at the time of drainage. In this moment, the soil is ready to be submitted to a special technique traditionally used in Italy since 1900 (Beigthley, 2010), known as the Stale Seedbed Method (SSM).

As a response for reducing herbicides consume, SSM (Figure 33) is employed as a weed management technique (Hook et al., 2014). It consists in spreading a non-dormant seed, called weedy rice. In the apparent seed germination, the weed seeds located below the surface are activated and start growing. So, as Hook et al. (2014) mentioned, "weeds which germinate and emerge before the crop is planted are easier to manage" and consequently, eliminated.

Because crops should be sown in weed free soil, the SSM is considered a valuable tradition in the Po Valley rice growing. In the last years, the weedy rice variety has been adapted to the soil, in other words, its efficiency is being reduced.

In the effort of clean the soil of weed competition before settling down the rice crop, farmers are introducing Clearfield, an American "non-transgenic, non-genetically modified crop technology that get(s) the toughest grasses and broadleaf weeds out of your fields and off your mind — protecting your return on investment in comparison to traditionally grown crops" (O-Basf, 2018).

Taking in consideration the number of milled rice tons that Italy has to produce annually and the market's volatility, Italian farmers try to bring to their crops the latest technologies –if affordable. Due to this, the varieties not only mutate by the experimental seeds planted, but also because of the different techniques for preventing weed and plagues.

After all the former activities, farmers focus their energy in the fertilization of the tilled and cleaned soil. With the appropriate fertilization, the soil should acquire enough macronutrients for the plant's healthy development and growth. Consequently, in the quality of the grain and panicles' yield.

Nourishing the plant with the right nutrients, the use of pesticides will decrease considerably as Gambus et al. (2016) explained:

> It is due to the applied fertilization or 40% is due to the use of mineral fertilization, and 20% results from using organic fertilizers. This is the total increase in yields up to 60%. The remaining 40% of the increase in yield is attributed to crop protection (15%), crop raising (15%) and other factors. Mineral and natural fertilization affects not only crop yields but also the quality of crop products.

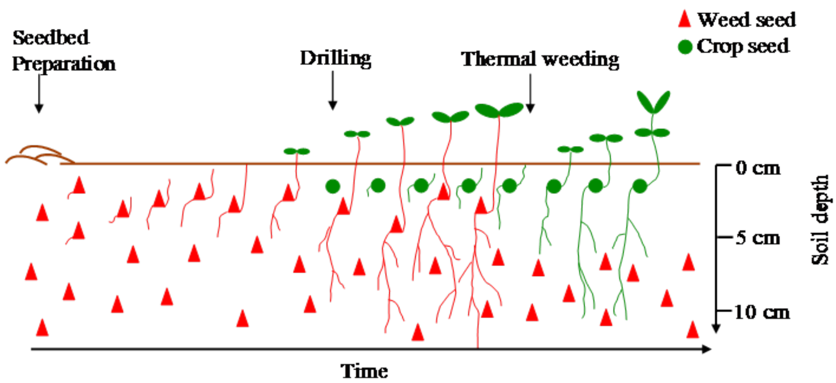


Figure 33: Stale seedbed method develpment. *Source: Suck and Pyon, 2011*

Mineral fertilizers are used in the Po Valley's rice crops. Assuming that the organic fertilizers are not capable of cover the total cultivated surface, the local agro-activity finds a big support in the mineral fertilizers.

Using fertilizers helps the crop profitability increases as improves the yield and its quality.

Sowing.

Seeding or sowing comes when the SSM have worked. Only when the soil is cleaned, the farmer starts with the seed spreading. In Italy, the traditional way of incorporating the seed in the land is by broadcast seeding in an irrigated soil. Even so, there is another method known as sow in dry.

In Italy, the seeding season starts in the middle of April or May, it depends of the temperature that should be between the 12° and the 14°C. When SSM is used, the farmer spreads the seeds the last days of May. Normally, the seeds that are planted are paddies that have been correctly storage from the last harvest. So, in the accomplishment of a high yield, according to Pecetti (2013) a farmer may invest 220 paddies' kilograms per hectare (around 350-450 panicles per square meter.

Broadcast seeding is made in a watery environment. The rice field chambers, ready to work, are irrigated (creating a 5cm depth layer). This method consists in the distribution of the germinated seed – paddies bags has been soaked for around 24-hours and cleaned with dithiocarbamates and iprodione- by a machine that covers a predetermined area. Often, after the seeding some farmers make sure that the seed will be buried and after the broadcast the harrows are passed.

One advantage of this seeding is its cost because the needed time and manpower is low, normally the machine can spread 80 to 180 kilograms per hectare. Having this last proportion in mind, over the years piedmont's farmers have introduced to their crops the sow in dry. With this type of seeding, the previous irrigation of the chamber is not necessary and the seed does not have to be germinated.

When sowing in a dry soil, the seed is spread in lines and must be three-centimeter buried from the soil's surface. This non-watery method does not mean that the plant will not grow irrigated. The difference is that water is only added when the seed is already germinated.

The variety to be seed is chosen depending the climate, water temperature and crop precession (Pecetti, 2013). The decision should be made depending of the market's demand. For example, if the terrain is needed for another grain crop cultivation, the early varieties (with a life cycle between 14 and 150 days) are the best option, but if the North-European market is buying, Lungo-B varieties will be the chosen options.

Irrigation.

The presence of water in Po Valley's rice fields is indispensable. The 5-centimeter depth portion of this valuable resource protects the plant from the temperature changes, helps to control weeds and parasites.

The local rice crops are watered by the irrigation network connected to Canale Cavour. In Figure 34 is possible to observe how the flow of the water is manipulated in order to protect the seed and prevent any harm or setback during the process.

During the irrigation period, there are three moments in which the water level is reduce in order to develop different treatments to the soil. The first is to help roots setting in good and strong conditions, in this way, if winds come with a high speed, the plant will be tougher. The second moment has the intention of spread herbicides and fertilize the soil coverage. The third dryness moment comes when in the lifting phase which fortifies the culms before the flowering.

The irrigation phase concludes with the pre-harvest drainage. When the plant arrives to the ripening phase, irrigation is stopped. For around forty days before the reaping, the terrain should be dry.

TRANSFORMATION AND PROCESSING

The transformation of the rice plant starts with the harvest and ends when the white rice is obtained. In this moment, the field finds the

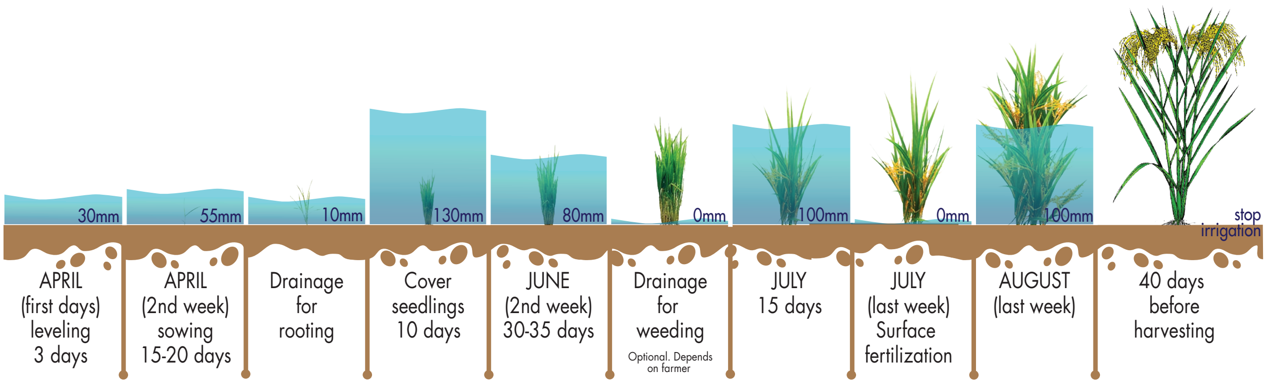


Figure 34: Stale seedbed method develpment. *Source: Suck and Pyon, 2011*

agro-industry in order to transform the paddies.

In other words, the plant was born because of the farmer's care; when the paddies arrive to the mill is responsibility of the milling to furnish de market with a standardize quality product.

Contemplating the technology present in the territory, it is important to explain why harvesting is considered at this stage. Recognizing the in-field separation of the paddies that many farms perform in Piedmont, the raw material is being treated physically in the exact moment when the rice plant is separated into rice straw and paddies as shown in Figure 35.

Harvesting.

Harvesting is one of the most demanding procedures of rice treatment. The farmer must be careful when deciding when to start collecting the grain. If panicles are still immature or if they are extremely matured, yield efficiency could be affected; in other words, the quality of the grain to be treated is determined in the harvesting, so, the possible losses and operations high costs.

Another factor directly affecting the crop yield is the quantity of sown varieties. The bigger the number of varieties, the higher risk of mixed grains. This is why, harvesting could be considered also one of the most demanding tasks in the fields.

Figure 35: Rice harvesting in-field threshing. *Source: Rice Knowledge Bank.*

The process often starts before the crop has reached the ripening phase and culminates when mildew, plagues, insects and birds are causing excessive damage to the caryopsides. If the plants meet the required conditions presented in Figure 36, harvesting could be done.

Harvesting is composed by two main activities: reaping and threshing (Rice Knowledge Bank, 2015). The first one is in charge of cutting the rice plant. Before beginning with the reaping, the crop administrator has measured a wide margin of post-production losses and so, the collected matter will be divided into the portion delivered in the mill and the portion that will be process all-year round.

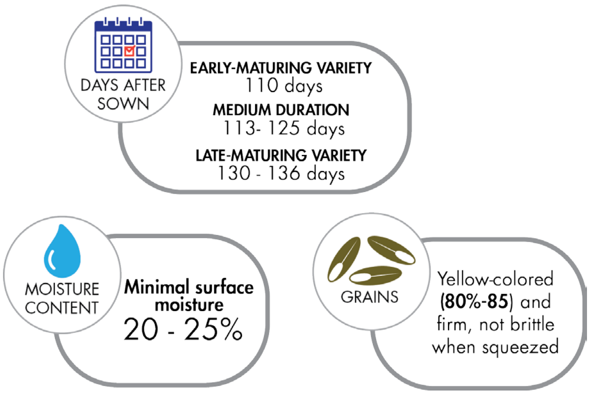


Figure 36: Ideal conditions for harvesting. *Source: Rice Knowledge Bank.*

In some cases, the machinery helps the farmer to do reaping and threshing at the same time. While the reaper is cutting and leaving behind the grass, from now on called rice straw, the same machine is threshing the seeds. Threshing is the separation of the panicle grains, also called paddies kernels (Atugba, 2016) and can be made by impact, rubbing action or stripping.

In-field threshing reduces costs and labor time because there is no necessity of taking the paddies to another machine. Once all the field has been threshed, the paddies has to be cleaned within 24 hours, otherwise, the humidity inside the kernel cold ruin the matter around it. Thus, paddies are carried to the drying structure.

The cleaning process decontaminate the paddies from particulate matter attached to the kernels (Figure 37). By cleaning the grains that will be send to the mill, the farmer "improves drying, storability, reduce(s) dockage at time of milling and improve(s) milling output and quality" (Rice Knowledge Bank, 2015). Furthermore, those paddies left as seed must be cleaned in order to reduce the risk of attacks and improve the variety yield.

Normally, the removal of strange particles is executed by approaching the aerodynamic and physical properties of the grain and obviously the other materials. In this order of ideas, is worth to mention that in large and medium size mills use scalping as an industrial process supported by rotating and vibrating filters, heated-air aspirator and magnetic separators.

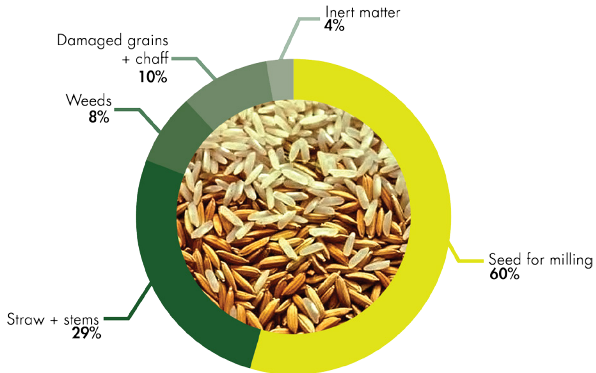


Figure 36: Solid matter need to be clean from paddies kernels. *Source: Own elaboration*

Parboiling.

Parboiled rice is submitted to a different process after been cleaned. The main reason this is considered as part of the transformation stage is because according to the Rice National Entity, in Italy around the 37% of rice consumers buy parboiled –this number is not updated since 2004. With such a growing market, it is important to considerate its role in the country's market.

Parboiling is a hydrothermal technique that changes the grain properties in order to add vitamins and nutritional value. During the process, the grains are soaked in hot water and cooked with steam to make the starch granules become gelatinized (Shabir et al., 2015) and sent to a gradual drying process.

The rice kernels are taken to silos after the drying phase in order to equalize the humidity concentration that remains in the surface. When the kernel is ready, it has been fortified enough in order to represent –in a nutritional scale, the 80% of the total nutrients present in brown rice.

Even so, the rice quality, color and taste had been modified, after the silos the grain pass through the milling process in order to be polished. In short, the manipulation of the organoleptic properties in the paddy kernel "improved the strength and nutritional profile of grain" (Shabir et al., 2015).

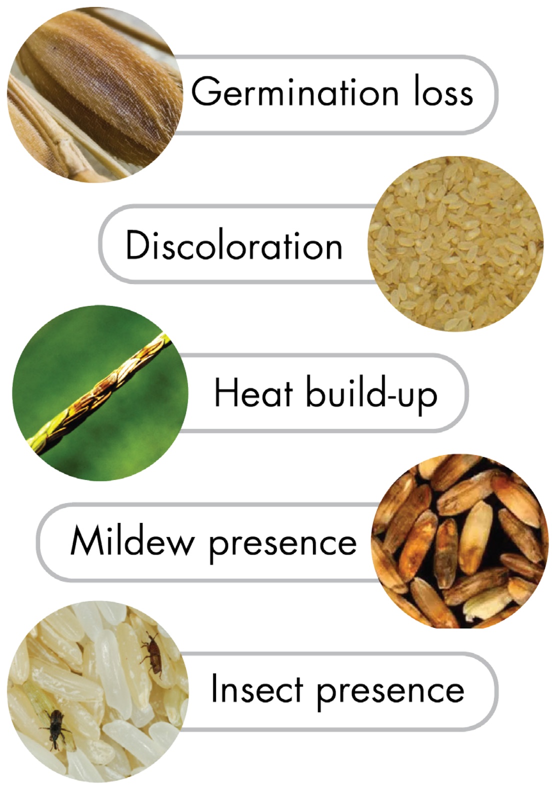


Figure 37: Grain loss linked to an inadequate drying process.
Source: Own elaboration

Drying.

Because of its hygroscopic condition, the caryopsides humidity will depend only of the environmental configuration, reason why in the rainy season -when the harvest is done, drying becomes an inflection point because of the huge quantities of rice managed in the Po Valley region.

The harvested grains contain a humidity between the 24% and the 26% and the aim of this stage is dipping humidity until it reaches a 12% or 14% of relatively humidity. When rice is processed or storage without an adequate moisture ratio, the paddies are submitted to a high risk of become useless, for illustrate the possible grain loss Figure 37 was constructed.

The mechanical drying process allows Piedmont's workers obtaining in a faster way a dried grain without losing its quality and reducing administrative losses. The heated-air machine evaporates the retained water from the respiration process that is isolated because of the husk properties.

Milling.

Rice milling is the longest processing phase consisting in subtracting the husk and the bran layers in order to prepare endosperm for human consumption (Lantin, 1999); endosperm is the edible part of the grain after its transformation. The activities that conform the entire process are husk separation or husking, paddy separation and polishing.

After the harvest, is only in this moment when the producer is going to be aware of the real quality obtained in the paddies. So, if the paddies are immature, there will be a lot of broken grains due to the high humidity level (more than 14%, even if dried) concentrated in the kernel.

The milling is considered the most important phase of the white rice production because the quality of the raw material is being treated. At the end of the milling, the majority of the rice panicle by-products will be recognized in different percentages Figure 38 as main actors that are been wasted. The same for the rice straw left after the reaping.

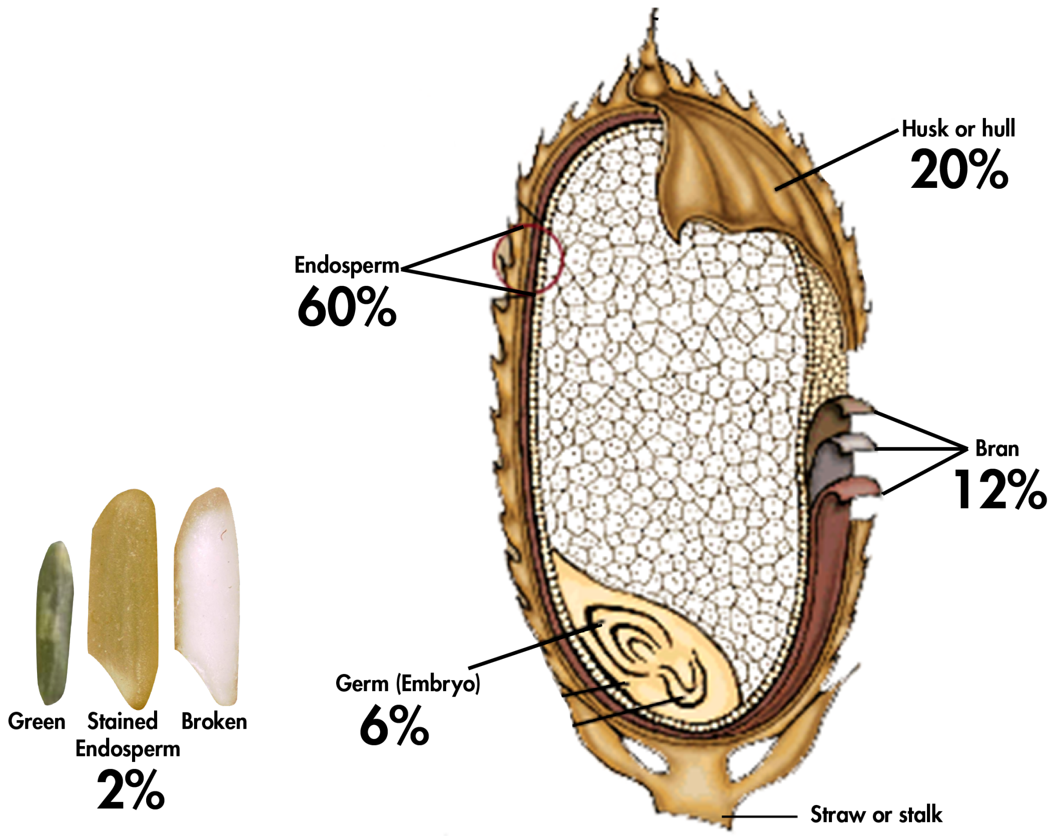


Figure 38: Piedmont's varieties average by-products after milling. *Source: Own elaboration*

In the Manual created by the International Rice Research Institute are expressed three different ways in which milling can be done as expressed below (Agricultural Engineering Unit, 2013):

ONE-STEP MILLING	**TWO-STEP MILLING**	**MULTISTAGE PROCESS**
husk and **bran** are removed in **one pass**. **White rice** comes directly from the paddy	**husk** and **bran** are removed **separately**. **Brown rice** is an intermediate product	white rice is the result of **different operations** and machines processing

Italian rice milling industry often uses a multistage process because of the huge quantities they are handling for market's consumption. Thus, this explain that the machinery they use is able to separate by-products during the different activities of the milling.

In the husk separation, the primary activity, the outer layer of the paddy is taken apart by friction between two spinning rollers adapted with an abrasive surface which separate the husk. Rice husk is aspirated (considering its lightness) and transported to a polyethylene bag attached to the machine's hole for husk passage. In the other hand, paddy is ready to be shaped.

From the first stage of the milling process, almost the 90% of the husk should be out of the paddy (Agricultural Engineering Unit, 2013). When rice paddies are free from husk, brown rice –also known as integral- is obtained. Next, the brown rice that is going to be polished goes into the paddy separation phase.

In the paddy separation, the bran layers are going to be removed from over the endosperm. This process is repeated three times trying to eradicate 90% of bran sheets (Agricultural Engineering Unit, 2013) by oscillating filters with tiny perforations that take the bran and the dust to another plastic bag.

The paddy separators, differentiate between length and size of the paddy, if it still thick, the process has to be repeated. Ultimately, when the grain gets white, it means the endosperm is ready to be polished.

Finally, in the polishing, the bran particles that did not go away in the process are eliminated by polishing the grain and giving a bright appearance to the grain. The progress of the white rice could be appreciated in Figure 39. Sometimes, husk residual is mixed with bran and both residues ended up in the husk plastic bag ready to be thrown or incinerate. On the contrary, the germ pieces, broken grains and immature paddies are separated through "self-cleaning filters" (Dara, Hong, Vichet, Chanmony, & Savoeun, 2009) and saved for other commercial usages.

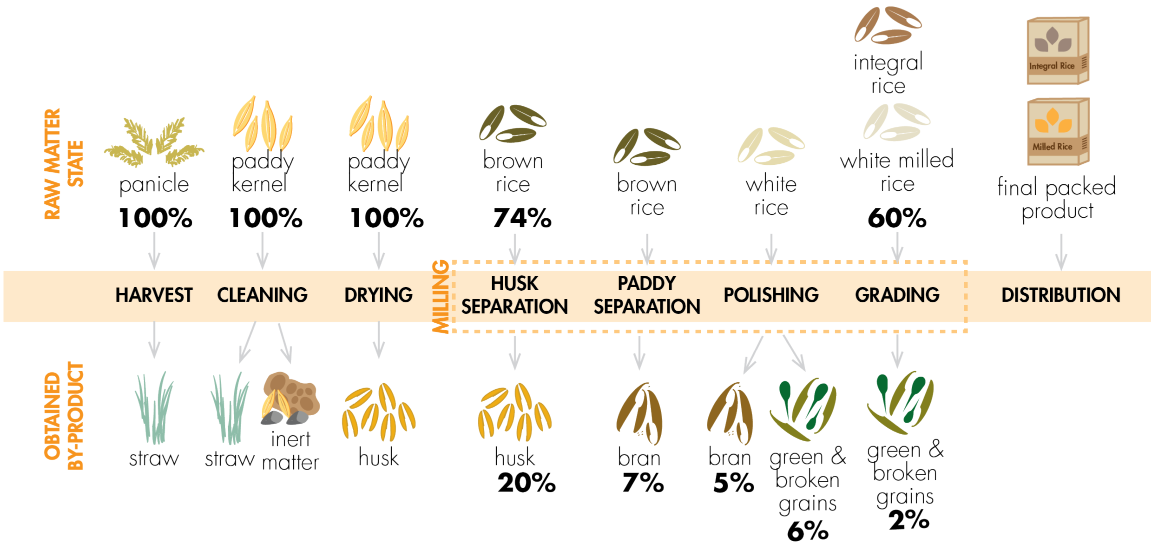


Figure 39: Raw matter transformation while rice milling. *Source: Own elaboration*

PACKAGING

The third big procedure in order to obtain qualified rice in the national and international markets is called in this document as packaging. In this moment, the rice is still a vulnerable food that can be easily attacked by humidity and plagues. Even though rice producers decided to manage different styles and presentations of their representative rice varieties the global process seeks the same, keep away the humidity from the milled product. This stage is considered a logistic solution that has been changing over the years, but still tries to keep intact the traditional rice varieties. In the Paddies creation and the Transformation process the raw matter is being treated and processed directly, now, what worth are the efficient methods in which rice is saved.

Grain selection (grading).

In the last activity executed in the milling process the polishing has helped to give a different superficial finished to the rice grain. As part of the quality control, the grains are passed through some graders. These graders have one big task in the accurate selection of the grains that are going to be sold and presented in the retailers shelfs. The responsible agents of this phase are – as mentioned before, rotating graders which recognize and classify the grains by their thickness, length, and weight.

Storage.

When talking about the storing of the finished products, an important division is contemplated always in the mill or in the packaging structure. The matter is divided into the milled rice that is going to be sold and the rice paddies that are going to be taken apart for the future seeding or transformation during the year.

Grain could be preserved for short or long terms. The preservation chain depends of the moisture of the grain; this is why if the producer wants to save the grains for six or more months, the humidity must be under the 12% (Lantin, 1999), in other words, is better wait until the cleaning and drying stages of the transformation process in order to prolong storage life.

Storage, as mentioned before, must protect the paddies from the environmental conditions surrounding the rice, for example the relative humidity concentration, the temperature picks during some seasons or germinating grains indicators.

Paddy usually goes through a bagging process, it does not matter if it will be storage for a long or a short term. Even so, some paddies are preserved in bulk using big containers or within wood or metal silos. These should be located in cool dry places with very little changes of temperature.

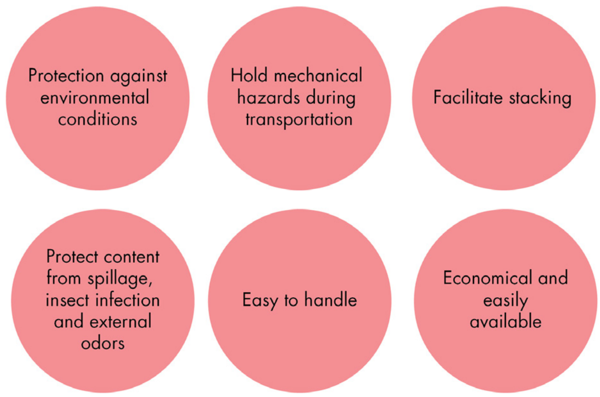
Storage could be considered a social feeding protection because if the climate conditions affected the crops during the year in which the grains are saved, the staple food would be available in those possible moments of crisis. Nevertheless, is one of the moments in which the matter is most exposed to the chemical substances used in the prevention and plagues management.

Producers have in mind the effectiveness of chemical fumigants in the rigid task of maintaining hygiene and sanitation levels controlled. These synthetic insecticides are sprayed through the whole merchandise that is being stored and at the same time in all the surfaces close to the stored material in order to eliminate the smallest possibility of insects or rodents. Versatility and low cost are the main reasons why these products are chosen and applied in the storing structures.

Packaging.

As storage takes care of the rice separated to be transformed or sown, the packaging is in charge of preserving the milled rice quality for the market's consumption. The packaging must increase the shelf life of the white, parboiled or brown rice. It is worth to mention that due to the presence of free fatty acid, brown rice is commonly presented in sealed polyethylene bags inside a cardboard box (Lantin, 1999).

According to Matta (2015), packaging materials should be related to the major indices of failure, which include loss of crispness, lipid oxidation and nutrient loss. Therefore, the packaging should satisfy the following conditions:



The grains for wholesale are commonly packed in 1000-kilogram jute bags, high density polyethylene or polypropylene sacks or multiwall paper sacks; over the years and because of the increasing market demand, the jute bags have been replaced by the plastic sacks which satisfy the same needs in an affordable way, in addition, there is evidence that supports the risk of contamination by insects' infection through the jute pores.

For smaller presentations (specifically the 250 g, 500g and 1000g), plastics like PET, BOPP or PE are preferred as mentioned by Matta (2015). Because of their flexibility and durability plastic pouches are used in milled rice packaging.

Another film used in rice packaging is the PET/Ink/LLDPE laminated structure. In the laminated skin composition, the pet is the outer coat that gives strength, in the ink layer comes the information, seals and marketing graphic strategy and the inner layer works as a humidity barrier. Figure 40 shows the variety of milled rice presentations in Italy's supermarket shelfs.

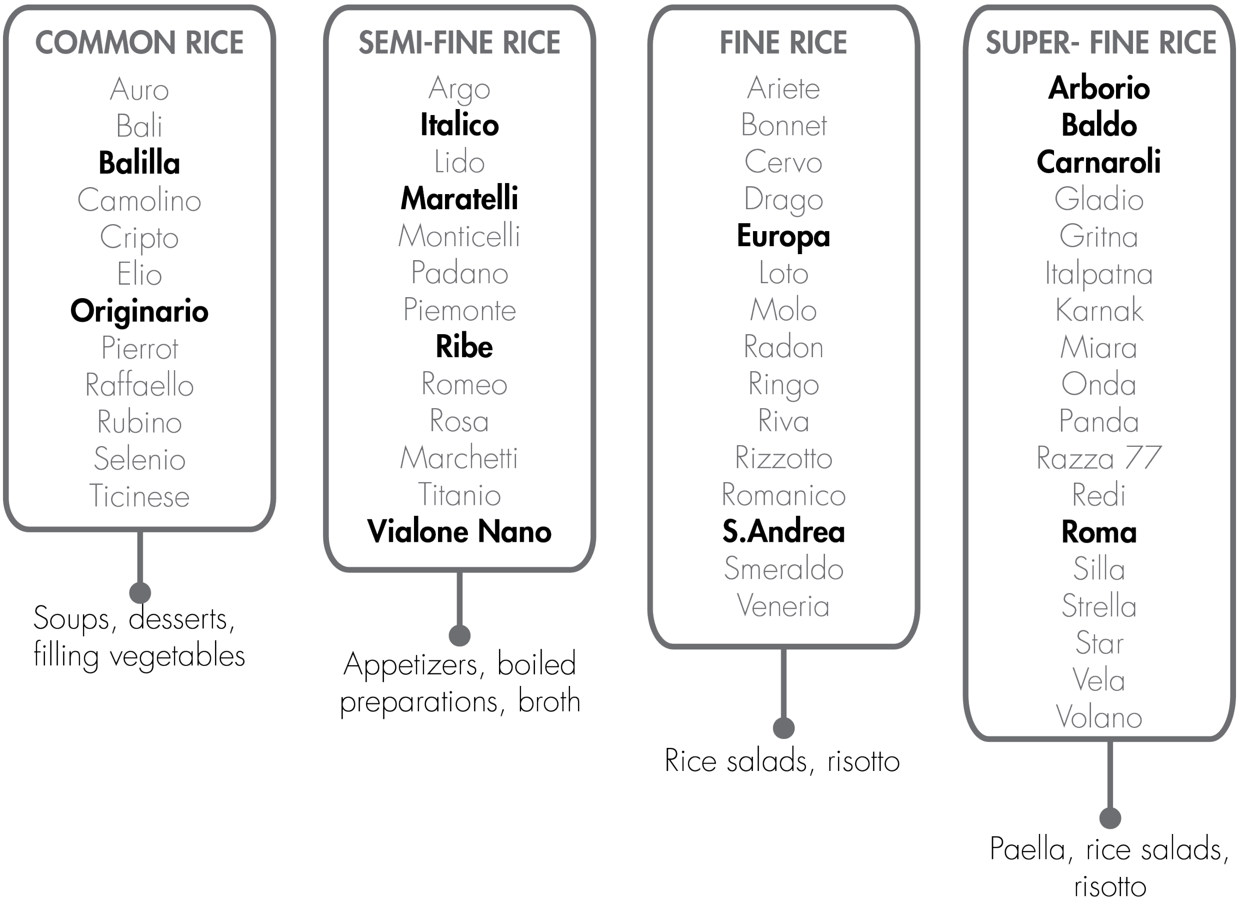
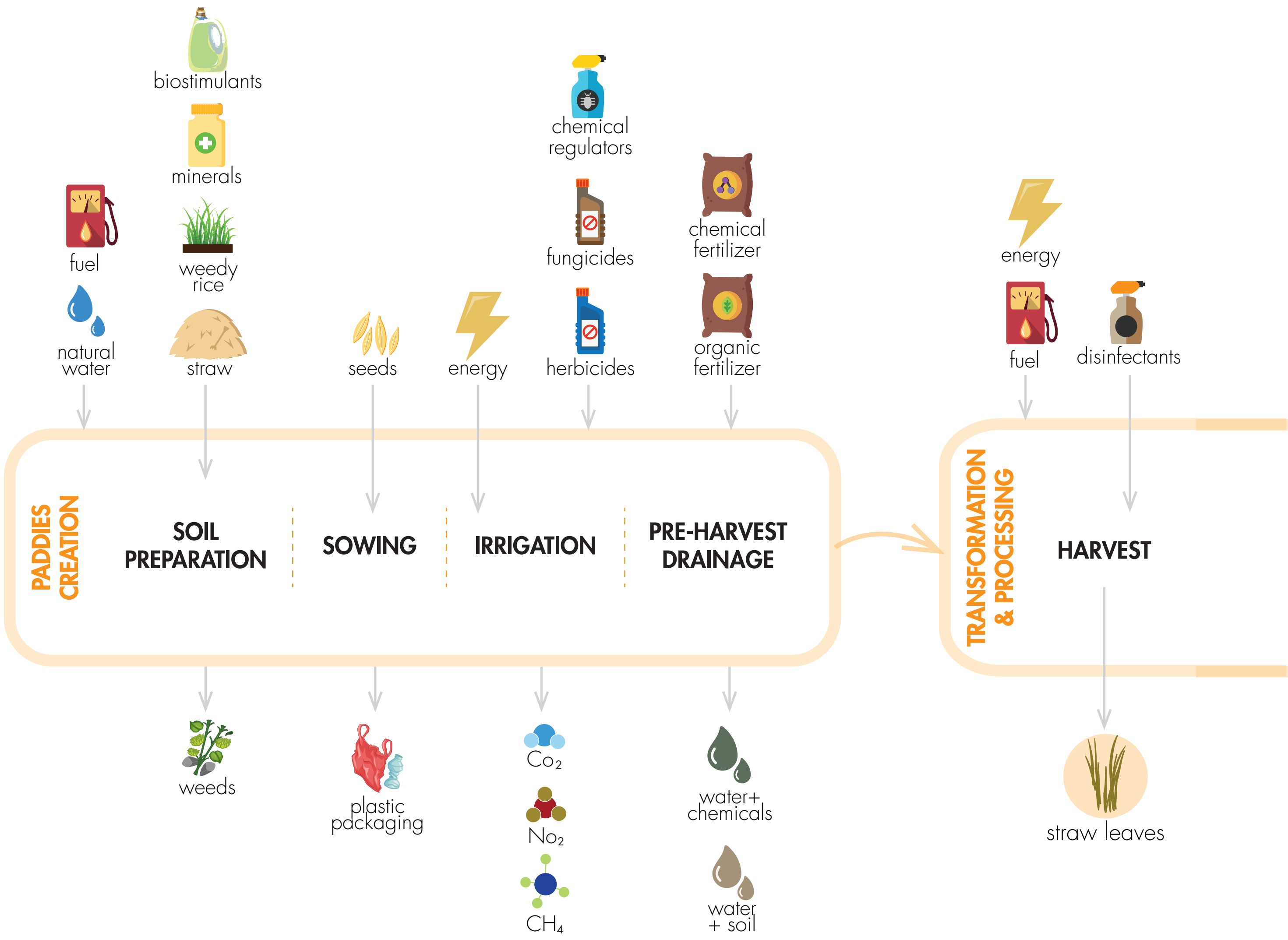
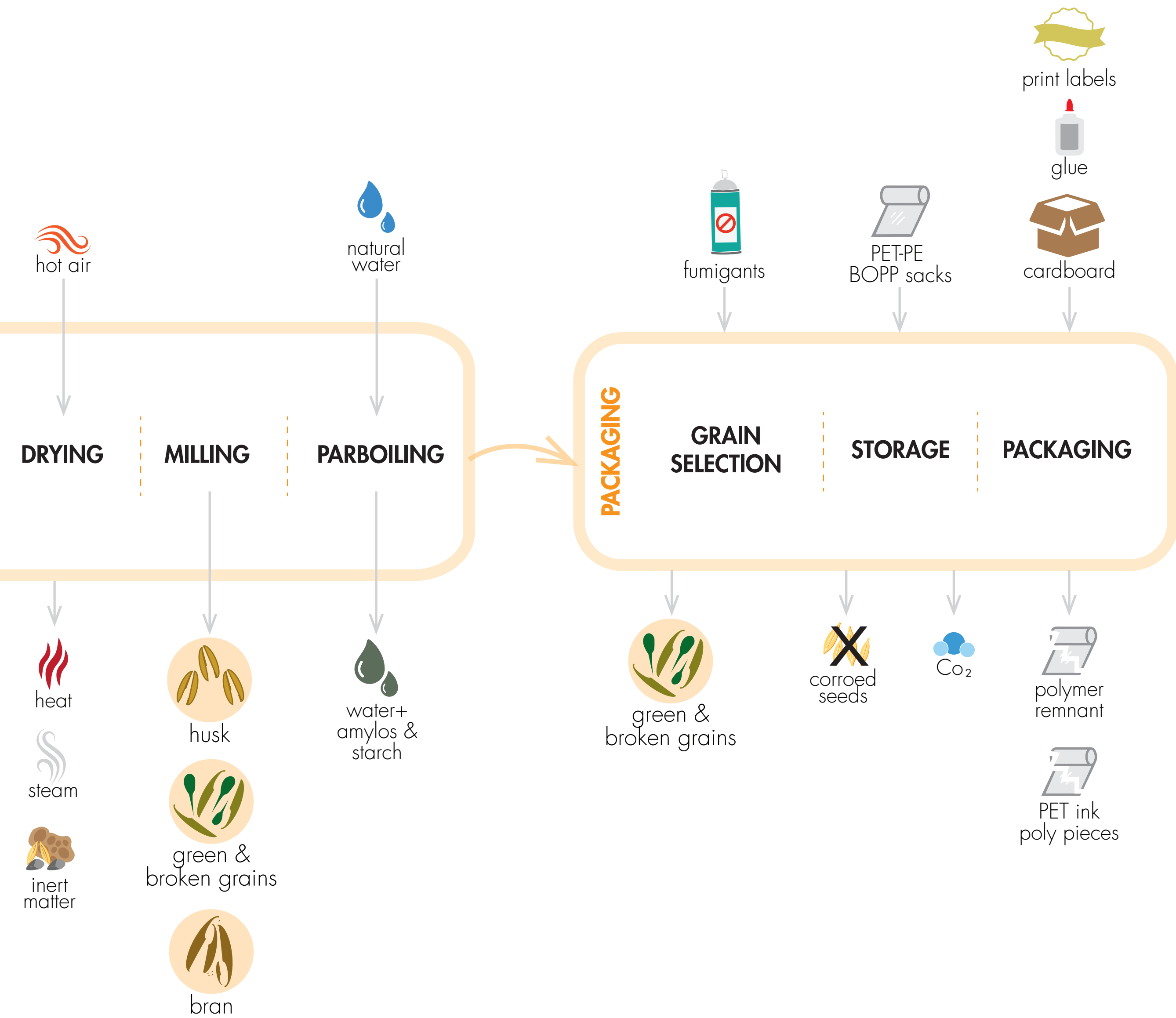


Figure 40: Italian most popular rice varieties. *Source: Own elaboration*

CURRENT RICE PRODUCTION

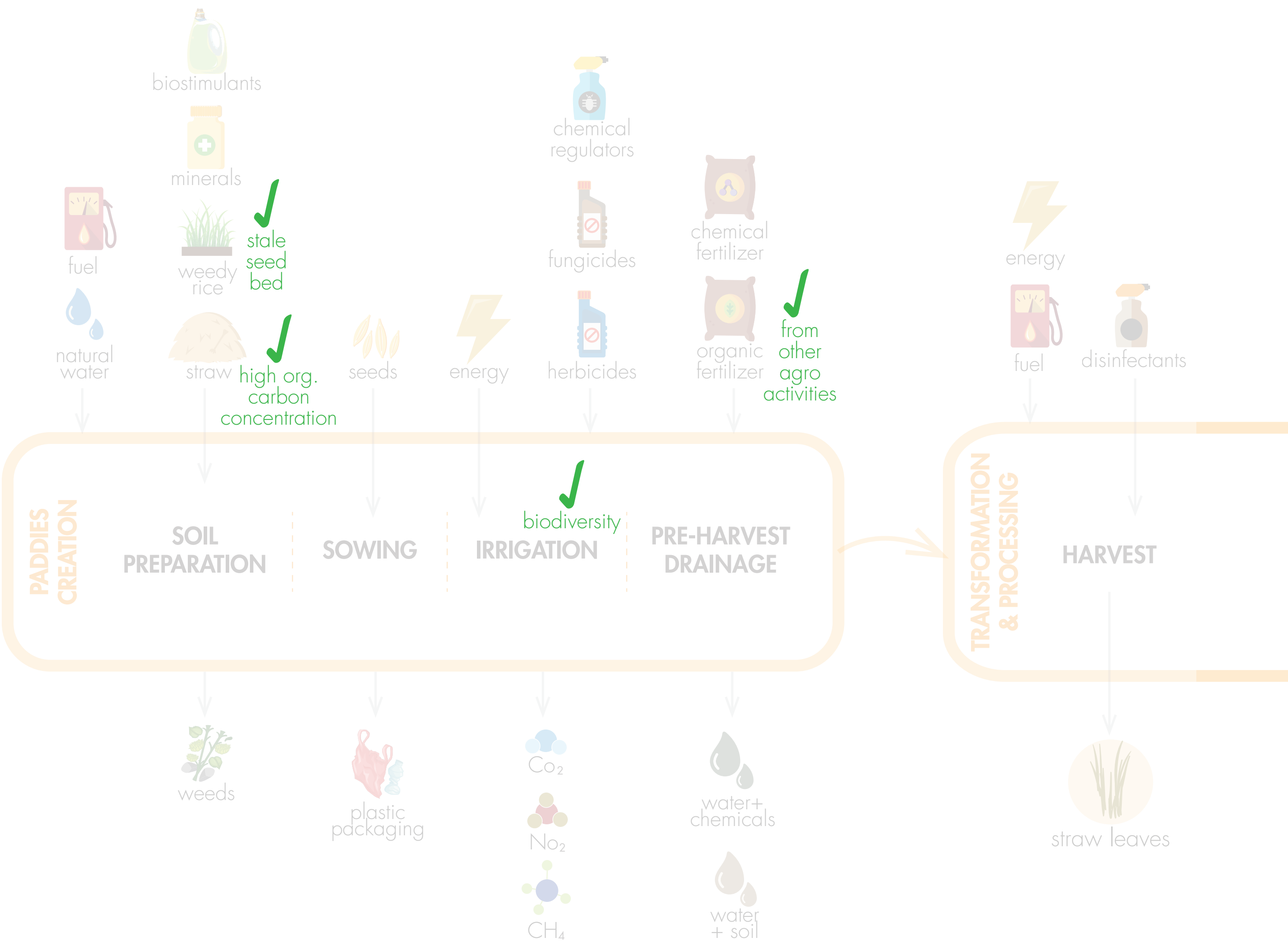
Input/Output value chain




print labels
glue
hot air
natural water
fumigants
PET-PE BOPP sacks
cardboard
DRYING
MILLING
PARBOILING
PACKAGING
GRAIN SELECTION
STORAGE
PACKAGING
heat
steam
inert matter
husk
green & broken grains
bran
water+ amylos & starch
green & broken grains
corroed seeds
Co2
polymer remnant
PET ink poly pieces

CURRENT RICE PRODUCTION

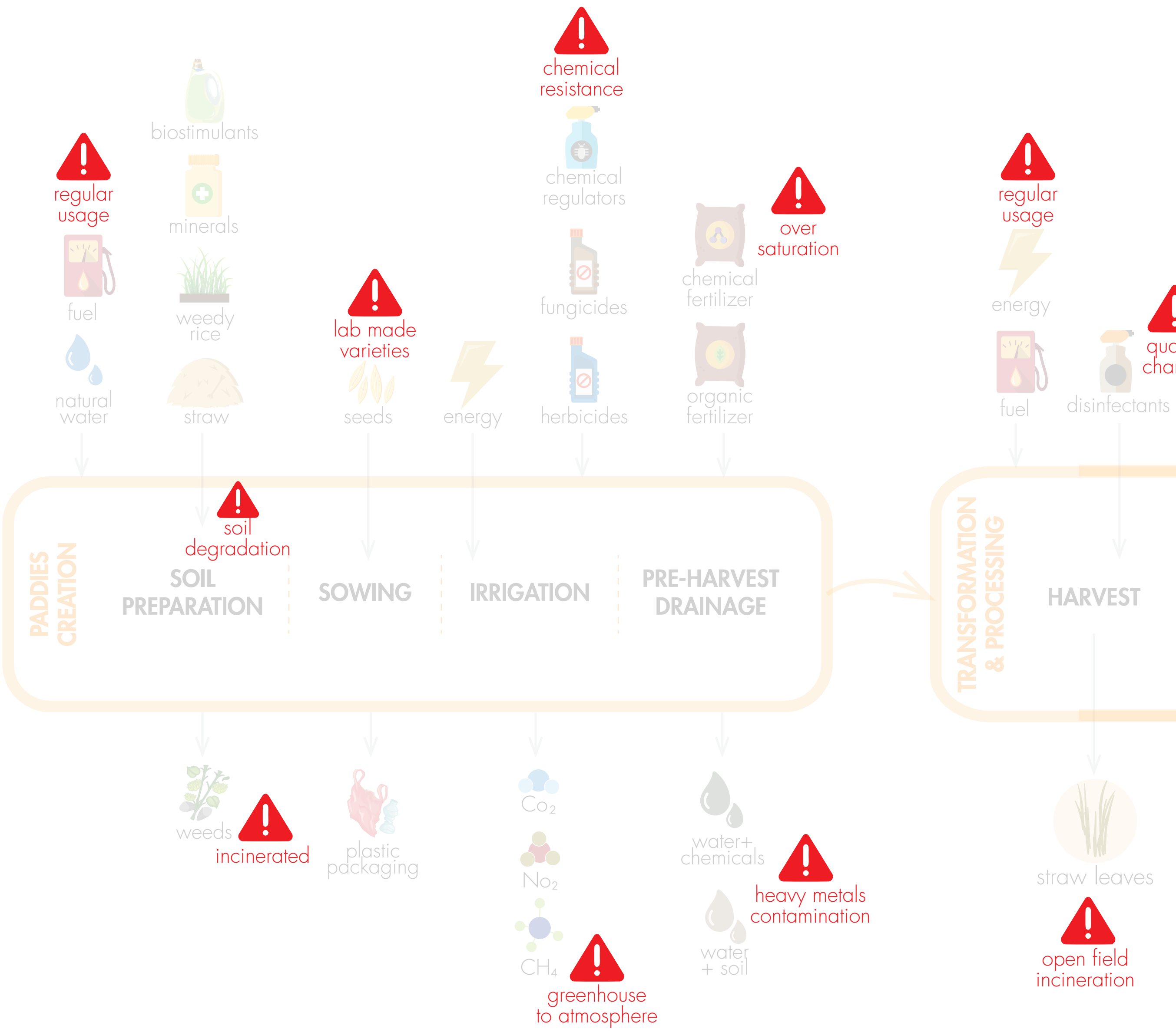
Value chain strengths




print labels
glue
hot air
natural water
fumigants
PET-PE BOPP sacks
cardboard
gain nutrients
safety conditions
DRYING
MILLING
PARBOILING
PACKAGING
GRAIN SELECTION
STORAGE
PACKAGING
heat
steam
inert matter
husk
green & broken grains
bran
water+ amylos & starch
green & broken grains
other activities
corroed seeds
Co2
polymer remnant
PET ink poly pieces

CURRENT RICE PRODUCTION

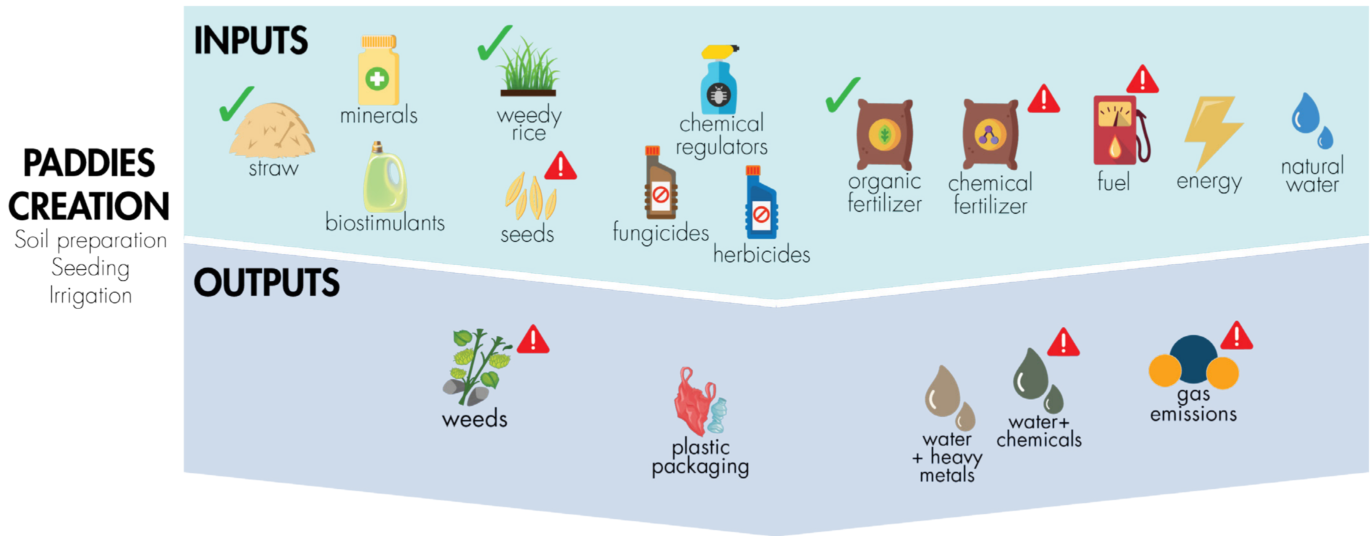
Value chain threats and weaknesses




lity
nge
hot air
natural water
huge quantities
grains contamination
print labels
glue
fumigants
PET-PE BOPP sacks
cardboard
DRYING
varieties mixture
MILLING
PARBOILING
PACKAGING
GRAIN SELECTION
STORAGE
PACKAGING
heat
steam
nutrients loss
inert matter
husk
green & broken grains
bran
quality not exploited
water+ amylos & starch
water contamination
green & broken grains
corroed seeds
Co2
polymer remnant
non reusable
PET ink poly pieces

in the following representations, it is possible to observe, specifically, the analysis made to the current system. This is why the every entry of matter that is transformed in the system has been understood as an input and formerly it is treated as an output.

Considering the three explained stages of the current chain, the analysis was made separatedly in order to appreciate the characteristics of every part of the system and its impact in the territory.



✓ CURRENT ADVANTAGES

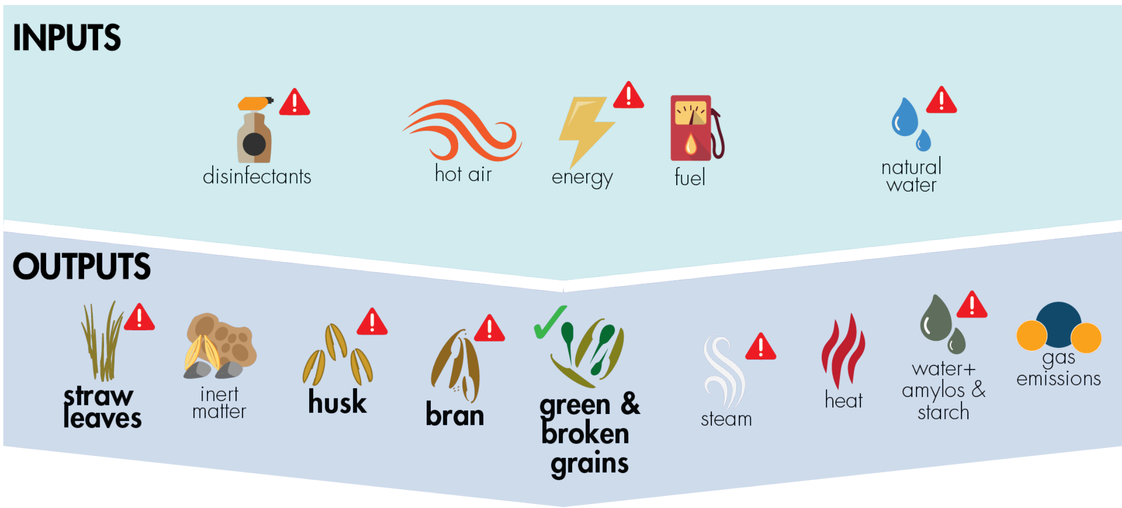
	SPECIAL CONCERNS	ADVANTAGE
INPUT		
straw	Obtained from other agro activities	- Incorporation of organic matter helps the soil to be prepared for a new seeding by increasing the carbon rate.
weedy rice	Stacks are often placed once and substituted if needed.	- Reduce herbicide use, manpower and weed management costs.
seeds		- Low chance of change variety quality because the seed is obtained from the previous harvest.
ACTIVITY		
irrigation		- Water and peat soil allows the congregation of different species, protecting local biodiversity.

CURRENT DISADVANTAGES

	SPECIAL CONCERNS	DISDVANTAGE
INPUT		
chemical fertilizer	Used because organic fertilizer lacks and apparently its correct use must be integrated with other organic substances	- Adding potassium and nitrogen rich (peat) soil is useless. - Soil is overcharged with macronutrients.
fungicides herbicides	Pyrethrum synergized (1:2 ratio) with piperonyl butoxide, primiphos-mythl, chlopyrifos-methyl, tetrachloryinphos, fenithrthion and metacrifas	- Chemical applied over bulk grain or bags. - Fumigants are generally toxic to humans and surrounding crops. - Pesticides leave harmful residues and release bad odors.
natural water		- Abusive use of water when the number of irrigations increase.
energy	Temperature regulation during cold peaks	- When the sunlight is not enough to heat the irrigation water, thermal structures should be constructed to maintain the right temperature.
fuel		- Semi mechanized processes reduce time and human-labor, but fossil consumption rises from 5 to 20 liters per hectare, especially when preparing the soil .
ACTIVITY		
soil preparation	Plowing, harrowing, leveling	- Reduction of canaliculus porosity where microorganisms work.
sowing		- Varieties with different growth rates could mixed.
irrigation		- High concentration of water and organic matter make harder the effective crop rotation. - The sudden changes in the water levels affect the natural develop of biodiversity around the rice fields.
OUTPUT		
weeds		- Open-field burning.
water+ chemicals	NO3-N pollution coming from mineral fertilizers	- Water is drainage and bacteria living on the soil cannot metabolize, neither by immobilization, nor denitrification, the high concentration of nitrates
gas emissions	CO_2, NO_2, CH_4	- Carbon dioxide and methane greenhouse gases are released to the atmosphere. - High concentration of nitrogen dioxide particles travels through the air polluting the surroundings.

TRANSFORMATION & PROCESSING

Harvesting
Parboiling
Drying
Milling



✓ CURRENT ADVANTAGES

ACTIVITY	SPECIAL CONCERNS	ADVANTAGE
milling	Polishing	- Reduces cooking time. - Increases storage life.
OUTPUT		
green & broken grains		- Cleaned and saved in order to occupy other commercial uses.

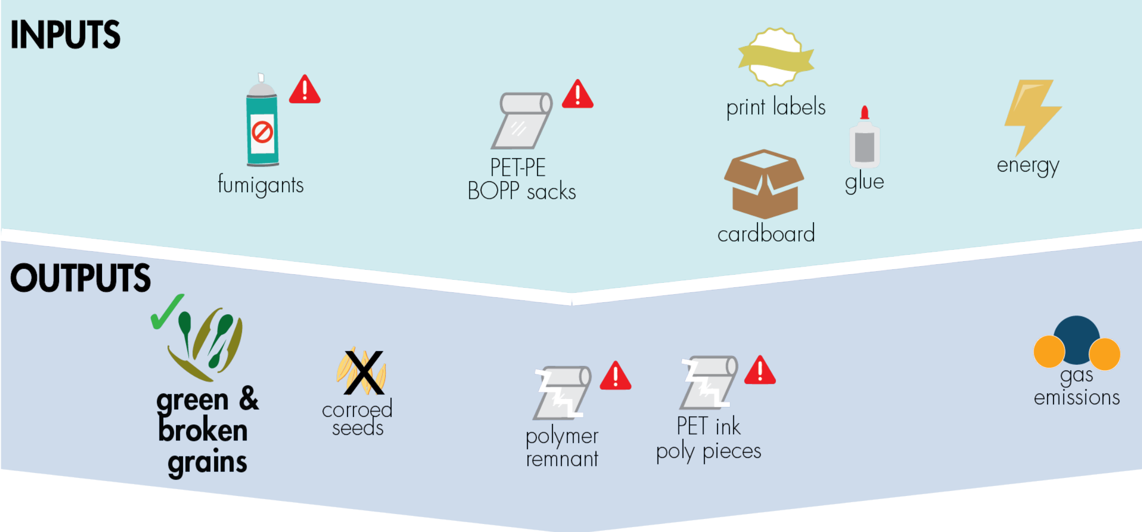
CURRENT DISADVANTAGES

INPUT	SPECIAL CONCERNS	DISDVANTAGE
disinfectants	Cleaning	- Paddy's quality is changed.
energy	Pyrethrum synergized (1:2 ratio) with piperonyl butoxide, primiphos-mythl, chlopyrifos-methyl, tetrachloryinphos, fenithrthion and metacrifas	- All the activities embraces the use of industrial machines that have to work more than 8 hours per day.
fuel	Drying	- High fuel cost because of prolonged use.

CURRENT DISADVANTAGES

	SPECIAL CONCERNS	DISDVANTAGE
ACTIVITY		
drying	Drying heat-air is spread at 43°C	- Some insects present in rice crops could bear temperature of 45°C. - Good or bad bacteria an mold lives from 0° to 60°C
milling	Husking Paddy separation	- There is no machine able of separating every by-product. Some operations have to be done twice. - Additional machines for by-product clean separation means a high investment to producers, which emphasizes the ignorance about by-products potential value - Because paddy is not edible, the processing means the reduction of the nutritional value, almost recovered with the parboiling
OUTPUT		
straw leaves		- Organic matter sent to incinerator.
inert matter		- Raw material is vulnerable to contamination after the cleaning if aerodynamic processes do not work correctly. - Inorganic particles damage the mill.
husk		- High silica and lignin content. - Mixed with bran and straw because it is considerate waste.
bran		- Contains the highest concentration of vitamins and nutrients as protein, fat and iron. - It is sent to the disposal or burnt.
steam		- It is released to the atmosphere when it could be used in other processing activities.
water+ amylos & starch	Parboiling	- Water rich in minerals is thrown.
gas emissions	CO_2	- Carbon dioxide and methane greenhouse gases are released to the atmosphere.

PACKAGING
Grain selection (grading)
Storage
Packaging



✓ CURRENT ADVANTAGES

	SPECIAL CONCERNS	ADVANTAGE
ACTIVITY		
packaging		- Continuous search of materials capable of satisfying packaging conditions and product's quality.
OUTPUT		
green & broken grains		- Used in other agricultural activities.

CURRENT DISADVANTAGES

	SPECIAL CONCERNS	DISDVANTAGE
INPUT		
PET-PE BOPP sacks	PET, PE, BOPP	- Expensive and not totally developed technologies for recovering or recycling these materials.
energy		- Required for plastic sheets filling.
fumigants		- Remain attached to the organic matter surfaces. - Re-drying of grains will be needed.
ACTIVITY		
grading		- Rice quality is compromised because of the varieties mixture.
OUTPUT		
polymer remnant		- Treated as waste and taken to the disposal.
PET ink poly pieces		- Inefficient separation of layers. Individualizing materials is not possible.
gas emissions		- Not only CO2, but the treatment of plastics releases toxic gases that are spread in the indoor factory.

4.2. Piedmont's current wine production

Following the principles of systemic design, it is important to deeply analyze the value chain of the process, how is it done, inputs and outputs and positive and negative critics about the current activities. In this way, it will be possible to determine the focus outputs that are going to be studied later on.

The wine production chain includes different phases, starting from the cultivation of the vines, an important part of the viticulture process. Viticulture means the production, science and study of grapes and is related to the activities done in the vineyard. Being the first stage of the process, it can be divided into two phases; the first one is the soil preparation, which includes all the steps and characteristics needed for the creation of a vineyard. The second stage of the cultivation is the crop management, which every phase of the plant's growth and the interventions that have to be done by the viticulturist for the optimal development of good quality grapes.

After the process done in the field, another important phase is the winemaking, also called vinification process, which is where the transformation of the grape into wine takes place. Passing from the field after the harvesting and arriving to the winery, vinification is the moment in which fermentation takes place.

Finally, when winemaking is done, the last stage of the wine production chain is the bottling and commercialization of the final product, this is when wine finished its process inside the winery for arriving to the different distribution centers in order to be available for the consumer to buy it.

SOIL PREPARATION

As mentioned before, the soil preparation includes all previous activities to the plantation of the vine, are the pre-planting phases which aim to improve the conditions of the soil and the efficiency of the vineyard.

Land clearing.

The first step of soil preparation is the land clearing, this consist on removing the undesirable vegetation and excess of roots of previous plantations, residues that in the current process are being collected for incineration or are crushed and left in the land as organic compound.

This is done in order to have a clean terrain, and it is important because is the soil where the vine will grow and from where it will absorb the nutrients. During the clearing phase is important to analyze the chemical situation of the soil, and check the balance of minerals, which must be for Magnesium and Potassium in a level close to 5 meg/100g.

When checking the minerals in the soil, it can be determined which kind of fertilization is needed according to the needs of the soil, taking into account that it is needed Potassium, Phosphorus and Magnesium, when the soil is very poor because of over production, the addition on manure is important for adding nutrients (Veneto Agricoltura, 2004).

Winegrowers use chemical and mineral fertilizers as protection from insects and possible aids, but these kinds usually change the soil composition for future crops, and instead of making it of better quality id decreases, creating a vicious circle where the plant and the terrain will always need fertilizers.

Tillage.

After land clearing and fertilizing, the soil has to be tillaged. Tillage consist on two principal phases, the first one is the Deep plowing in order to break and loose the soil while making sure there are no presence older roots. Once plowed, the harrow is applied in order to reduce the size of possible soil clods and to make the surface smoother. During this two phases, thanks to the movement of soil the fertilizer is mixed and the soil is starting to absorb and assimilate minerals (Goldammer, 2015). Taking into account the characteristics of the territory, for Piedmont's vineyards there's no need of the application of an artificial drainage, as said before, Piedmont's hills are good enough as drainage structure.

As well as drainage, irrigation system varies depending on the climate conditions, and usually vines can be adapted to dry terrains, but with climate changes, it was applied the method of "rescue irrigation" which is the artificial irrigation of vines for cases in which the plant is going through a hydric stress (Sequino, 2017). This irrigation method is also useful for the first years of the vine growth, because being not yet established it is important to guarantee the proper absorption of water and nutrients.

Figure 41: Cover crops in Vineyards. *Source: Skinkis, 2015*

Crop covering.

Planting cover crops is another important activity when preparing the vineyard land, this crops are important between vines rows in order to control weed and preserve the soil avoiding erosion (Figure 41). This covering vegetation can also influence positively providing good properties to the soil where the vines will be developed. Generally, this crops are types of grasses that additionally reduces the need of tillage on further soil treatments, help increasing the microbial population and beneficial fungi, providing stability to the terrain (Skinkis, 2015).

Another option for covering the soil between rows is mulching (Figure 42), as well as the cover crops it provides moisture conservation and avoid the appearance of weed. Generally, mulch is applied in fall, after the harvest, taking advantage of the remaining straws (Skinkis, 2015).

Figure 42: Mulching in Vineyards. *Source: Tim Martinson*

Stacking.

As part of soil preparation for vineyards, and before the plantation of vines, is done the staking, which consist on the construction of the support for the vines growth. The importance of this support is that acts as training system, which means that it gives direction to the trunk and allows the proper and controlled growth of the plant.

There are different types of staking but the most commonly used is the espalier training system also known as guyot (Figure 43), it consists of a vertical trunk which serves a tutor for each plant allowing the growth of the plant perpendicular to the terrain and allowing the plant to grow no more than 90 cm from the floor (Regione Piemonte, 2008).

This system is constructed with poles and wires (commonly of iron) that support the branches of the vine. Each supporting trunk is spaced from the next one with a distance of about 40 cm (Valente, 2016).

Figure 43: Espalier training system. *Source: Valente Pali*

Vine Cuttings Plantation.

Once the training system is done, the land is ready for the vine cuttings plantation. In contrast with other types of crops, grapevines are not propagated by seeding, instead is done by propagation of cuttings.

This method consists of cutting a shoot from a "mother" vine, which will be first in a nursery phase (Figure 44), and then will be taken to the field, where it will be planted and develop its own root system. With time will get mature turning into a complete vine plant. The plantation of vine cuttings should be done between the end of autumn and the beginning of winter (Veneto Agricoltura, 2004).

Figure 44: Vine cuttings nursery. *Source: Flickr*

As mentioned before, these soil preparation activities are for the first time that a vine is being cultivated. In the cases when the training system is already constructed and the vine cutting is already planted and mature, the process of soil preparation is reduced to the fertilization and control of minerals in the land or directly to the vine plant. On the other hand, if one mature plant has to be changed because of diseases or plagues, it can be replaced with a new vine cutting, but is important to plant it according to the phases of the mature vines.

An important factor that have to be taken into account when constructing the vineyard is that the density of the installation has to meet certain parameters. The one is that the crop has to be of 3000 shackles, when using the vertical training system (espalier).

CROP MANAGEMENT

The crop management have to be done during the plant growth and maturation, and when the vine is already mature, this process is done following the perennial development of the plant. Starting with pruning and finishing in the winter dormancy.

Pruning.

Once the crop is planted, one of the most important activities is pruning, because it is in charge of giving shape to the crop, but most important is that it maintain clear the plant from non-productive shoots in order to concentrate the flow of nutrients to those producing the fruit.

Pruning is distinguished is two different types, breeding pruning (Figure 45), in charge of shaping the young plant and pruning of production, to maintain the shape and the balance of the adult plant.

For the first two or three years of the plant, the root system is getting stronger for the stimulus of exploration of soil. In fact, this are the years when the plant is more vulnerable to aggression from weeds. Because of this, it is not recommended to start pruning production in this years in order to avoid suppressing young shoots and potentiate the photosynthetic apparatus. But, Productive shoots constituting the permanent cordon should be selected from the second year (Veneto Agricoltura, 2004).

Pruning is important for the management of the vineyard because it allows to achieve the balance between the vegetative activity and the productive activity of the plant, having direct impact on both, the yield and the quality of the grape. Additionally, dry pruning aims to guarantee the production longevity of the plant and to control its development in the space assigned to it, maintaining the settled form of breeding.

The proper time for pruning and adult vine is during the winter, when the plant stops its activity of the previous season. Preferably, once the coldest period of the year has passed, in this way it is possible to eliminate the branches with gems that may be damaged by low temperatures (Castaldi, 2008).

From winter pruning activity, result a significant quantity of shoots that are no longer part of the plant, this new organic matter, is currently either being minced for the production of compost, left on the terrain for degradation or incinerated. These current uses do not exploit the natural properties that this branches can provide. These characteristics will be deeply explained on chapter 5 (Figure 46).

While pruning a young vine, is also important the proper tying of the shoots, following their growth; it aims to support the branches that can break under the weight of the bunches or by the action of the wind. After the winter pruning, the plant continues to develop on its growing and maturation phase, during this phase are applied chemical treatments for the protection of pests and irrigation is applied when needed.

On the growing stage the buds on the branches start growing leaves and flowers and then the flowers turn into the fruit. Furthermore, this fruits start growing and getting green, until the maturation phase, when they start accumulation sugars on each berry getting a red-purple color.

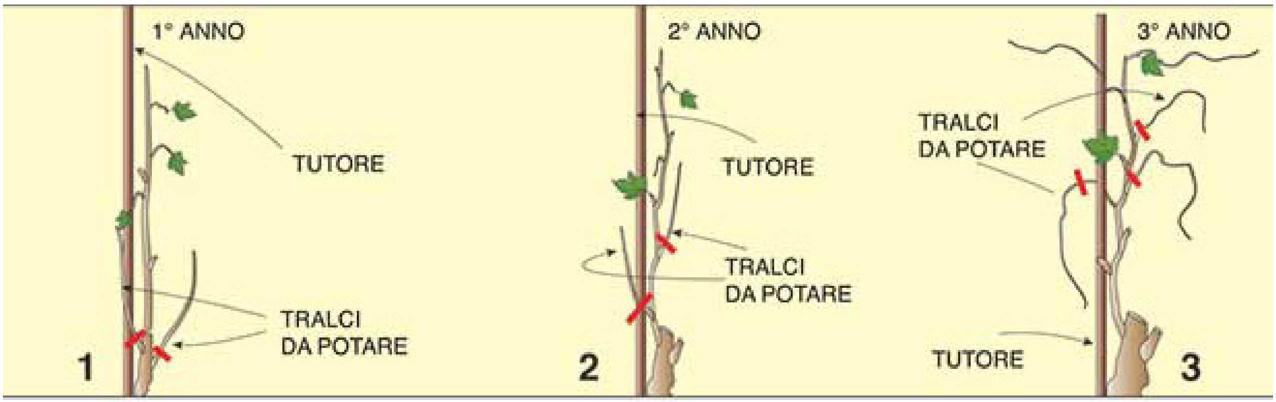


Figure 45: Breeding Pruning. *Source: faidateingiardino.com*

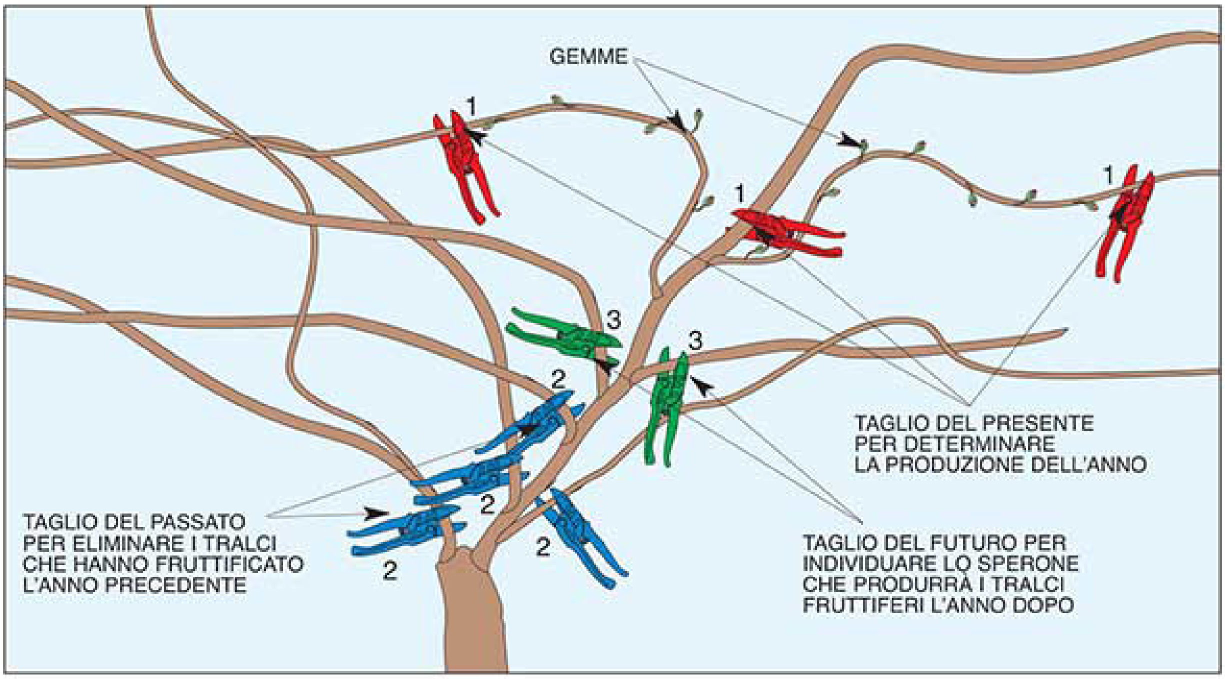


Figure 46: Adult Pruning. *Source: faidateingiardino.com*

Grape Bunches Thinning.

An important factor during maturation is to control the quality of the grape bunches, taking into account that they have to accomplish certain characteristics in order to be of the proper quality for the wine. This is the phase of the thinning of the bunches and it can be considered as the gentlest intervention in green because is when a certain amount of grape production id eliminated when is not yet harvest.

The thinning is done to the bunches that are not such big as the others of the same crop, or to those that have caught a bacteria or pest and is not of quality for wine making, or those which have not receive the proper quantity of sun and are no developing properly. This elimination has a purpose, in first place it balances the production, and in second place reduce the load of grapes due to an abundant winter pruning.

Eliminating this bunches of grapes or just a part of them is frequently done in companies that produce high quality grapes, since it allows to define the exact bunches of grapes for each individual plant according to what is established at the time of production planning. The thinning must be done before the veraison (color change) starting from the fattening phase of the berries (Giannone, 2010).

Harvest.

Once the thinning is done, the plant continues its maturation phase, for finally reaching the time of the harvest. Grape harvesting is the last stage of crop management and the first of the vinification process, being the transition from the field to the winery.

In ancient times, wine harvesting was made exclusively by hand, but today it is mostly done mechanically. however, this type of harvest is less accurate than when it was manually done because it does not allow to make a selection of the bunches.

Nowadays, the manual harvest in done for the production of high quality wines and sparkling wines, as it is necessary to make a careful selection of the bunches; but this leads to an inevitable increase in production costs.

On the other hand, it it the mechanical harvest method, done with facilitating and grape harvesting machines. The product that comes off the plant is collected before it touches the ground, cleaned from any impurities and placed in a hopper (pyramid-shaped container), which is then emptied into suitable containers.

During the harvesting phase is important to follow some considerations:

> Wet grapes shouldn't be collected, because rain water or humidity from dew or fog can influence in the must quality.
>
> The harvesting time of the day shouldn't be the hottest in order to avoid the premature unwanted fermentation.
>
> The containers for the bunches can't be very large, in this way it is avoided the crushing on field.
>
> The transportation from the field to the vinification center have to be done as soon as possible after the harvesting, this to avoid unwanted fermentation and fruit maceration.

During the harvesting process, either by hand or mechanical, there is a risk of the grapes being bruised and releasing juices. In order to avoid the degradation of tis juice, it is added sulfur dioxide compounds.

The harvest period varies between July and October and depends on many factors: climatic conditions, production area, type of grapes, type of wine to be obtained determined by the greater or lesser presence of some components such as, sugars, acids and aromatic components (Nimda, 2015).

WINEMAKING

Once the grapes arrive to the winery, they become on the raw material for wine making, and it have to go over certain phases before being transformed into the beverage.

The winemaking process depends always on the type of wine and the principles of the wine maker, the principle stages are explained then, but the process can be done in a different order or with other steps in various cases.

De-stemming and Crushing.

The first step of winemaking is de-stemming and crushing the grape bunches, which consists on removing stems and leaves in order to control the presence of undesirable components that can change the production and quality of the wine.

This step is done in a machine that have a central aluminum trough with a screw shaped axis. While the screw turns on its own axis, the grapes are squeezed, being separated from the stems which are no longer needed in the process. By the other side of the machine pops out the crushed grapes.

This process has to be done as gently as possible in order to avoid crushing the seeds. An eventual crushed seed can contribute to a change on taste of the final wine.

Removing stems is important because of its large amount and concentration of tannins, that if are left on the must during fermentation the result will be a tannic wine that will not be so enjoyable for customers. Tannins amount contained on the grape skins is enough for this process (Nimda, 2015).

Immediately after de-stemming, the grapes fall into the crusher, through which the must obtained is purified from the impurities and corrected with substances that regulate the acidity and the sugary component. Thanks to the application of sulfur dioxide, during this step are being generated greenhouse gases (Musee, 2004).

Maceration and Pressing.

Just after crushing, the must passes to the maceration process, which is in charge of breaking down grape solids and releasing phenolic compounds. The maceration process for red wine is done allowing the skins to be in contact with the must, this in order to allow the red color, tannins and flavor extraction.

Once the maceration is in process, takes place the pressing of the wine, which helps to the extraction of the juice and the separation from the solid parts by the application of force in order to force the remaining juice in the grape marc to be extracted and separate it from the must.

During this process, there is a high discharge of organic content, the grape marc containing seeds and skins, which are eliminated from the process in this phase and the must or juice that will continue its transformation into wine.

Draining.

This process is when the must is separated from the skins and seeds before its fermentation, thus will be obtained obtained white wines that are generally to be drunk within 3 years from the date of harvest. For achieving this in the draining phase, the objective is the separation of the juices, freed from crushing, from the solid part. The juice obtained by draining is called flower must, while the solid parts called pomace or marc can be subjected to subsequent pressing, or are stored before for sending them to the proper disposal or to the distillery. To obtain rosé wines, is carried out a partial white vinification.

Fermentation.

After maceration and pressing, the must obtained is ready for fermentation process, which can last about to 1 day or 1 week, and for complex wines can be extended up to 10 days. It is during this biochemical process that the sugar contained in the must gradually turns into alcohol, carbon dioxide and heat.

The vinification follows a different process according to the type of wine to be obtained, it takes place inside vine vessels, in which are found the must and the grape skins.

During the vinification process, is done a treatment for musts correction called sulfidation, it consists in adding sulfur dioxide (SO_2) to the wine mass in order to regulate the alcoholic fermentation and to perform antioxidant functions.

Filtration.

The fermentation process leads to the development of bubbles of carbon dioxide which in their ascending movement induce the rise of the solid particles that form a mass of marc at the top of the fermentation vat. On the other hand, during fermentation and filtration is also formed a deposit of yeast and particles that remain at the bottom of the container, this remaining is called lees, and are left behind when wine is filtrated from one container to another (Tosti, 2017).

This filtration is reached by a racking process, here the wine is passed from one vessel to another and by gravity the un desirable particles are leaved behind in the previous vessel. This process can be done manually or by the automation of the vessels. During this process, due to the changing of containers, there is a loss of organic matter and waste water after the cleaning of each vessel.

Malolactic Fermentation.

For red wines that are intended to be aged, after the filtration it has to be done a second fermentation phase called malolactic fermentation, which consists on transforming the malic acid into lactic acid. This second fermentation is done thanks to the addition of bacteria and temperature changes.

Wine aging is considered the last phase of the winemaking process, and although is a conservation and storage phase, it is considered as part of the process because it changes the wine quality during time. During the storage of wine in wooden barrels or steel tanks, the wine suffers some physical, biological and chemical changes under a specific temperature of 15°C on the cellar.

Aging.

Aging of wine can be done before or after the bottling process. When done before, the aging is done in large vessels of stainless steel or wood barrels.

This process helps the wine to retain flavor and aromas and depending of the wine it can be also be softened.

When conserved on wood barrels the wine obtains wood tannins which contribute to the change of flavor of the final product. When aged after bottling, the wine is conserved in a cellar, where the evolution is slower and changes aromas, flavors, and in some cases the body of the wine (Musee, 2004).

Bottling.

The final stage of the vinification process is bottling and packaging. The most important in this phase is to avoid the oxidation of wine, for which is added sulfur dioxide. Another step that is done for avoiding oxidation, is flushing the bottles with inert gas before filling to avoid contact with air. Some wineries don't do the bottling stage and sell the wine directly in high volume to other companies (Musee, 2004).

During the winemaking, is where the grape, after its maturation suffers the biggest changes in the transformation into wine. From a solid stage as bunches of grapes to the extraction of juices, and separation of solids to finally obtaining the alcoholic beverage. These changes can be best noticed on Figure 46 Which explains graphically the changes by step of the grape and the by-products obtained.

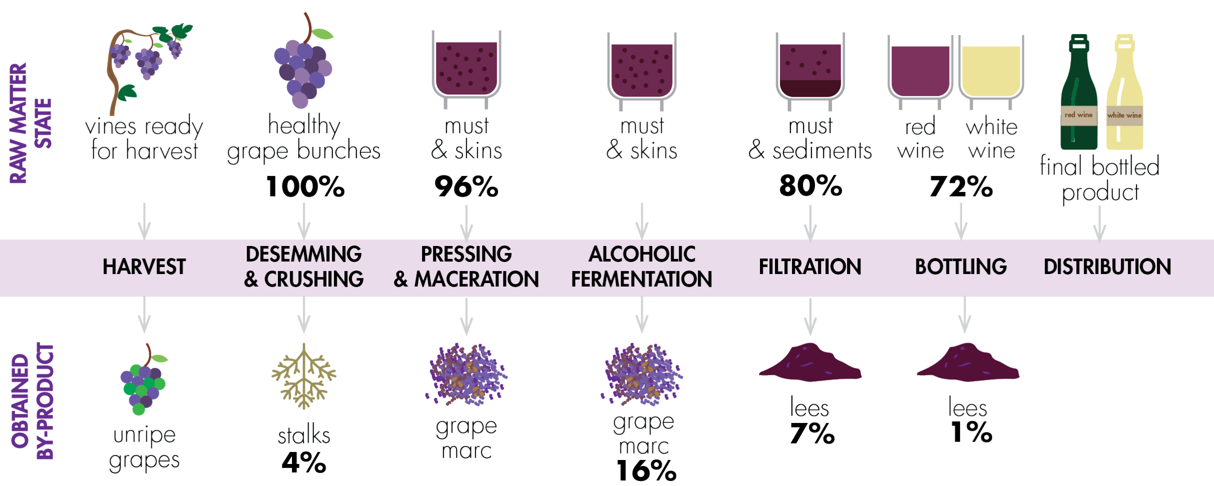
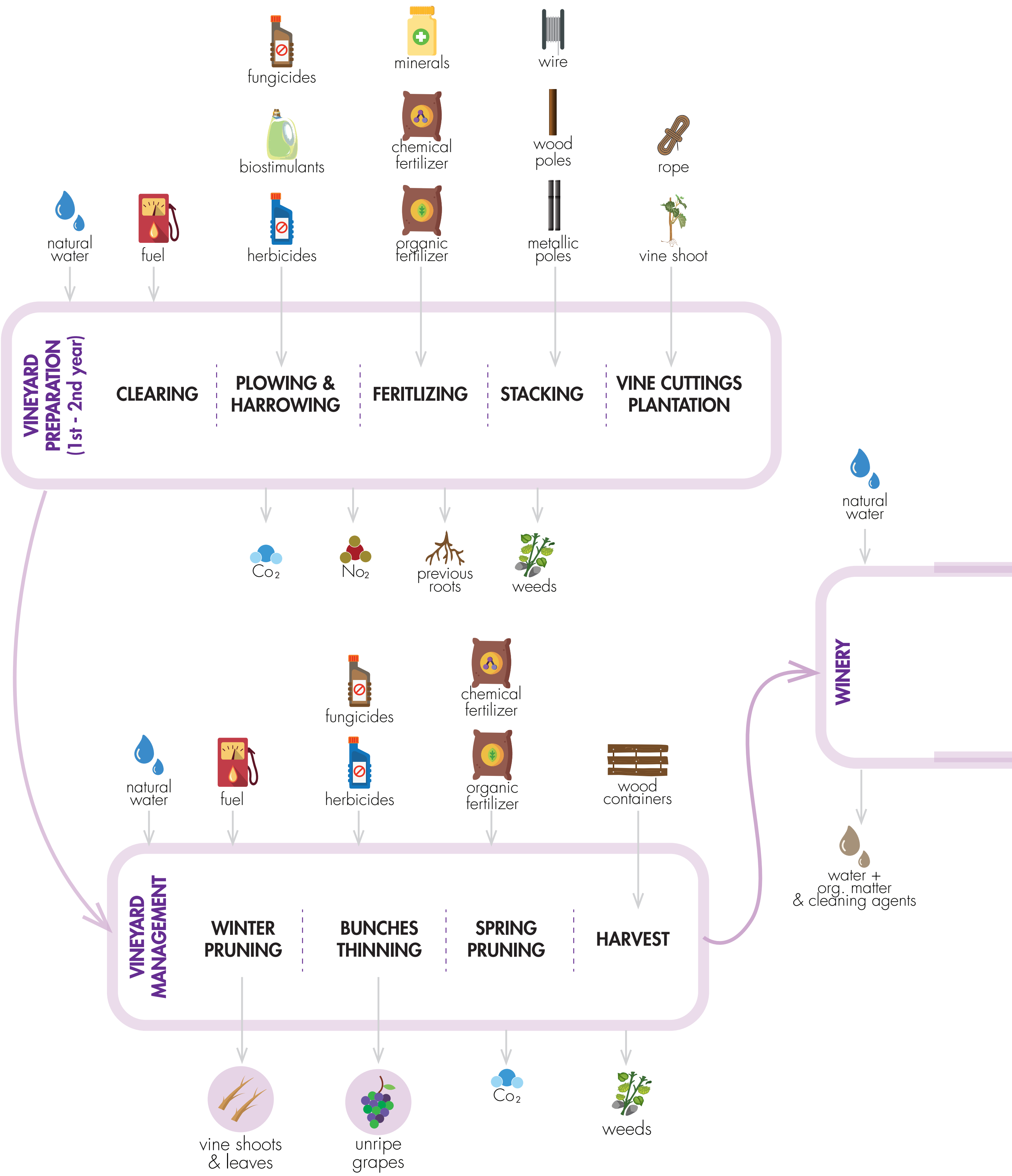
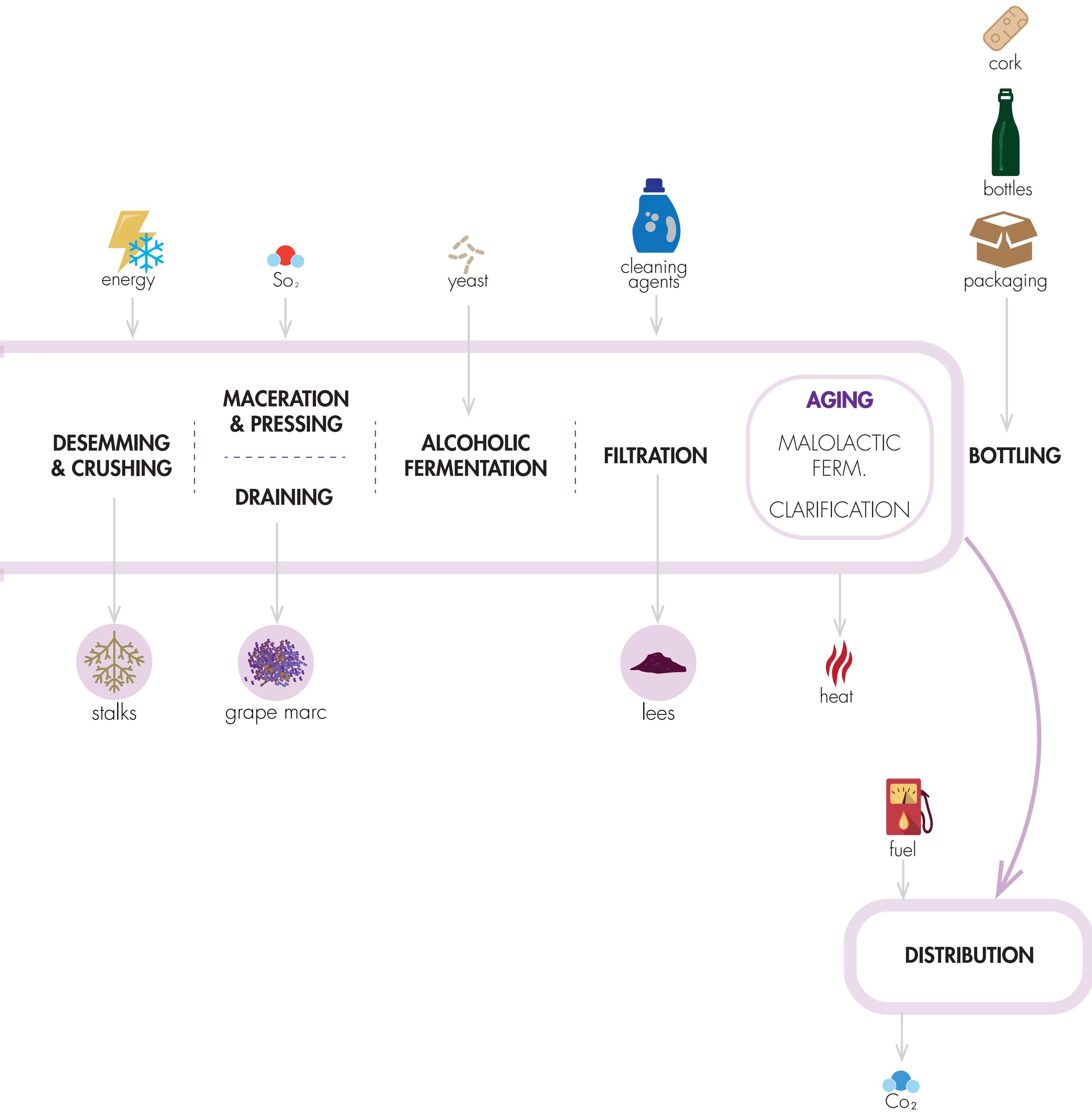


Figure 47: Raw matter transformation while winemaking. Source: Own elaboration

CURRENT WINE PRODUCTION

Input/Output value chain

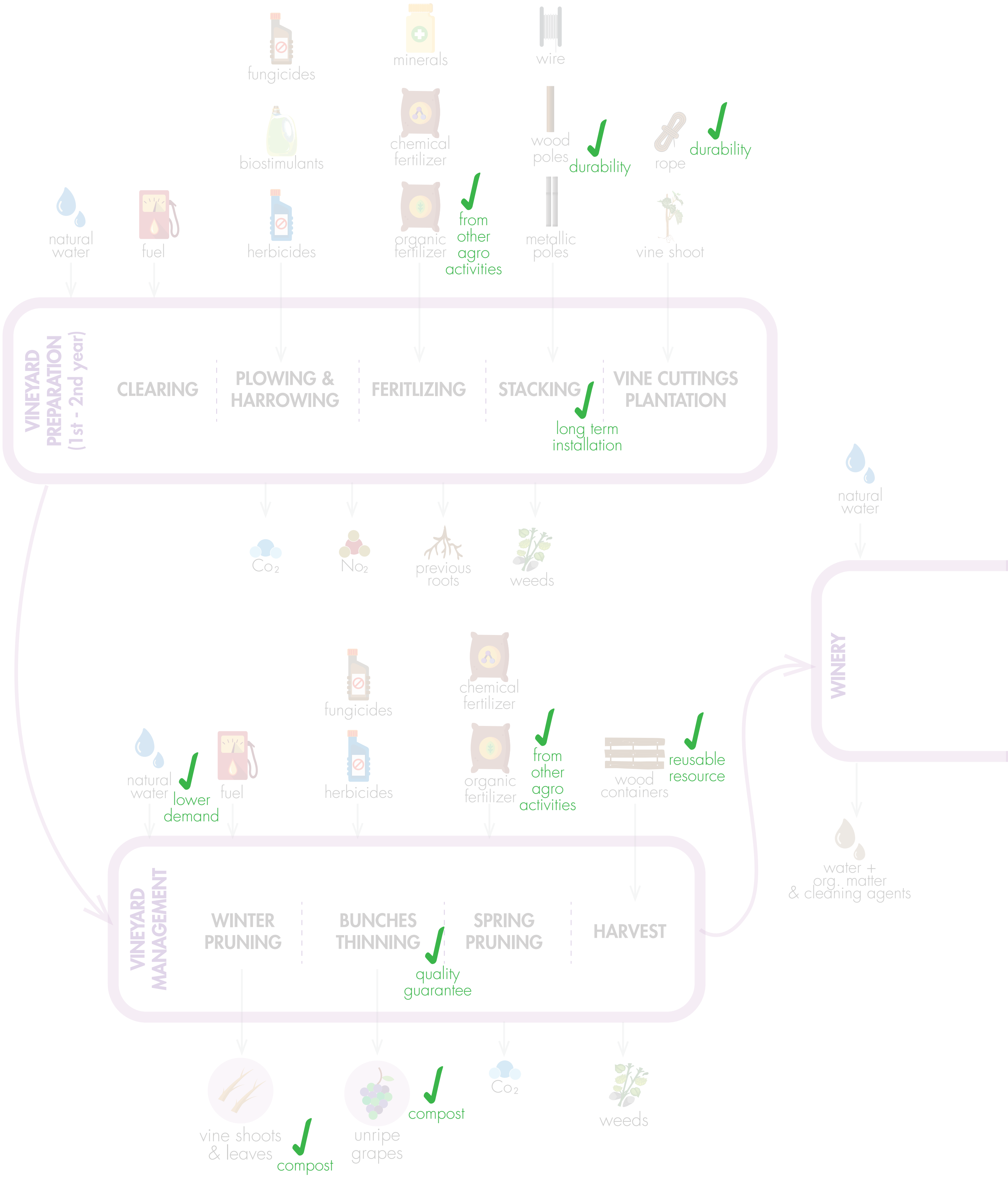


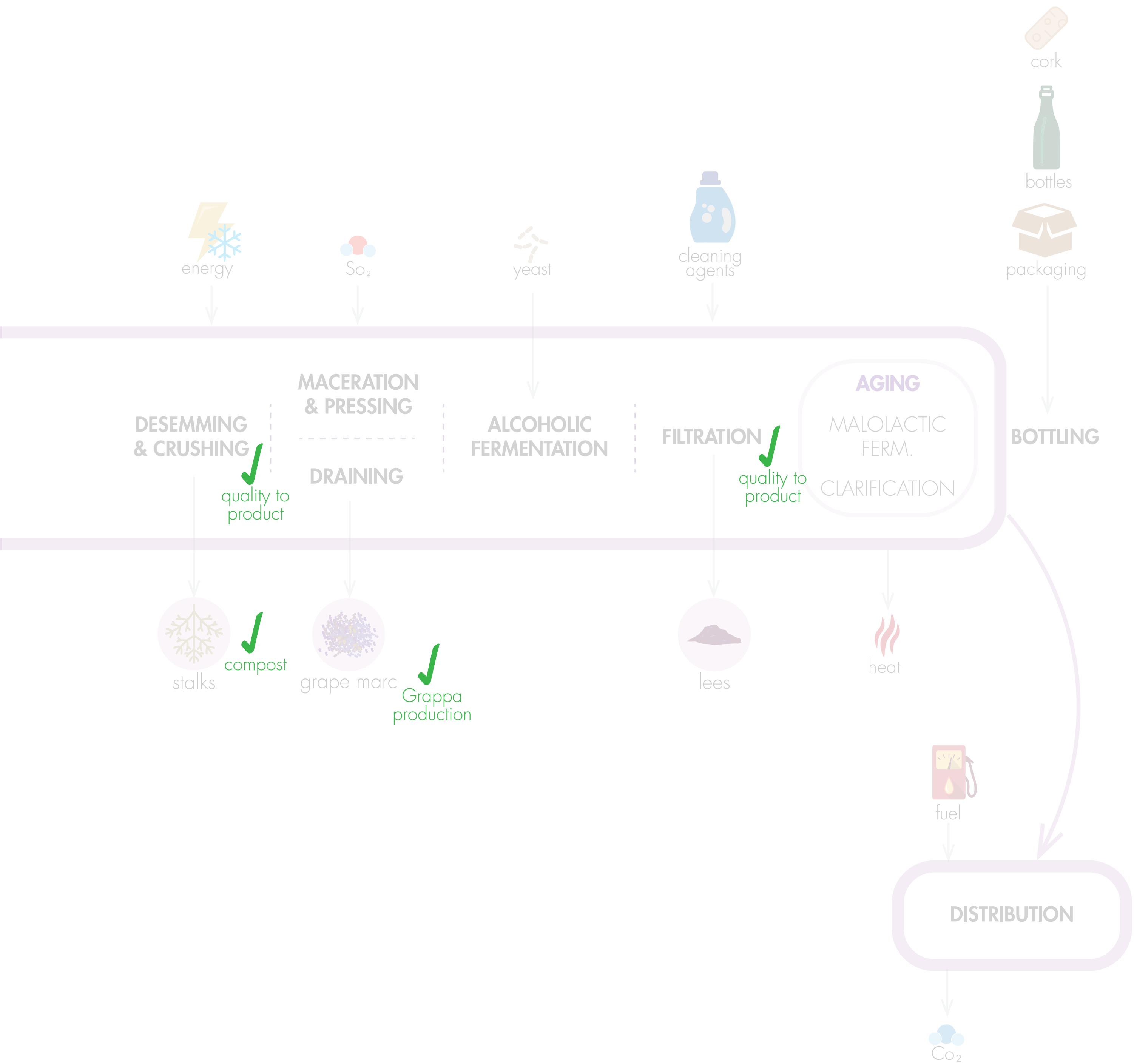


cork
bottles
packaging
energy
So₂
yeast
cleaning agents
DESEMMING & CRUSHING
MACERATION & PRESSING
DRAINING
ALCOHOLIC FERMENTATION
FILTRATION
AGING
MALOLACTIC FERM.
CLARIFICATION
BOTTLING
stalks
grape marc
lees
heat
fuel
DISTRIBUTION
Co₂

CURRENT WINE PRODUCTION

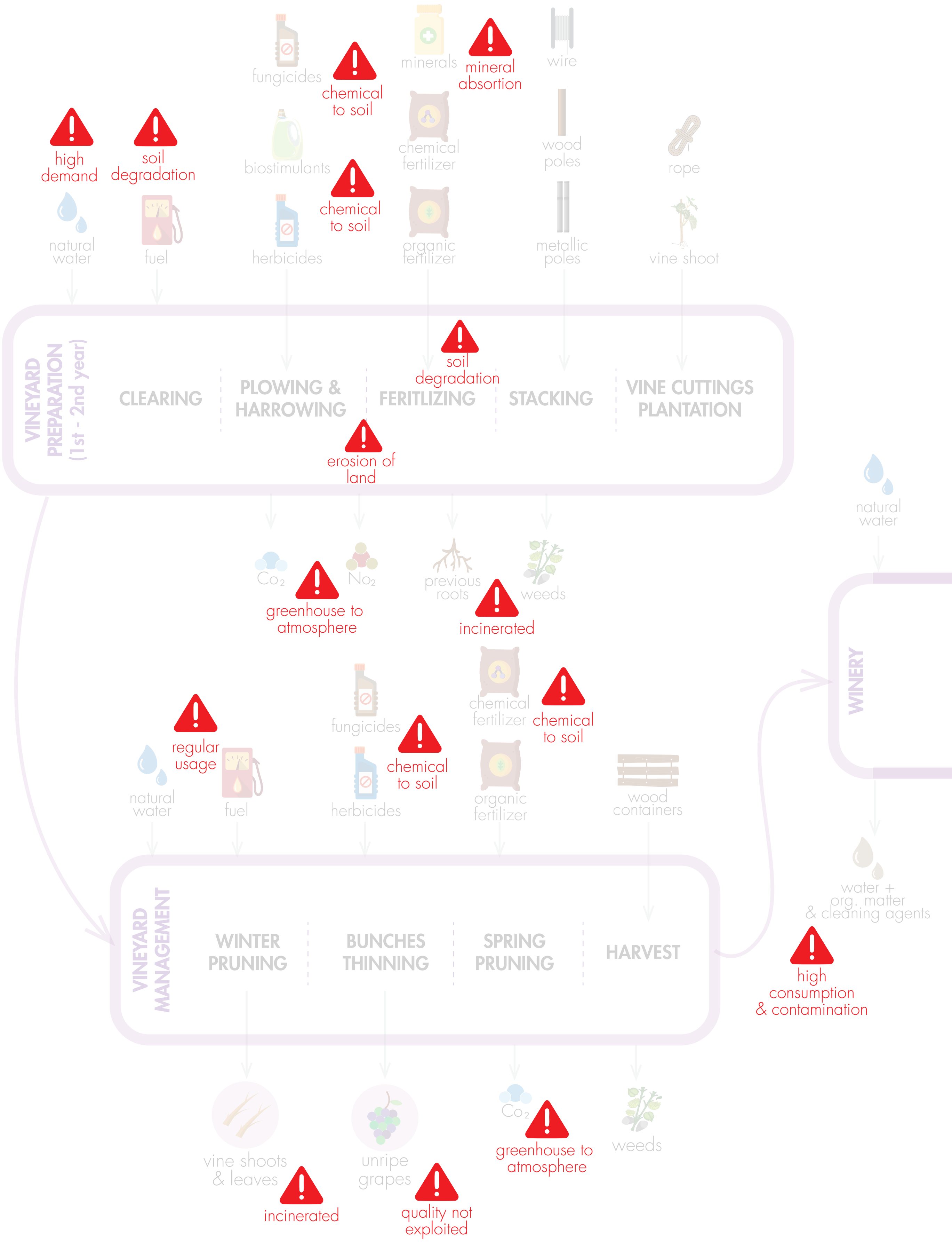
Value chain strengths

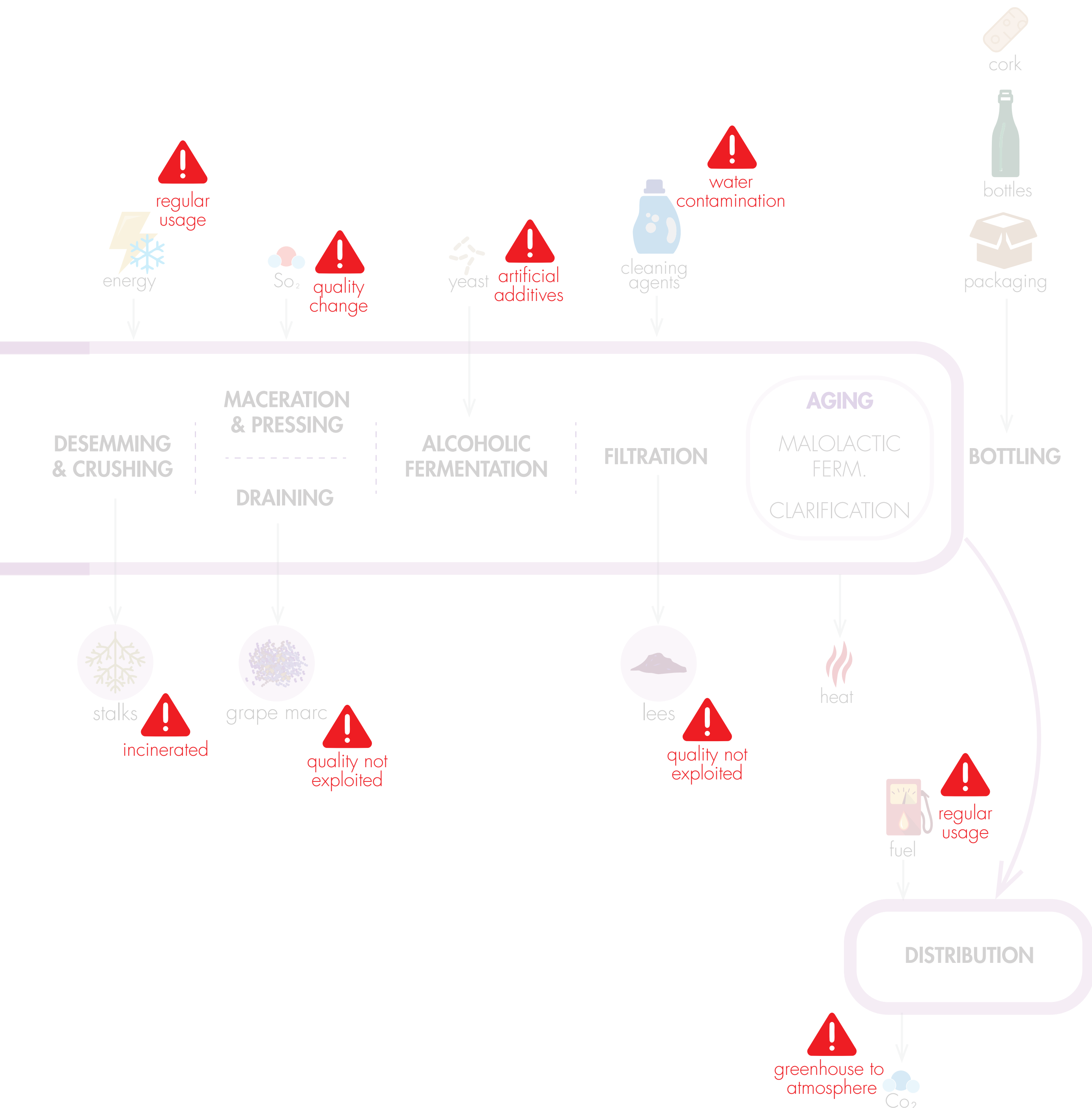



cork
bottles
energy
So2
yeast
cleaning agents
packaging
DESEMMING & CRUSHING
MACERATION & PRESSING
DRAINING
ALCOHOLIC FERMENTATION
FILTRATION
AGING
MALOLACTIC FERM.
CLARIFICATION
BOTTLING
quality to product
quality to product
stalks
compost
grape marc
Grappa production
lees
heat
fuel
DISTRIBUTION
Co2

CURRENT WINE PRODUCTION

Value chain threats and weaknesses



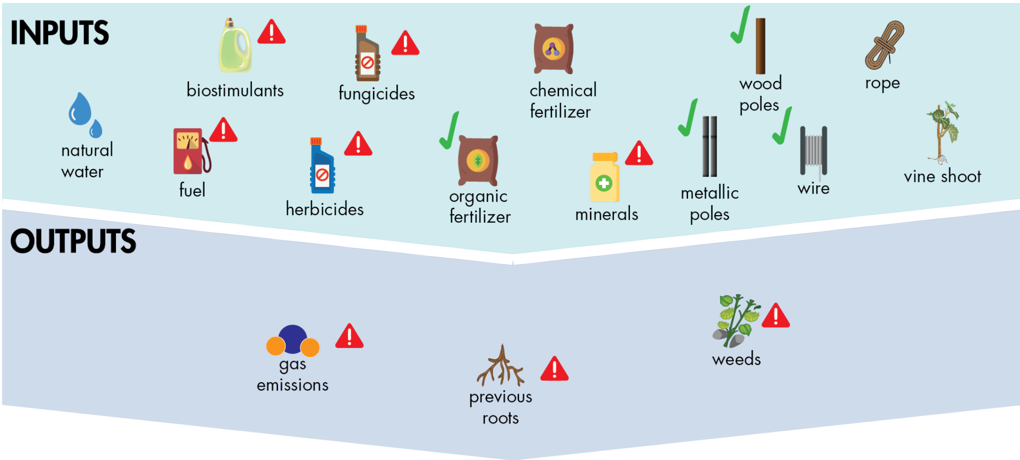

cork
bottles
packaging
regular usage
energy
So₂
quality change
yeast
artificial additives
cleaning agents
water contamination
DESEMMING & CRUSHING
MACERATION & PRESSING
DRAINING
ALCOHOLIC FERMENTATION
FILTRATION
AGING
MALOLACTIC FERM.
CLARIFICATION
BOTTLING
stalks
incinerated
grape marc
quality not exploited
lees
quality not exploited
heat
fuel
regular usage
DISTRIBUTION
greenhouse to atmosphere
Co₂

After recognizing certain intervation spaces within the current wine process, the following representations, as done formerly with the rice value chain, show the specific matter flows that enter to the vine and wine production during the whole process and are transformed.

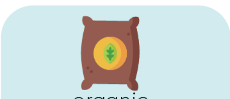
Considering the three explained stages of the current chain, the analysis was made separatedly in order to appreciate the characteristics of every part of the system and its impact in the territory.

FIRST TIME SOIL PREPARATION

Land clearing
Plowing
Harrowing
Fertilization
Staking
Plantation



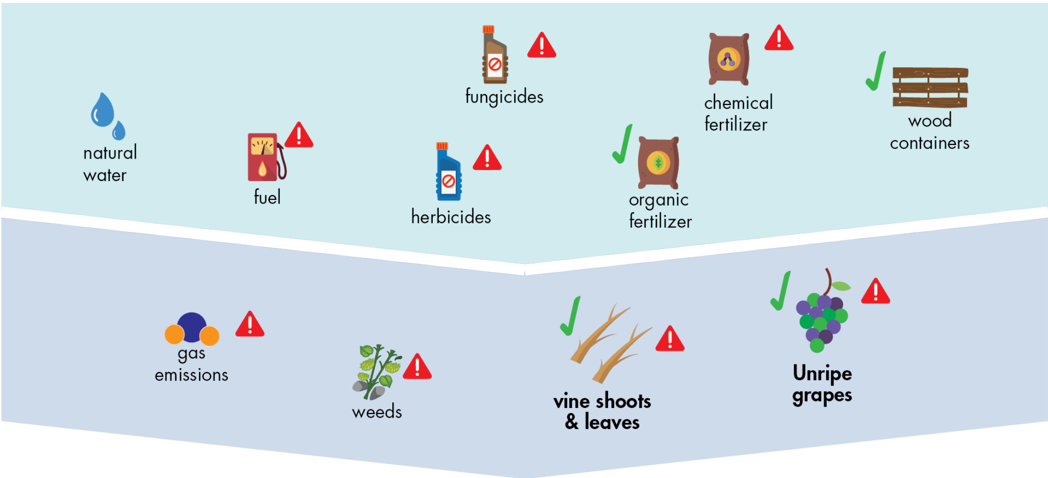
✓ CURRENT ADVANTAGES

	SPECIAL CONCERNS	ADVANTAGE
INPUT		
 organic fertilizer	Obtained from other agro activities	- Gives nutrients to the soil without contaminatint it with toxics.
 wood poles, metallic poles	Stacks are often placed once and substituted if needed.	- Wood and metallic poles gurantee durability of the stacking structure. Is done as a long term installation.
ACTIVITY		
 covering crops	Grass sowing in between vines	- Reduces the need of fertilizer by contributing organic matter to the soil.

CURRENT DISADVANTAGES

	SPECIAL CONCERNS	DISADVANTAGE
INPUT		
minerals	Applied because of need of protection for pests.	- They diminish the quality of the soil and the plant during time. - Residues of its chemicals are passed to the fruit, and so one to the wine.
fungicides, biostimulants herbicides		- They use large quantity of water for being diluted. - Toxic to humans and surrounding crops. - Pesticides leave harmful residues on the plant and its fruit.
natural water		- Types of fertilizers uses great quantities of water for being diluted. - Machinery cleaning use large amount of water.
fuel	Harrowing, plowing	- Semi mechanised processes reduce time and human-labor, but fossil consumption rises from 5 to 20 liters per hectare, specially when preparing the soil.
ACTIVITY		
Soil preparation	Harrowing, plowing	- Contribute to erosion of the land.
OUTPUT		
previous roots, weeds	From previous plantations	- They are currently being incinerated.
Emissions	CO_2, NO_2	- Carbon dioxide and green house gases are released to the atmosphere. - High concentration of nitrogen dioxide particles travels through the air polluting surroundings.

CROP MANAGEMENT
Breeding pruning
Bunches thinning
Spring pruning
Harvest



✓ CURRENT ADVANTAGES

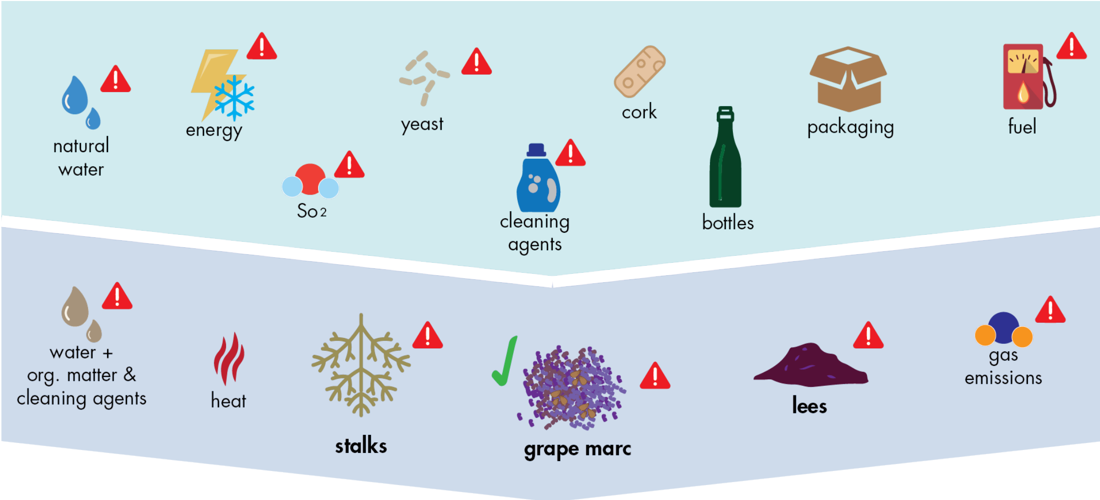
	SPECIAL CONCERNS	ADVANTAGE
INPUT		
organic fertilizer	Obtained from other agro activities	- Gives nutrients to the soil without contaminatint it with toxics.
natural water	When not uses as "rescue irrigation"	- High quantity of water for irrigation is not needed because the vines can support drought.
wood containers		- Wood container are reused and they allow the air pass through in order to avoid premature fermentation of grapes.
ACTIVITY		
pruning thinning	Pruning and manual thinning	- Pruning benefits the optimal development of the crop by leaving the productive buds and eliminating the non producers. - Thinning give quality ti the production process and so to the final product due to the proper grape selection.
OUTPUT		
vine shoots, unripe grapes	Used as compost resource	- Organic matter provides calcium and potassium when used as compost.

CURRENT DISADVANTAGES

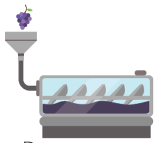
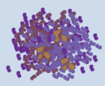
	SPECIAL CONCERNS	DISADVANTAGE
INPUT		
chemical fertilizer	Applied because of need of protection for pests.	- They diminish the quality of the soil and the plant during time. - Residues of its chemicals are passed to the fruit, and so one to the wine.
fungicides herbicides		- They use large quantity of water for being diluted. - Toxic to humans and surrounding crops. - Pesticides leave harmful residues on the plant and its fruit.
natural water		- Types of fertilizers uses great quantities of water for being diluted. - Machinery cleaning use large amount of water.
fuel	Harvest	- Semi mechanised processes reduce time and human-labor, but fossil consumption rises from 5 to 20 liters per hectare.
ACTIVITY		
winter pruning	Mecanised pruning after dormancy	- Produces a lot of vine shoots that are being incinerated.
OUTPUT		
vine shoots	From winter pruning and spring puning. Includes leaves	- They are currently being incinerated.
unripe grapes	Obtained from thinning and sometimes from harvesting	- Are currently being used for compost or just sent to disposal. wineries don't take advantage of its qualities.
emissions	CO_2	- Carbon dioxide and green house gases are released to the atmosphere.

WINEMAKING

Destemming & crushing
Maceration & pressing
Draining
Fermentation
Filtration
Aging
Bottling



✓ CURRENT ADVANTAGES

	SPECIAL CONCERNS	ADVANTAGE
ACTIVITY		
 Destemming	Removing the stems from the fruit	- Benefits the quality and flavor of the wine.
 Filtration		- Eliminates possible residues of particles that can damage the wine quality.
OUTPUT		
 grape marc	Separating seeds from skin	- Seeds are used for distillation and production of Grappa.

CURRENT DISADVANTAGES

	SPECIAL CONCERNS	DISADVANTAGE
INPUT		
SO_2, yeast	Applied as antioxidants and helper for the fermentation process	- SO2 is a irritating substance that can provoke head ache to the consumerwhen used in high quantities. It can change the flavor if is not used correctly. - Natural yeast can be used instead of artificial.
cleaning agents		- Chemical agents are being applied for cleaning the machinery and contaminate water.
energy		- The need of constant refrigeration obbligates to the hughe amount of energy use.
natural water		- High amount of water is required for cleaning the machinery.
fuel	fuel needed for distributing final product to consumer	- Constant use of fuel that generate emissions to the atmosphere.
ACTIVITY		
vinification	considering fermentation, filtration and aging	- Processes for which is needed a high amount of energy due to the controll of temperatures.
OUTPUT		
stalks	From destemming process	- Are being incinerated or disposed by other companies.
marc, lees	Obtained from draining and filtration	- Curently its properties are not being exploited.
emissions	CO_2	- Carbon dioxide and green house gases are released to the atmosphere.

5. By-products analysis

5.1. Rice industry by-products

RICE STRAW

Japonica's varieties are the most cultivated in Italy because of the high yield, short and strong straw and its nutritional value is higher than Indica's. Rice straw, as a lignocellulosic biomass, is comprised of three components: lignin, cellulose, and hemicelluloses (Klass 1998).

Rice straw is obtained from reaping. Each kilogramg of milled rice produced results in roughly 0.7–1.4 kg of rice straw depending on varieties (International Research Rice Institute [IRRI], 2016), it not only is the base of the rice panicle but a moisture holder during harvest. Rice straw is separated from the grains and left in the field until is dried. The portion that is not dried, is burnt over the field or pulverized and left over the soil.

Traditionally it is used for feeding animals but the major percentage ends polluting water bodies, open-field burnt or spread irregularly causing greenhouse emissions. Burning the biomass reduce its volume, control weeds, and a variety of pests and diseases. Studies show nutrient loss, depletion of soil organic matter present in peats, and reduction in the presence of microorganisms that live in the soil and are in charge of regulate it.

Greenhouse gas emissions including 0.7–4.1 g of CH_4 and 0.019–0.057 g of N_2O per kg of dry rice straw, and emission of other gaseous pollutants such as SO_2, NO_x, HCl and, to some extent, dioxins and furans (Oanh et al 2011, Jenkins et al 2003).

The biggest consequence of burning this material, in or off-field (Figure 48) is the pollution of the air quality (Engling et al 2009) bringing unaffordable health risks to the farmers who are working the land and the surrounding areas.

A small portion of rice straw is used as organic matter used in the soil preparation before the sowing. The know-how of this technique must be learnt but because of the slow decomposition rate of the biomass do not works for the producers planned times.

A study developed by the IRRI (2012) showed that the total carbon dioxide equivalent (CO_2-eq) per ha converted from $CH_4$and N_2O in a rice crop season with straw incorporation emitted about 3,500 kg CO_2-eq per ha, definitely a value that almost doubles the emissions of the harvesting released emissions.

With evolution in the technics for its collection and implementation fields, rice straw is increasingly move away from the camps to be used for better purposes like for cattle feed and energy and mushroom production.

Even today one of the harder steps of the rice straw handling is collecting the rice straw itself. After the introduction of the harvesters that leave the rice straw in the soil, this operation has become more complicated and expensive. There are three main operations in the rice straw collection process: harvest up of rice straw materials, compacting them into bales in order to reduce transportation costs, and put them into a storage or processing area (Rice Knowledge Bank, 2017).

In this process is use a compacting unit, called a baler. There are many types of

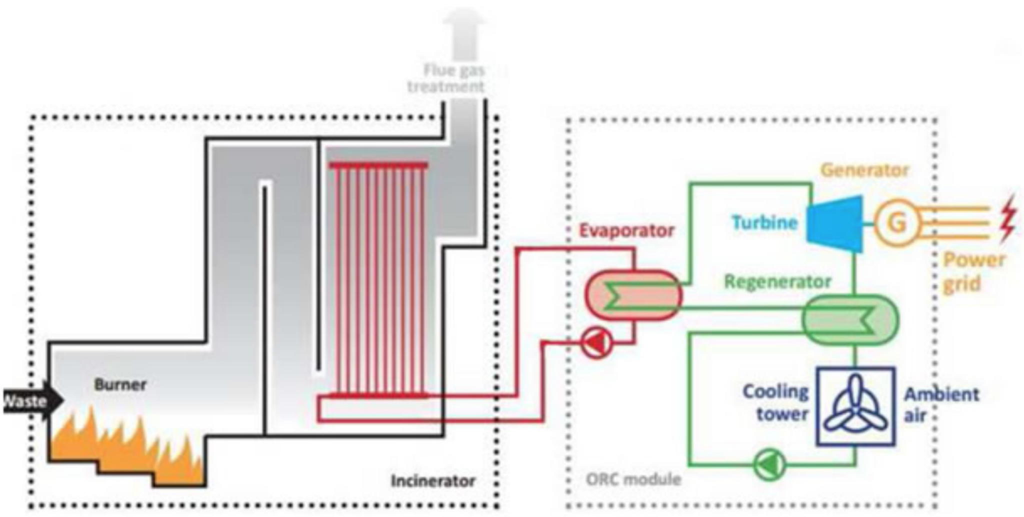


Figure 48: Rice straw incinerating process. Source: Guillemot et al 2014

bolers sometimes includes the other two operations—picking up of straw and hauling of baled material—which depend on operational conditions and purposes. Studies about these machines demonstrate the high fuel consumption and intense air pollution (Entling et al. 2009).

Three common uses of rice straw in the agriculture sector are animal fodder, mushroom and biochar.

Rice straw in its raw form has low amounts of nutrients and energy for growing livestock. Hence, the rice harvest should be cut close to the ground. By the other hand, nutrient improvement is often done by treating the rice straw with urea or sodium hydroxide which is safer and more practical to use than anhydrous or aqueous ammonia, but still toxic in high concentrations.

Biochar, serves in carbon storage, filtration of percolating soil additives to improve its productivity (Lehmann and Joseph 2009). The use of rice straw to produce biochar has an increasing trend. Also, adding carbon to biochar helps reducing emissions to the atmosphere.

RICE HUSK

Also called hull is the outer layer of a rice seed, form by silica and lignin to protect seed when growing.

Produced during rice milling, the rice husk is already dried and accumulated at the factory. The specific weight of uncompressed rice husk is about 100 kg/m3. The chemical composition contains of cellulose 40-50 percent, lignin 25-30 percent, ash 15-20 percent and moisture 8- 15 percent (Hwang and Chandra, 1997).

During many years, rice husk was used as essential part of animal feed mixtures, but over the years is had been revealed the big difficulties when talking about the digestion of it. Husk without previous thermal treatments can harm the digestive tube of animal because of the high quantities of silica that composed it.

Currently, it is submitted to combustion on order to obtain ashes from which produce pellets or briquettes in an extrusion process allowing the creation of energy capable to supply some working hours of small machines within the mill. Because its high amount of silica, husk is a perfect raw material as a power driver.

RICE BRAN

After the husk separation, the next protection layer is the bran, normally removed in the paddy separation process of the milling phase. Has a high percentage of oil, from 14 to 18% (reason why it is easily affected by oxidation), protein, vitamins and minerals.

Normally, the milled rice is passed through the polishing at least three times in order to remove the entire percentage of the bran from the grains, for this reason, it could be said that the major percentage of nutrients is lost in the process and white milled rice is no longer a competitive staple food as integral rice (the unpolished paddy which contains the nutritional content).

Even though, because brown –also called integral rice, is hard to storage because the fat present in the bran, its nutritional value has been replaced with a thermal procedure called "parboiling" where the vitamins are retained by submitting the grain to a steam allowing the adhesion of nutrients to the inner part of the grain.

Defatted bran is a useful binder in mixed feeds. Defatted rice bran can be used at higher levels than ordinary rice bran. Rice bran is often adulterated with rice hulls, as it should have a crude fiber content of 10-15% (Göhl, 1982). After the milling, it is the rice pollards, a mixture of bran and polishing. It is composed from about 60% husk, 35% bran and 5% polishing.

GERM, GREEN AND BROKENS GRAINS

Germ or embryo.

Located at the central portion of the grain, where the grain has been attached to the panicle of the rice plan, the germ is the specific part of the rice paddy that allows the reproduction or future seed germination. It is separated during the milling phase.

Nowadays, it is integrated to the cattle feed and because its high nutritional content, it has a commercial value, even though germ yield is less than the 10% of the total by-products from the value chain.

Brokens.

As it is called, brokens are those grains which humidity levels did not support the milling process and at some stage they fractured. Reason why, it could be said that brokens have the same nutritional content that white rice. As the germs, brokens have a commercial value either for animal feed or for the production of flour or starch.

There are three different types of brokens. The first one are the "big brokens" (FAO 2003), those pieces of kernels varies approximately from the 50% to the 80% of the unbroken kernel length. In second place are the "medium brokens" (20%-50%) and finally the "small brokens" which length goes from 0% to 20% of the unbroken kernel.

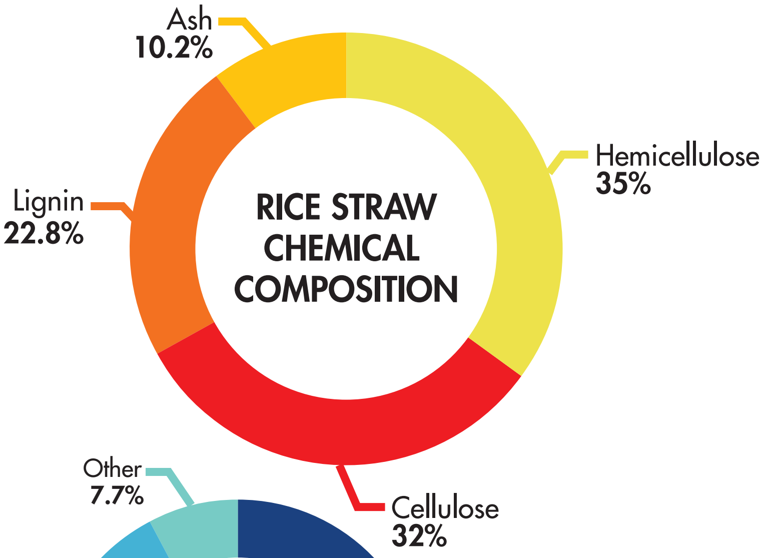
Green grains.

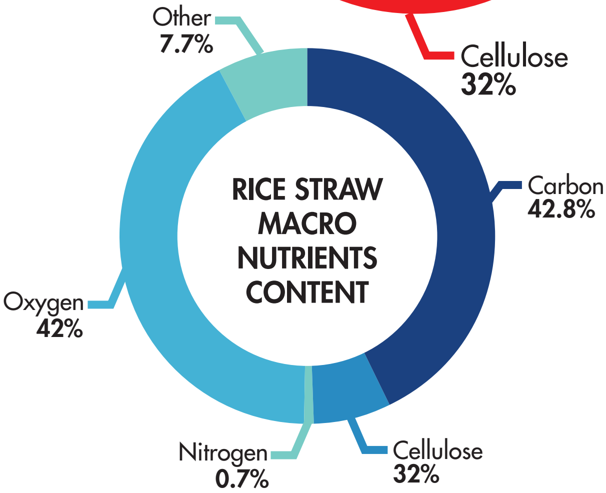
There are undeveloped grains without the proper maturation process. Different factors could affect this type of by-product, for example the lack of sunlight or nutrients, the early harvest or the natural competition between grains inside the rice panicle. It has a considerable percentage of starch but is not proper for human consumption.

RICE STRAW

Base of the rice panicle and moisture holder until harvesting.

50%
of rice plant mass





VALUABLE PROPERTIES (RAW)

- Moisture retention
- Flexible fibers
- Macronutrients

CURRENT APPLICATIONS

RAW

- mulching — soil recovering
- livestock bedding
- livestock feed
- compost (31%) — organic fertilizer

MECHANICAL TREATMENT

- construction material — unstable structure
- dried straw — contaminated animal feed

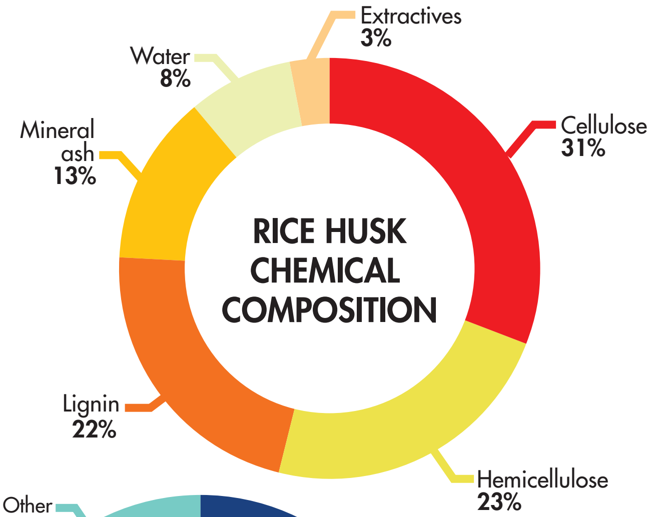
CHEMICAL TREATMENT

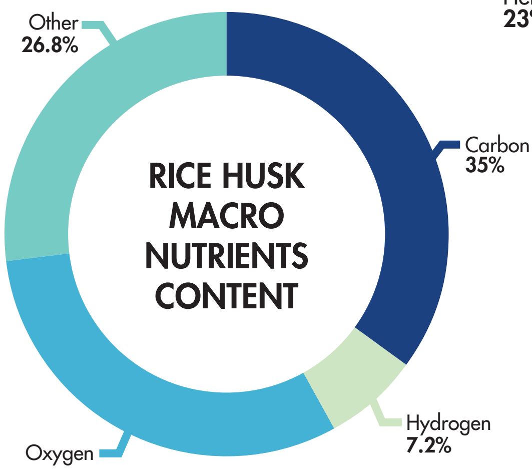
- incineration — emissions; soil and health affected

RICE HUSK

Outer coat of the kernel. Protects the seed until maturity.

20% of rice kernel





VALUABLE PROPERTIES (RAW)

- High silica content
- Water permeability
- Thermal insulator

CURRENT APPLICATIONS

RAW

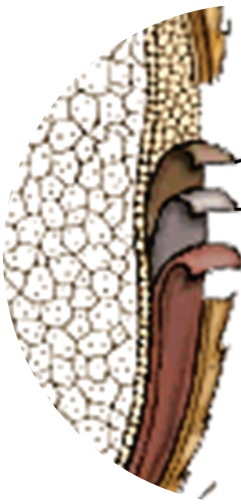
- disposal — water and soil pollution
- livestock bedding
- livestock feed — unstabilized hard to digestion
- soil recovery — crop integration

CHEMICAL TREATMENT

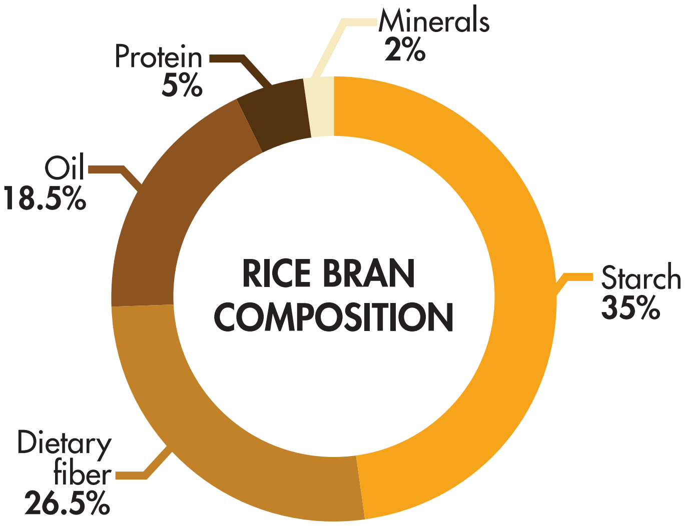
- combustion for energy generation — emissions when getting ash
- construcion materials fillers — unused as raw matter
- cleaning products — hazardous working spaces
- thermal insultor — handling density

RICE BRAN

The bran is a multilayered structure,outer coat of rice endosperm.



12%
of rice kernel



fiber
sugars
omega 9
omega 3
omega 6
saturated fats
proline
oxidative peroxide
lysine
calcium
sodium
phosphorus

VALUABLE PROPERTIES (RAW)

- Rich in dietary fibers
- High starch concentration
- Efficcient antioxidant activity

CURRENT APPLICATIONS

RAW

- livestock feed — high nutritional content
- disposal — valuable matter loss; mixed dirty matter

PRESSURE AND THERMAL TREATMENT

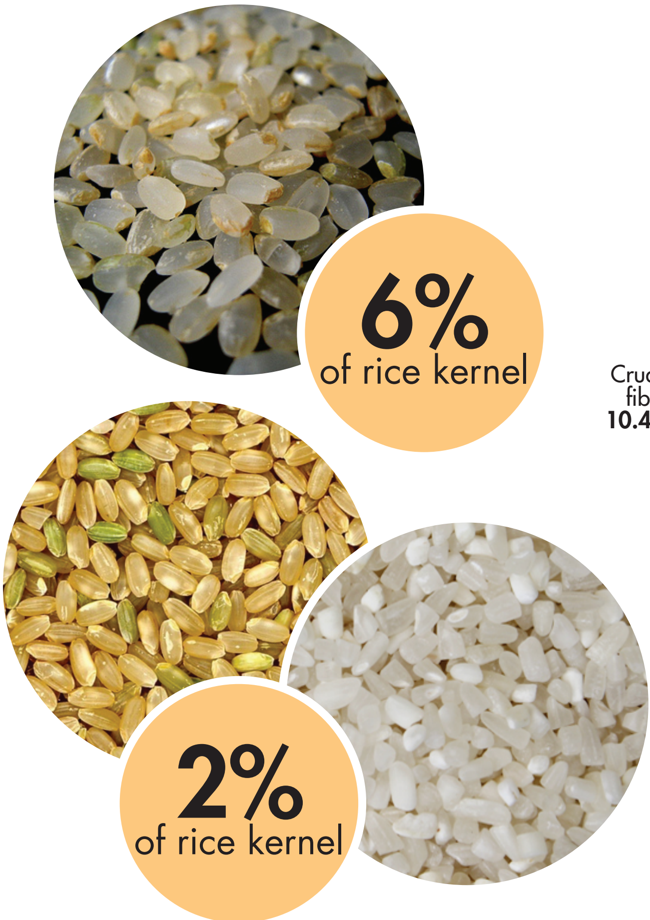
- cooking oil — residual waxes not used

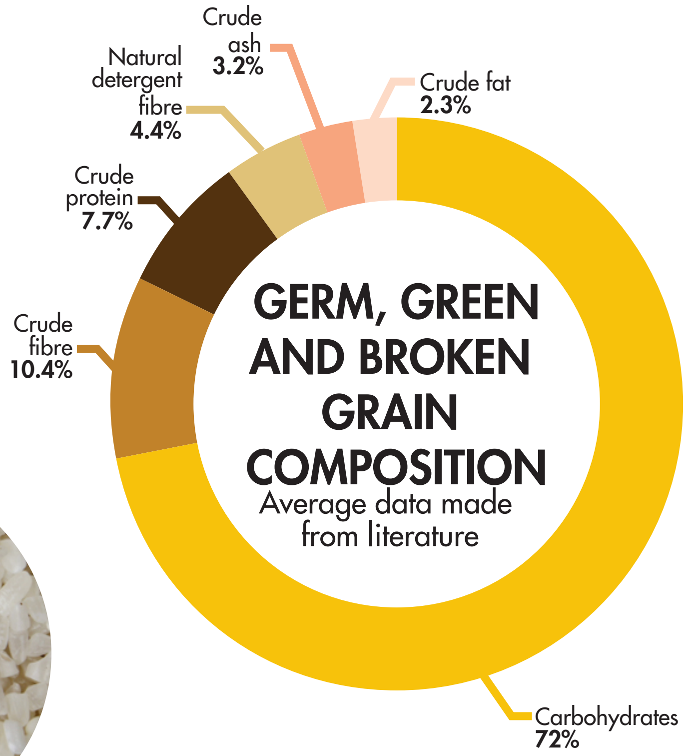
CHEMICAL TREATMENT

- skincare lotions — peptides antioxidants separation
- flour — new products creation; matter not stabilized

GERM, GREEN AND BROKEN GRAINS

Damaged seeds because growth, humidity or pests.

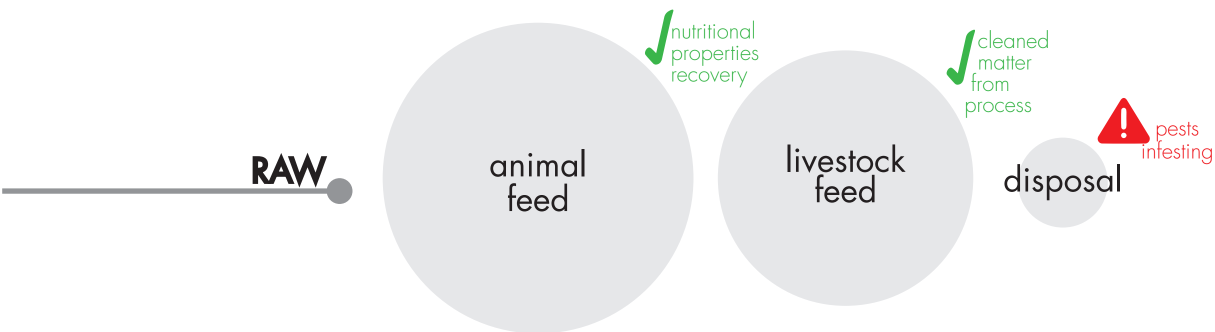




VALUABLE PROPERTIES (RAW)

- Prevent chronic diseases
- Stimulates the growth of useful bacteria
- Excellent source of vitamins and minerals

CURRENT APPLICATIONS



5.2. Wine industry by-products

During the wine production, the generation of by- products can be divided into the two main phases of the process. First, on the vineyard during the crop management is the generation of vine shoots and unripe grapes. Then, during the wine making process, is the the generation of stalks, marc and lees.

VINE SHOOT

The vine shoots are the principal residues during pruning, specifically in winter after the dormancy period, before starting the new cycle of production, the higher amount of vine shoots are removed. It can be calculated that for the espalier cultivation method, the quantity of vine shoots residues in one year are of about 1.5 to 2 tons per hectare, and because of its high volume they are, sometimes, a problem for the wine markers because of the disposal procedure they have to follow (Tomasi & Marcuzzo, 2012).

The composition of vine shoots consists of cellulose and hemicellulose (68%), lignin (20%), which is a high molecular cross-linked polymer present in all woods, proteins (5%), and other various molecules (Galanakis, 2017).

Vine shoots, as pruning residue is being disposed in two principal ways:

- Shredding on field: which is a good option as natural fertilizer if the vineyard is healthy and the shoots are not going to be a source of infection. By the other hand, if the vineyard is not healthy, this action may expand the disease from one vine to another and this will cause the deterioration of the plants and the decrease in quality of the grapes for the winemaking process. Due to this, the vine shoots have to be removed from the ground in order to prevent the phytosanitary contamination, not being able to be exploited as natural fertilizer.
- When not used as fertilizer, the second disposal way is the incineration on the sideline of the crop, where allowed, polluting air and surroundings and getting exposed to the possible generation of dangerous fires (Barella, Paniz, & Antonini, 2010).

Some wineries, concerning about the environmental fact, have been using the vine shoots for vermin composting, for this, they minced the branches in a controlled system in a way that they can be able to collect all the matter for then apply it as bed to the earth worm in the vermicomposting process. In this process, the vine shoots are able of increasing the humic materials, nutrient contents, and pH of the organic matter in the compost process (Nogales, Cifuentes, & Benitez, 2005).

UNRIPE GRAPES

Unripe grapes are the by-product obtained from the vine thinning activity, these bunches are manually cut off the vine because they don’t meet the needed characteristics for being of certain quality for wine production.

The selection of this racemes is done by comparing on each branch which are the best bunches in size and color and off course taking into account that if there is any raceme affected by plagues it has to be removed as well.

The principal reason for the thinning of these bunches is that the over production of the vine can lead to a high production of low quality grapes, instead, what winemakers look for is for the appropriate yield with the best quality of the grapes for the wine production.

The main characteristic of these grapes is that they are not completely mature, they are smaller on size but they still have a high number of compounds that could be exploited. The amount of this by-product depends completely on the vineyard conditions, and the previous pruning procedure, because according to this two factors it can exist or not a high quantity of unripe bunches for cutting.

The composition of these grapes enclosure most of the characteristics of the winery by-products due to the fact that is the complete fruit but in a previous stage. Berries are still attached to the stems and they include the skin, the pulp and the seeds.

The skin is the external layer of the fruit, made of various layers of thick cells, and it is covered with a kind of wax-like coating called cuticle that is what generates the strong protective layer of the fruit. The compounds on the skin are mainly coloring matter, tannins, aromatic substances, potassium and other minerals.

The following layer and the one that generates more volume is the pulp, which is the one containing the juice. And finally, the seeds are in the center of the grape and they are rich in tannins.

The grapes mainly consist of water and sugars and for unriped berries the main sugar compound is glucose.

Wine makers, often leave the removed bunches on the land, taking into account that is organic matter containing high levels of nutrients that can contribute to the soil quality, but this is not the best option, the decomposition can attract insects and this will risk the healthy bunches are still one the vine on its maturation process.

Other alternative applied is the use of this organic matter as a source of compost, which is a good option for the production of bio fertilizer and can contribute to a better soil quality without chemical agents.

A very ancient application of unripe grapes from thinning id the production of verjuice, which is the juice obtained from the pressing of the fruit for being then boiled and mixed with species and olive oil. This mixture is used as food condiment for its acidic flavor and is also thought to be good for human health (Dupas, 2016).

On the other hand, another application of this, grapes are in the food industry, because even though they are not anymore suitable for winemaking, they can be eaten or used as ingredient for different recipes in bakery, in this way the components of the fruit are being exploited in a better way contributing to the nutritional values of human beings.

Additionally, the content of phenols in grapes have been studied and supported for the use of this compounds in the food industry for increasing the antioxidant activity of bread and reduce lipid oxidation of raw and cooked chicken.

STALKS

Grape stalks are the first by-product obtained in the winery, they are the residues generated after the de-stemming process. Principally they consist on the skeleton of the grape raceme and are about the 4% of the initial matter processed in the winery. Stalks have a high fiber content, mainly lignin and cellulose, as well as a high percentage of nutritious mineral elements such as nitrogen and potassium.

The composition of the stalks and the concentration of its compounds depends on the type of vine, the geographic origin, the climate, and the harvesting time, but the main components and an approximate composition consist of: lignocellulosic compounds, such as cellulose, hemicellulose and tannins in about 6% to 7% and a high content of lignin between 22% to 47% (Galanakis, 2017).

Stalks are mainly used for composting and consequently for spreading in the soil. The use of compost in the vineyards is becoming increasingly successful due to the poverty of nutrients available in the soil, the low concentrations of humus and the excessive erosion of these.

The obtained compost can be also used for the cultivation of *Agaricus bisporus*, a mushroom used in traditional cooking. On the other hand, when mixed with *Pleurotus spp*, another species of fungi, for solid state fermentation, is can be obtained animal feed additives, providing potassium to the composition of the feed (Finesso, 2004).

MARC

Grape marc, also called pomace is the by-product generated in the production of the must, specifically after the pressing process. It is also one of the most abundant by-product in the entire winemaking process. Also, it is estimated that from the production of 6 liters of wine it is generated 1 Kg of grape pomace, being about the 20% of the total grapes used for wine processing (Galanakis, 2017).

Specifically, the marc is the solid remaining part of the grape, constituted by seeds, skins and eventual stems that could remain after the de-stemming procedure. This by-product can be obtained in two different stages, which means that can be of different qualities. In the first place, it can be obtained before maceration and fermentation from white winemaking and after maceration, from red winemaking.

In the case of non fermented pomace, and because of the amount of non-digestible polysaccharides, it could be needed an additional fermentation process in order to avoid gastrointestinal disorder when mixing or integrating this by-product with food or animal feed.

The principal components present on the pomace are water (50% - 70%), cellulose (10% - 20%), fixed acids such as tannins, flavonoids, and phenolic acids (1% - 2%), sugars and anthocyanins. The composition of the grape marc can change according to the variety that have been planted, the crop care and management and the ripening state of the fruit. But currently, the main insoluble components in the pomace are (Teixeira et al, 2014):

- Lignin content from 16.8% to 24.2%. Protein content less than 4%.
- Peptic substances as main polymer-type component of the cell walls existing in grape pomaces, from 37% to 54% of cell wall polysaccharides.

Taking into account that grape marc is formed by two main different components, is important to analyze each one of the deeper. From the total amount of pomace, the 80% are skins and the 20% are seeds.

SEEDS

The content of the seed is constituted of about 40% fiber, 16% essential oil, 11% protein, 7% complex phenolic compounds such as tannins, and other substances like sugars and minerals. The amount of extractable polyphenolic compounds oscilates between 60 and 70% thanks to the fact that during the pressing process of the wine it is extracted a minor quantity of these compounds (Teixeira et al, 2014).

SKINS

Grape skins, as said before, are about the 80 % of the total material of grape pomace. It has been found that his component is a rich source of phenolic compounds, but this depends on the type of vinification process applied and the extraction method, which could be by solvents, time and temperature. All of these variables can change the composition of the skins.

Nowadays, the grape seeds obtained from the winemaking process, are principally used for the production of other liquors, such as Grappa, and the remaining solid compounds after distillation are disposed for composting, energy production or for animal feed.

From the pomace is also being extracted tartaric acid, which is obtained from the potassium tartrate and the calcium tartrate present in the marc. For this process, the marc is treated with sulfuric acid which salts the calcium and potassium, releasing the tartaric acid. Calcium hydroxide is added and salified acid precipitates. It is left for cooling and then, the calcium tartrate crystallizes and subsequently is separated by centrifugation. Sulfuric acid is added and tartaric acid is obtained.

The tartaric acid is main used to acidulate jams and juices and as fermentation agent for bakery products.

Another extraction that is done from the grape marc is the seed oil, which have a high content of polyphenols, is resistant to high temperatures. Currently is used as antioxidant compound in the cosmetic industry (Magarò, 2012).

The antioxidant compounds also allow the reuse of dry grape pomace in the conservation of different kinds of food such as meat, cheese, and some vegetables. This process is to be done taking into account that the marc has to be dried and previously used in the fermentation process in order to make it suitable for consumption.

But even though the grape marc has various current uses, there are high amounts of compounds that are not being exploited and that could be interest for the pharmaceutic, cosmetic and food industries in order to give more value to this by-product and so to the winemaking process.

Teixeira et al (2014) found out that "grape skins have been highlighted for their antioxidant and anti-glycation activities because of their anthocyanins and proanthocyanidins content." Currently there are in course researches about the extraction conditions and new ways and designs needed for the optimization of the release of phenolics from grape skins in order to maximize the properties of the wine pomace and make it suitable for more uses.

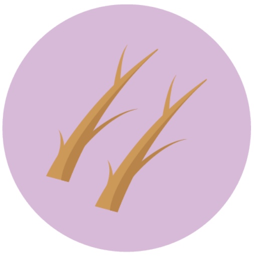
LEES

These are the formation of organic matter at the bottom of the vessels where the wine has been fermented, filtrated and storage. The normal process of the disposal of lees is that after the racking process (filtration) and before the cleaning of the vessels, the lees are collected and then disposed. Lees are mainly formed by exhausted yeasts that have ended their life cycle during the fermentation process, other tartrates and grape impurities (small fragments of skins, seeds or stems) are present in the wine lees.

Generated because of the importance of removing matter from the wine by the racking method; its importance falls on the fact that being an organic compound and therefore being formed of different cells, staying in contact with the wine alcohol would lead to the dispersion of these cells inside the wine and it will generate changes on the wine quality and composition and a possible bad smell. Wine lees contain 12% of tartaric acid, 20% of proteins, 25% of dietary fiber such as cellulose, pectin, hemicellulose lignin, and polyphenols. Contains also sugar and pigments in about a 10% and 4% of lipids.

Wine lees are used for the extraction of tartaric acid in a similar process by which is obtained from the grape marc. The extraction, has many applications in the food field, as it is proven to be an excellent stabilizer and it can replace the citric acid (Finesso, 2004). Alcohol extraction is also dome with wine lees, by using them as resource for distillation process and so for ethanol production.

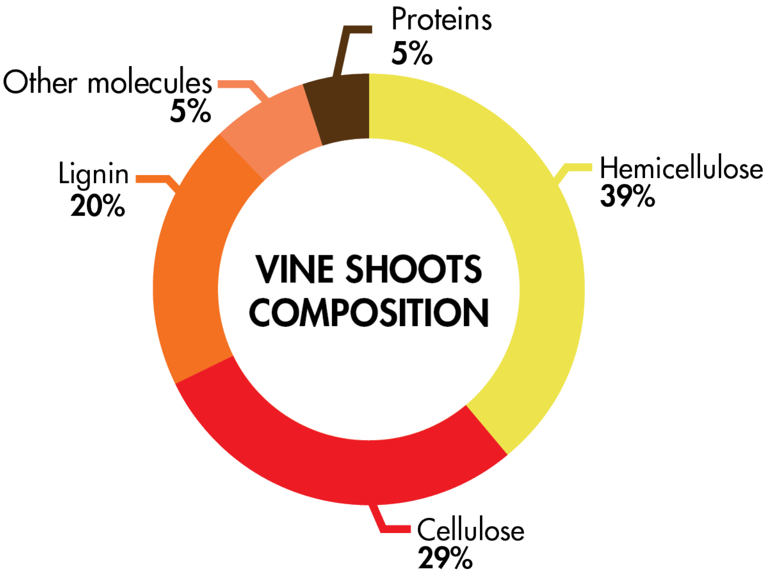
Although wine lees have to be filtered from the wine process, many wineries extend this process by the practice of bâtonnage which consist of leaving the lees for more time in contact with the wine and mixing them in in order to put the again in contact with the entire content inside the vessel, facilitate the lysis of the yeast and so obtain a modification on the aroma, astringency and texture of the wine, also the color intensity can change. This procedure is sometimes done for traditional aging wines (Fia et al, 2015)



VINE SHOOTS

Vine canes obtained after winter dormancy period pruning.

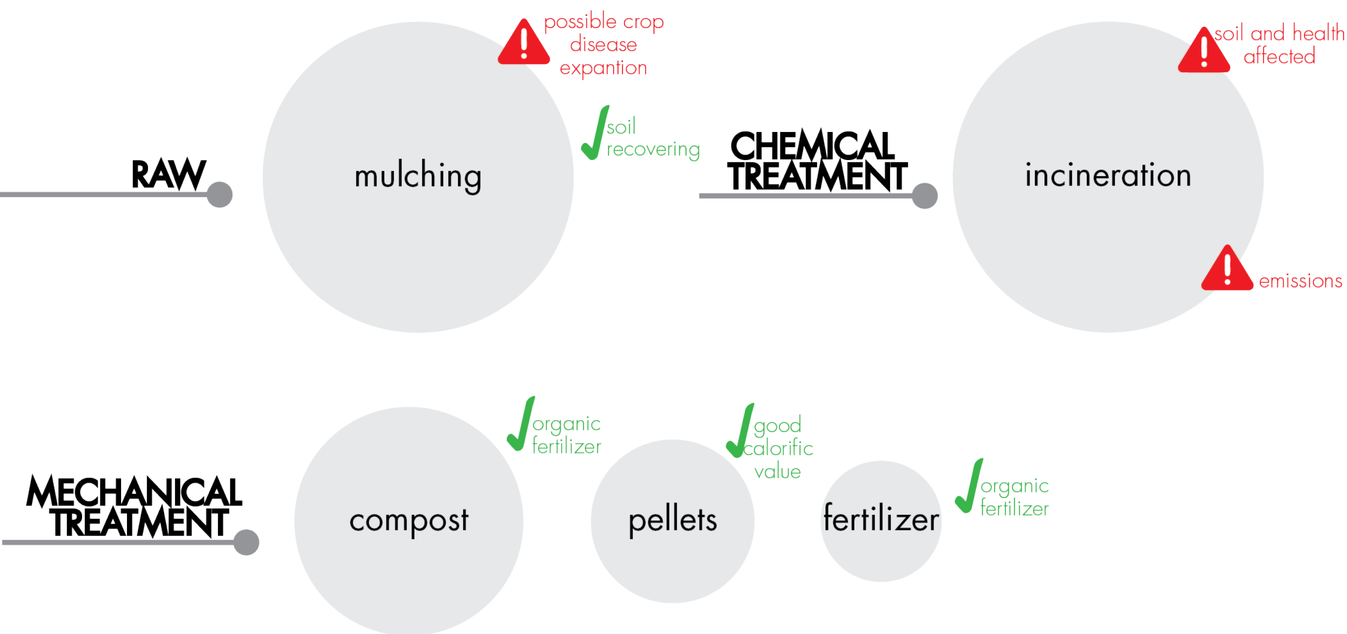
1.8
tons/ha
per year

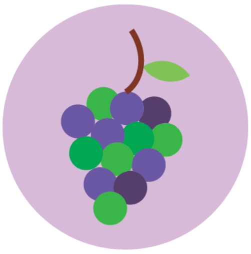


VALUABLE PROPERTIES (RAW)

- Protein content
- High phenolic content
- Flexible fibers

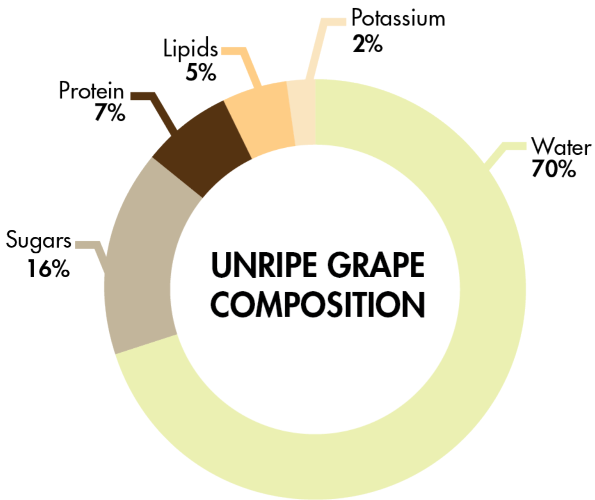
CURRENT APPLICATIONS





UNRIPE GRAPES

Non mature cut off racemes from vineyard production.



VALUABLE PROPERTIES (RAW)

- High phenolic content
- Water permeability
- Versatile matter

phenolic compound

organic acids

nitrogen compounds

aroma compounds

minerals

pectic substances

CURRENT APPLICATIONS

RAW

disposal on field — not controlled decomposition

compost — organic fertilizer

MECHANICAL TREATMENT

verjuice production — high nutrients components

food — raw matter

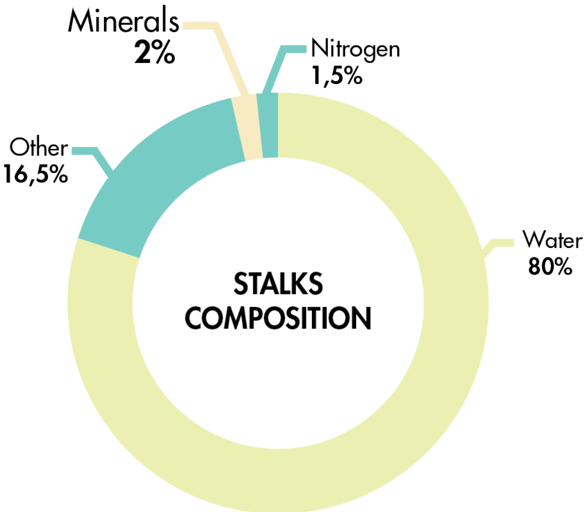
CHEMICAL TREATMENT

combustion for energy generation — emissions when getting ash

STALKS

Grape stalks are the first by-product obtained in the winery, after the de-stemming process.

4%
of initial raw matter



VALUABLE PROPERTIES (RAW)

- Antioxidant properties
- High fiber content

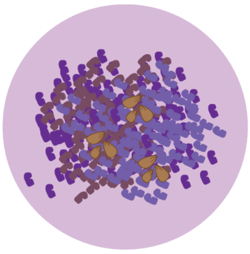
lignin
tannins
cellulose
hemi cellulose
potassium
poly phenolic

CURRENT APPLICATIONS

RAW
- compost — soil recovering

CHEMICAL TREATMENT
- incineration — soil and health affected; emissions

MECHANICAL TREATMENT
- animal feed — unstable structure
- fungus production — feed additives



GRAPE MARC

solid remaining part of the grape, constituted by seeds, skins and eventual stems that could remain after the de-stemming procedure.

20%
of initial raw matter

MAIN COMPOUNDS

Water
50 - 70%

Cellulose
10 - 20%

Fixed acids
1 - 2%

Sugars
2%

OTHER COMPOUNDS

Lignin

protein

peptic acid

poly saccharides

VALUABLE PROPERTIES (RAW)

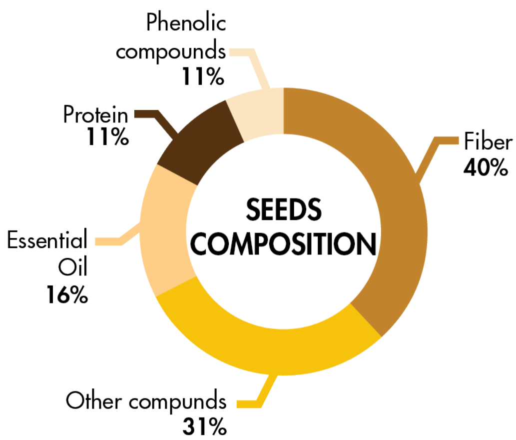
- Antioxidant properties
- Versatile matter

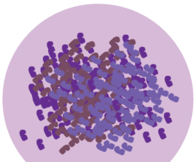
Seeds

20%
of marc

VALUABLE PROPERTIES (RAW)

- 60-70% of extractable phenolic compounds.





Skins

80% of marc

Hydroxycinnamic acids

p-courmaric
caffeic
ferulic

Flavonols

quercetin
kaempferol
myrcetin

Stilbenes

resveratrol
vinifernis

Hydroxybenzoic acids

gentisic
gallic
salicylic

VALUABLE PROPERTIES (RAW)

- High source of phenolic compounds

CURRENT APPLICATIONS

RAW

compost — soil recovering

animal feed — natural nutrients

food preservation

MECHANICAL TREATMENT

liquors — loss of valuable matter

Tartaric acid extraction — loss of valuable matter

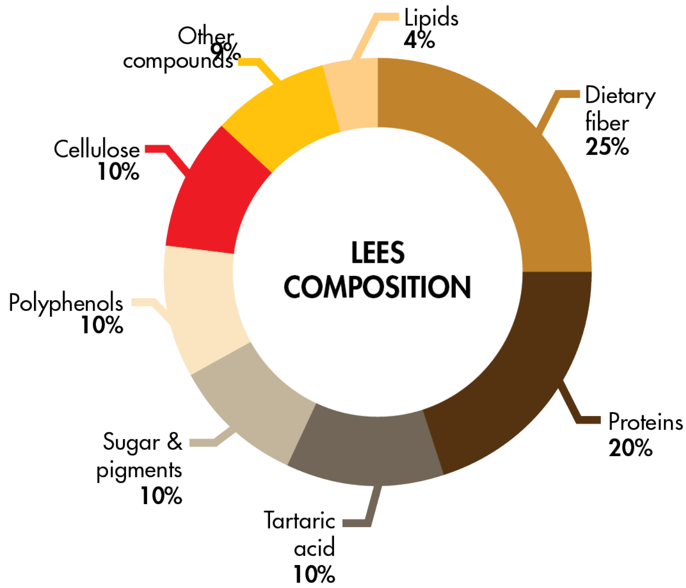
CHEMICAL TREATMENT

cosmetics

LEES

Organic matter mainly formed by exhausted fermentation yeasts.

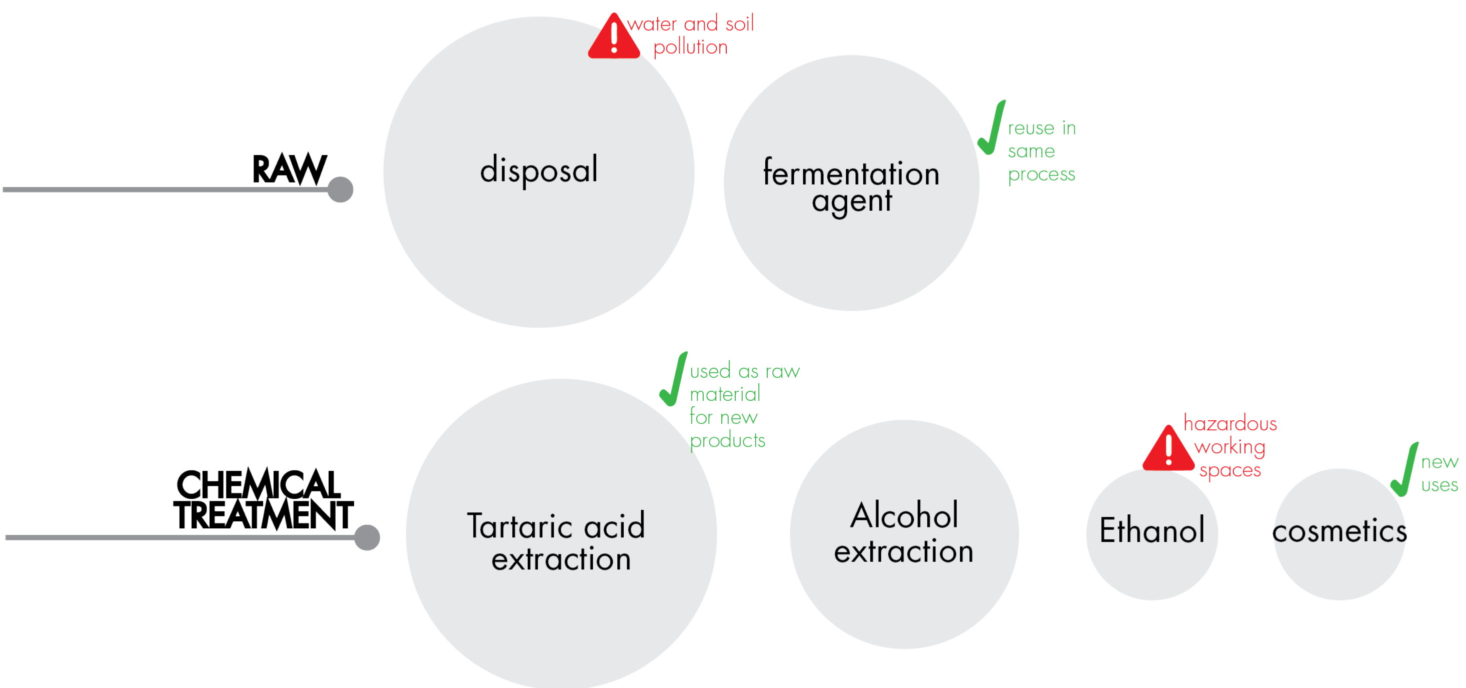
8%
of must



VALUABLE PROPERTIES (RAW)

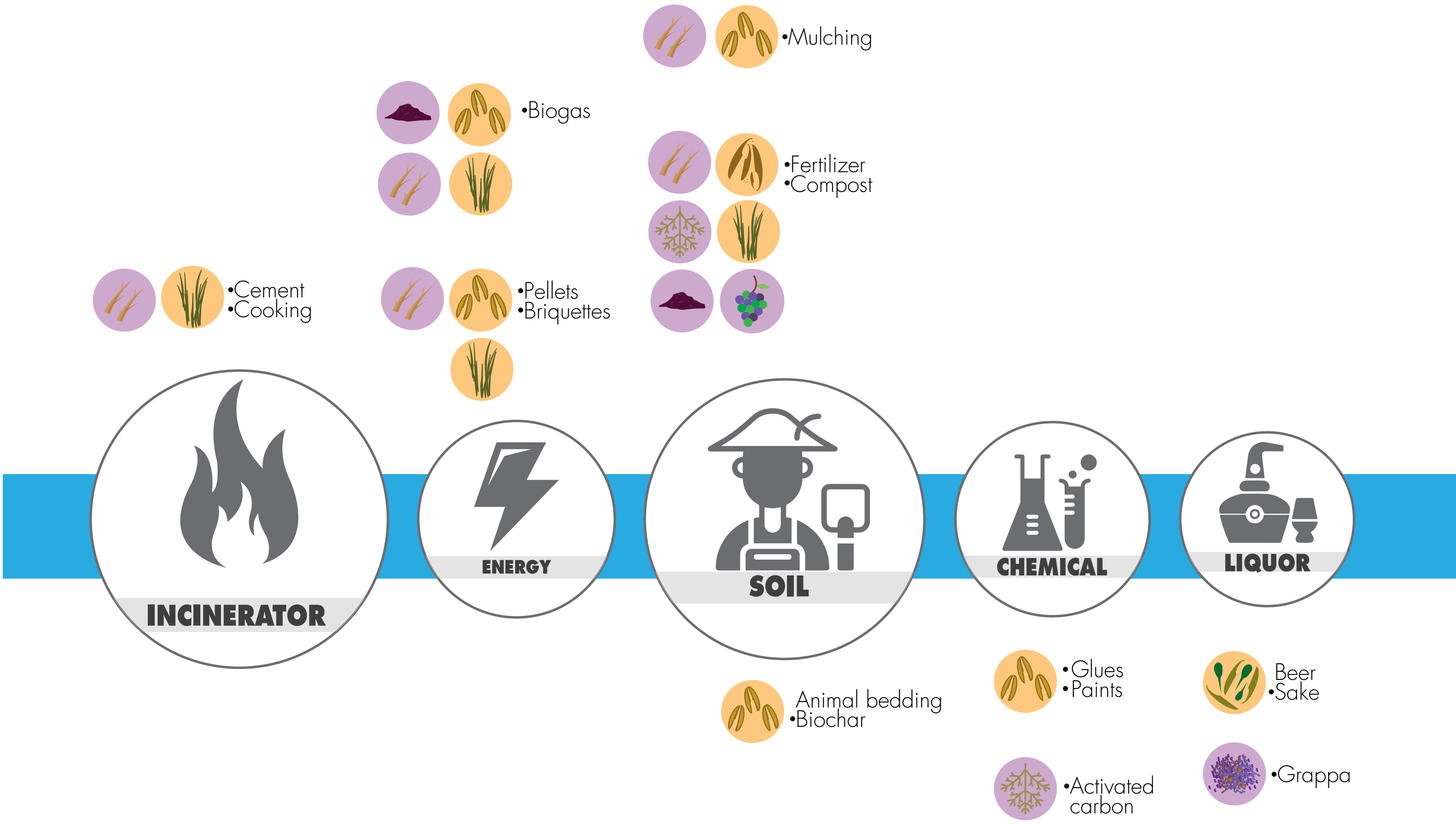
- High fiber content
- Reused in wine chain
- Antioxidant properties

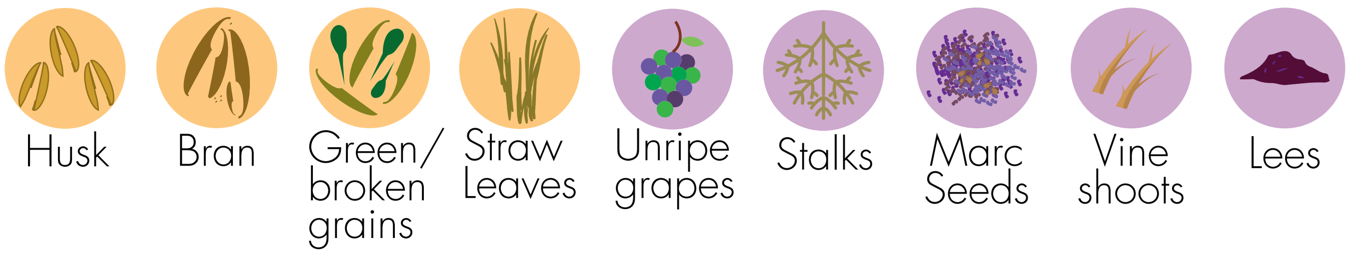
CURRENT APPLICATIONS

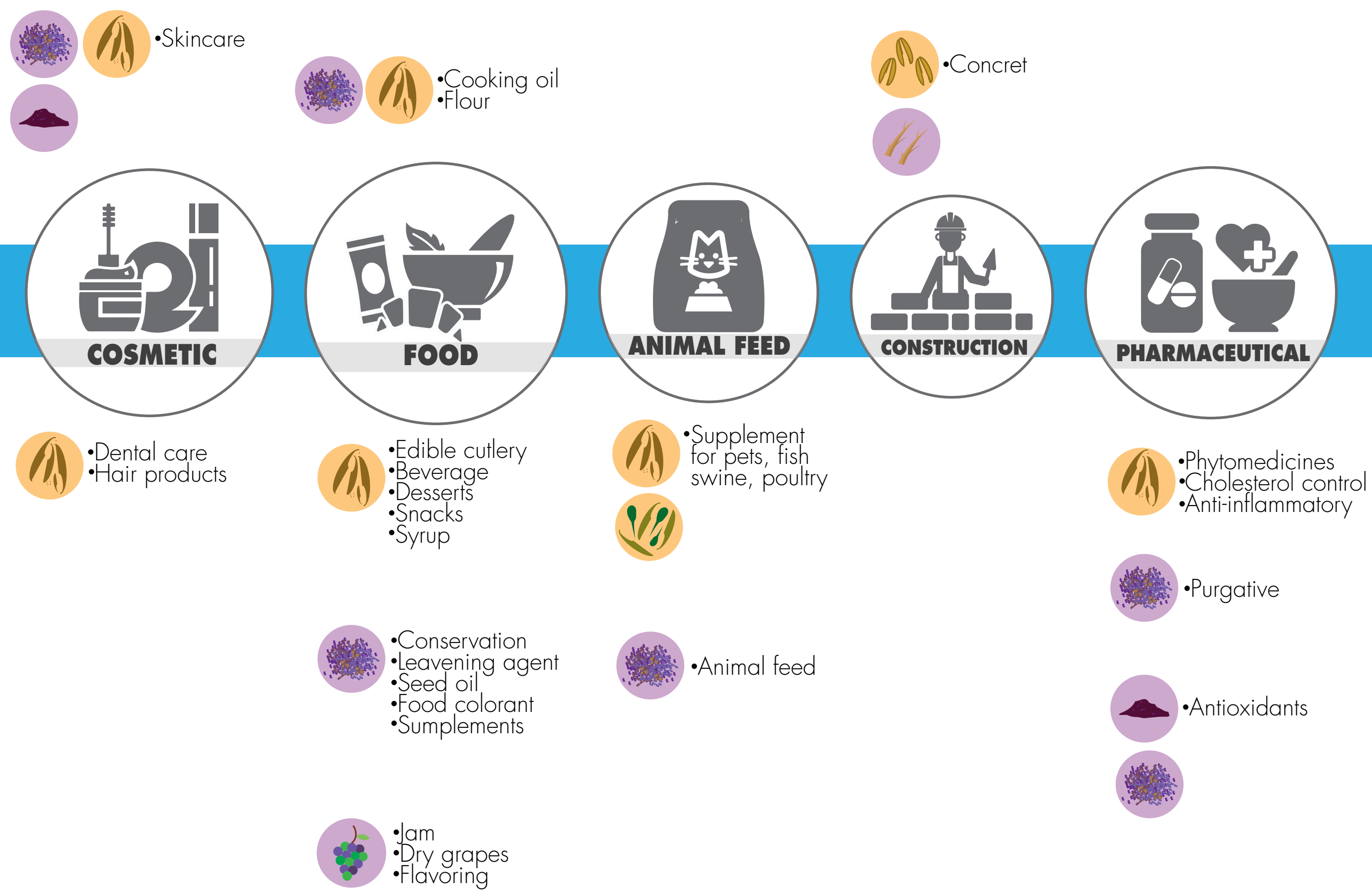


BY-PRODUCTS APPLICATIONS

Current applications with commercial value




Husk
Bran
Green/ broken grains
Straw Leaves
Unripe grapes
Stalks
Marc Seeds
Vine shoots
Lees


•Skincare
•Cooking oil
•Flour
•Concret
COSMETIC
FOOD
ANIMAL FEED
CONSTRUCTION
PHARMACEUTICAL
•Dental care
•Hair products
•Edible cutlery
•Beverage
•Desserts
•Snacks
•Syrup
•Supplement for pets, fish swine, poultry
•Phytomedicines
•Cholesterol control
•Anti-inflammatory
•Purgative
•Conservation
•Leavening agent
•Seed oil
•Food colorant
•Sumplements
•Animal feed
•Antioxidants
•Jam
•Dry grapes
•Flavoring

6. New value to the production chain

6.1. Systemic process for a new industry: Rice and wine value chain

The current rice production system in Piedmont is delimited by a demanding market with different tastes and predilections, so, in the urging of offering the traditional quality product, farmers and rice producers must need to be open-minded and embrace change in order to recover the real tradition that once meant quality.

In contrast, the wine industry is positioned, but it has been gradually decreasing during time; without changing its quality, instead, there are always new regulations in order to produce every day better wines. But for gaining one more time the leadership in production, is important to make changes not only by regulation production, but also by taking advantage of the valuable resources that the same chain provides. The systemic approach realized to the wine and rice production chains offers a sustainable view of the whole process, integrating the local resources as fundamental part of the context development.

If one losses the valuable proposition of his or her business, the quality of the product will be affected. Then, when talking about embracing change, the value will not be found in reducing costs. If the systemic approach is well performed, cost benefits are going to appear as a direct consequence in each value chain.

As wine and milled rice production increases in the territory, the availability of by-products, from now on considered raw material, will be taken into account as a competitive input or resource in three different levels as shown in Figure 49.

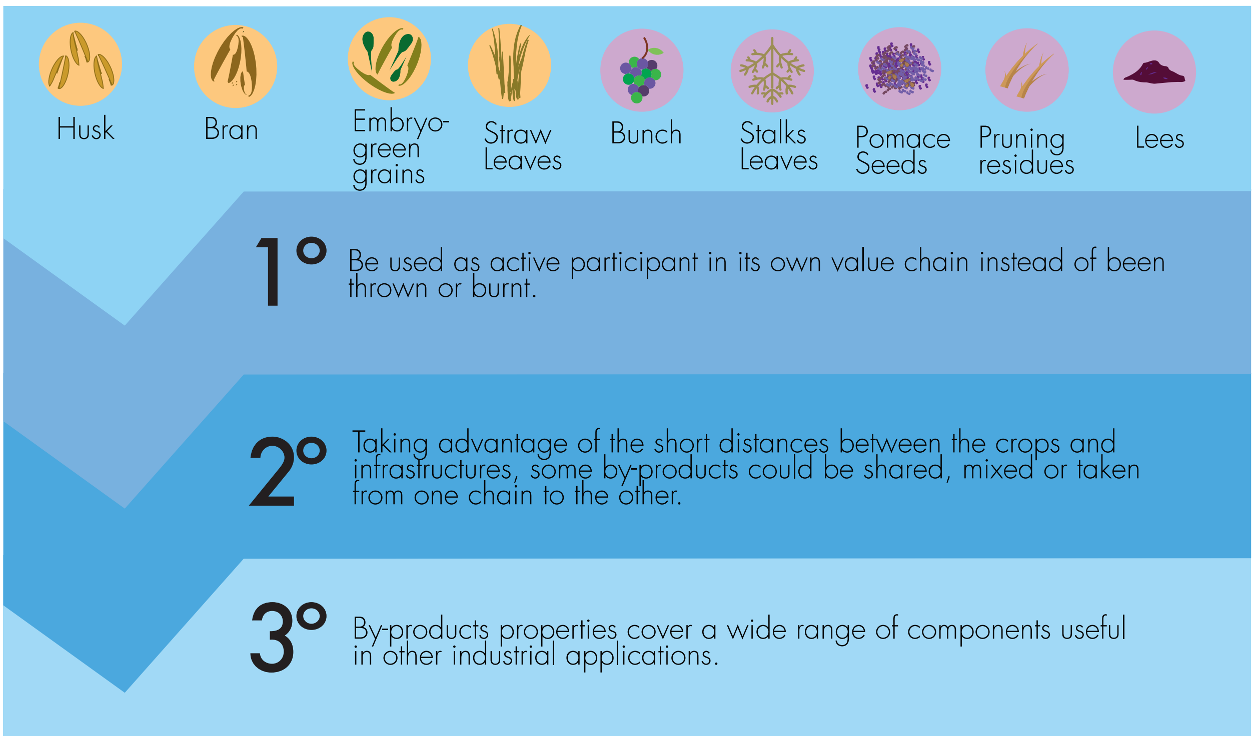


Figure 49: Hierarchical flow of by-products matter. *Source: Own elaboration*

The proposed system considers the improvement of the wine and milled rice qualities, but also presents a new horizon of quality products. If these products are spread among different markets, the territory would be revalued and the local economy will grow and develop.

The first aim of this system is to change the wrong perception that more quantity justifies quality loss, reason why, the revaluated process could expand a company portfolio without risking excellence. In addition, new areas of development would let producers to perceive association as a win-win strategy and a way to communicate better with consumers.

CROP CARE PLANNING

INTEGRATED PEST MANAGEMENT

This is a set of techniques and practices developed to address any pest complex. When talking about pest in an agricultural environment, one refers to the possible threats of the crops like insects, diseases, weeds, fungus and other biological predators' agents around the area. The IPM proposes a series of unique programs that can be arranged for any different reality. "IPM practices can vary within a single farm, between crops and from year to year depending on pest pressures, weather, crop varieties and other factors. This makes it an effective and responsive approach for producers" (FAO, 2016)

In other words, these different techniques would be modified depending the specific requirements of the crop. Therefore, it can be adapted to any production goals in the agro-industry sector from organic ways of production to sustainable production chains. One of the main objectives of this management is meet the new global challenges like food security.

When reaching a field, it is possible to observe some vulnerable aspects: more than the weeds, the insects and fungus. Thus, the IPM tries to define a sustainable practice without losing production or affects the high yields. On the contrary, it is an ecosystem-based strategy willing to prevent in a long-term spectrum the consequences of pest or other organisms that interfere with the healthy growth of a crop.

The very two pillars of this philosophy are in first place pest prevention and secondly the use of pesticide only as really needed. IPM expresses the effectiveness of non-chemical methods capable of provide similar results to those pesticides give to the crop. As Baker et al. (2015) mention, "broad-spectrum insecticides often create new pest problems because they destroy the balance between plant pests and their natural enemies".

The producers who use pesticides are not taking care of the food supply, the environment or the field workers as a whole –it is not possible to say that these particles spread into the air are no dangerous for human or animal respiratory tract. Also, "pesticides users face increasing pest resistance to pesticides, the loss of economical pest control products due to regulatory actions and market forces, and higher costs of new reduced risk pesticides" (Baker et al., 2015).

Even though the IPM requires more labor than the current crops, normally costs are lower over the time because since the beginning the pests are being treated and handled as part of the whole system. Then, it not only benefits the environment, the soil and production's quality, but allows producer save money or at least reduce the expenses related to pest management.

As said before, every single activity has its own conditions, this is why a new program should be generated on order to combine the necessary and efficient techniques in that specific piece of territory.

The IPM program could be made by combining four big categories of techniques that conform each specific program such as biological, chemical, cultural and mechanical control. The main purpose of every technique integrated in each category is prevent pests by biological controls able to manipulate a certain habitat as part of a cultural change made by the society (in this case, the producers are the ones who start making the change possible).

Cultural control.

Reduce pest establishment, reproduction, dispersal, and survival. In this part is when the scientific advances and the traditional know-how are put together to generate new behaviors in some stages of the value chain. With the insertion of new techniques and new equipment, the crop management would be easier.

These controls are the first prevention signal that a producer might plan before the sowing. With good sanitation, removal of infested organic matter (that is not well treated) more competitive plants are going to grow.

Biological control.

It is also understood as introduction of natural enemies—predators, parasites, pathogens, and competitors. For instance, with the insertion of a beneficial organism, the flowering and nectar-production could maintain the presence of these species that also are natural predators of the possible pests.

Physical or mechanical control.

These group of techniques kill a pest directly, block pests out, or make the environment unsuitable for it. Include mulches for weed management, steam sterilization of the soil for disease management, or barriers such as screens to keep birds or insects out; another practices include using barriers and traps, the sunlight or thermal treatments.

Chemical control.

Finally the least techniques included in a program could be the pesticides or chemical control. Pesticides must be used only when needed and of course, this activity will be works better if it is supported by other (cultural, physical or biological) methods.

Furthermore, these chemical agents get a new way of being applied to the territory in order to protect the worker and the surroundings organisms' health.

CROP MANAGEMENT

The quality starts from the sown seed for rice and for wine from the proper vine cutting plantation (if the first time), or from pruning for mature vines. Being in a temperate zone, the variable peaks in temperature affects the crops. Additionally, if soil has not been well prepared, the rooting process will be hard and seedling would be inexistent. The environmental conditions are fundamental actors in the development of the plants before harvesting.

Soil preparation for rice growing contemplates the surrounding ecosystems as a symbiotic process. With the organic fertilizer obtained from animal manure, vermicompost with Eisenia foetida earthworms and compost mineral fertilizer dosage will be reduced in a significant percentage. As well, this procedure will be supported by (nitrates metabolizer) bacteria present under the substrate.

With the bacteria action, the formerly macronutrients offered by mineral fertilizers are going to be replaced by those inherent to the peat soil. The same principle can be applied for the preparation of the soil for the first time that is going to be planted the vine, instead when the vineyard is mature the process would be different.

Vine weeds control, can be managed with the different section of the covering crops, or by mixing the types of grass that will we planted, in this way the soil will gain organic compound from the grass and will avoid the creation of weeds, a good complement for the type of grass are the clover. For the control of pests and diseases, the best option is the biological control with natural "enemies" such as fungi, and microorganisms.

Also with the augmented porosity of the soil, rice drainage will become easier, as the ditches rearrangement is executed before the seedling and land is going to adapt easier to crops rotation. Even though, Piedmont's farmers have tried to protect the quality of their fields, the plants varieties should be properly divided in order to prevent varieties mixture, which helps to the loss of traditional properties of the grain.

On the other hand, as mentioned before, for the vines there is no such problem with drainage due to the fact that they a commonly planted in hills which contributes to naturally in this aim

The experimentation with rice grain is positive when the variety is not drastically changed and yield will be optimized, but traditional qualities must be recovered and preserved.

Another vital factor is the mulch coming from the reintegration of reaped rice straw collected from the harvesting and from winter pruning activity dine in the vineyard. Its major characteristic is the soil's protection from cracks and terrain's fractures which inhibit the fixation of the roots even if the land is retaining water.

The systemic process contemplates the vulnerability of both rice and vine plants. By listing the number three principal enemies of crops, where the first place is taken by the insects, the second belongs to weeds and the third is given to fungi, the farmers will have to actively use Integrated Pest Management (IPM) strategies in their crops.

The idea of IPM use is to reduce the use of harmful pesticides and chemical regulators due to the effectiveness of introduced species inside the crops. The most feasible insect control for rice plant would be the sterile insect technique in order to minimize the dangerous predators. Instead, for vines will be the "sexual confusion", which will not allow the reproduction of harmful insects on the crop. This is achieved by applying diffusors with artificial pheromones that will be emanated to the air, this will create confusion to insects, who will not be able of identifying the female and so of reproducing.

For weeding, the biggest supporters of manpower and machines will be the mycoherbicides and the broad-spectrum allelopathy; in this way, the stale seedbed method becomes more productive and Clearfield (even if it is a weedy rice) shall not be considered in Italian production. Another way that weeds are going to be controlled is by the bacteria Closttidium thermocellon, a microorganism able of breaking down cellulose without harming the soil.

From the vines crop management, can be obtained leaves, stalks, vine shoots and stressed bunches that were before disposed by other entity and instead use them for the enrichment of fungi production or organic compost that can be then used for soil fertilization for both of the crops, in this way the nutrients will be easily absorbed and the soil will maintain homogeneous.

For the irrigation, there are multiple considerations. Firstly, the reduction of water consumption due to dry-sown already used in some Piedmont's farms and new methods like line sowing where harrowing will be made only after seeds are dropped. If the truck is not passing so many times per each hectare, the soil will heal and canal maintenance cost are going to drop.

The irrigation continuously ups and downs are not going to cause problems to the ecosystems created around the crops. For allowing biodiversity be part of the systemic process, fauna will not have the necessity of migrating to other crops (bringing bad potential diseases to the cultivated plants) because with the constant flow of water coming from the husk filter and the fito-depurator close to field chambers moving for surviving is not urge.

Finally, with the irrigation as a complementary resource for biodiversity, aquatic organisms will also contribute to water and air purification. It is worth to say that thinking about the small-scaled businesses -even by their own or working as an association-enable a new economic opportunity to the land owner. With the prudent integration of local biodiversity (not in extension) surrounding the crops, would be possible to breed some of these species in order to amplify the business model.

From what said before is possible to recognize that rice and wine qualities are still the protagonists of the activities developed, but bringing the enough help from other natural species, not only are going to enrich the territory, but will generate part of the organic fertilizer needed by the fields.

TRANSFORMATION AND PROCESSING

This is a set of techniques and practices developed to address any pest complex. When talking about pest in an agricultural environment, one refers to the possible threats of the crops like insects, diseases, weeds, fungus and other biological predators' agents around the area. The IPM proposes a series of unique programs that can be arranged for any different reality. "IPM practices can vary within a single farm, between crops and from year to year depending on pest pressures, weather, crop varieties and other factors. This makes it an effective and responsive approach for producers" (FAO, 2016)

Taking into account, that unlike the crop management, the transformation and processing of rice and wine are immensely different, for these phases the systemic approach will be exposed separately but highlighting possible common uses where the two chains can be similar or complemented.

Rice transformation and processing.

The incorporation of new activities brought by the reuse of some of the by-products of the process and the integration of some organisms to the crop management is the biggest change in the seed's handling. Therefore, the harvesting will manage the specific times for the varieties to grow, in other words, panicles will we reaped and threshed when the right moment arrives and grain yield is no longer considered the grain to be milled, but the green and possible broken grains.

The rice straw and vine stalk and stems will be used in the agricultural sector for supporting the in-field activities hold through the crop growth, as the fertilization and feed for the animals living in the field's surroundings. Because of its characteristics and properties, rice straw and stalks from the wine production are also able to be combined in the paper and pulp industry.

Considering the provenience of the parboiling process, it is important to considered that the grain is submitted to a thermal and pressure treatment not only reinforcing its nutritional value, but increase the time it could be storage. Even though, the properties and benefits of integral rice need to be communicated in order to intensify its consumption and production having in mind that brown rice (integral rice), expends less energy and needs less finishing procedures.

When cleaning the grain, the solid inorganic matter has to be reviewed and revaluated the obtained amount because its quality is not always the same. As always, the particles are obtained from processes that ensure the separation of material by its physical or mechanical properties.

For the drying procedure, the energy consumption will be reduced by heating the paddy to maximum 150°C in order to do not affects the nutritional characteristics. Respecting the time and the heat need to accurate dry the grains, the paddies will be submitted to direct flame for less than a minute. With this new approach, drying time should spend half the time it does now because of the gelatinization process reflected in the grain surface.

Finally, for the commercial milling, the machines have to be updated in order to manage the by-products in a cleaned and contaminants-free procedure. From milling processes, the husk, the bran and the broken grains are obtained. Due to this, milling still being the focus activity of the transformation process.

Changing the perception of rice crop's yield as only the produced white milled rice will help producers to truly appreciate the quality of this matter. Husk for the husking process first use will be as an active filter supported by the active carbon filter generated with the biochar coming from both rice and wine industries.

Additionally, it will be tested as the energy producer for the milling machines. In this way, hydroelectric structures fed by the irrigation network shall reduce its water consume.

As husk applications could satisfy operational procedures, the major quantity of the material will remain in-field or close to the land energy source. The systemic approach contemplates the creation of biogas generators that be turned on with rice and wine chains organic matter ready to be processed.

The efficient separation of green, broken and stained grains, is thought to be achieved in the period between the paddies separation and the polishing. As today's functioning, the more sensitive graders will be prepared for taking away the grains for the self-cleaning filter passage.

The matter obtained for this grain classification, will send to the prior activities, but also part of the total will be used as a moisture isolator to protect the in bulk paddies or transformed in order to extend the spectrum of utility in the food industry.

When talking about the paddies separation, normally the same procedure is done three times, depending of the desired final whiteness demanded from the market. In this order of ideas, bran layers cannot be mixed with the husk. Bran and its new applications are attributed to the third level of usage such as the food, cosmetic and pharmaceutical industry.

The reason why bran takes an important commercial and competitive value in the market, is because its high nutritional value, antioxidants, vitamins and fiber concentrations. As well, the amount of produce bran is almost a 10% of the total by-products left after milling processes.

Lastly, the storage will be managed with integrated biological pest control strategies and by moving rotating the silos content and the bulk paddies –only if moisture level allows, preventing insect infestation or grain yellowing because of exceed humidity.

Wine transformation and processing.

Taking into account the previous changes that would be done in the vineyard, the quality of the grape will be upgraded from the beginning, this means that in the vinification the quantity of SO2 applied can be lowered in order to reduce the risk for consumers of getting un desirable disturbances by the product.

Taking into account that the SO2 is principally being used as antioxidant and preventer of undesired fermentation, a solution would be a careful treatment of the raw material in order to avoid that the damaged grapes or the spiked ones gives place to the changing of state of the organic material.

By the other hand, for replacing the SO2 used during fermentation for the stabilization and correction of wine, it will be used the remaining yeast o previous fermentations for the control of factors that can change the quality of wine, in this order of ideas, the wine will no longer receive artificial additives, but it will receive natural organic matter from previous processes that will help stabilize it.

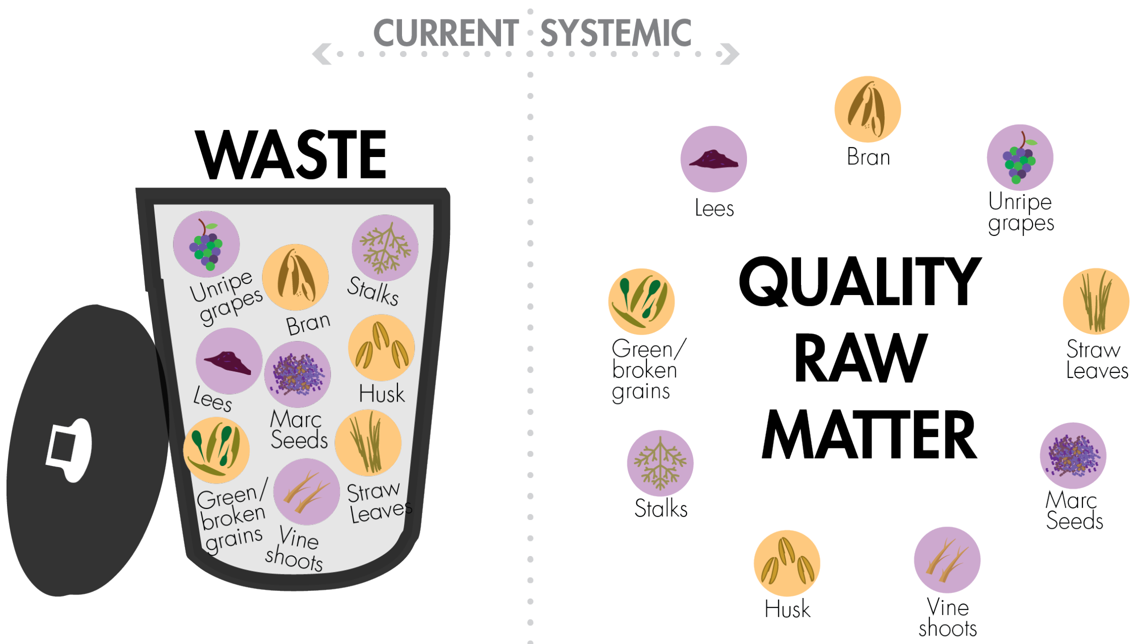
In the current value chain of wine, in the process between harvesting and de-stemming it was needed a high amount of energy because grapes had to be refrigerated in order to avoid the ripening before starting the vinification process. For the systemic proposal, this will be reduced with the use of solar energy, and by the planning of the harvesting on the proper day in which the temperature is adequate for grapes. Also, the proper storage during transportation of the grapes have to be done in containers that allow the air flow in between the fruits.

The same principle will work for the high energy consumption in refrigeration processes and energy used for the other machinery to function. This can be reduced with the hydroelectric structures conformed by the irrigation system of rice production, or with the implementation of photovoltaic panels which can help reduce the energy usage.

During the winemaking process, the waste of potable water is high, because the producers use water (from 0.5 to 14 liters of water per liter of wine produced) that in some cases have extremely high organic loads.

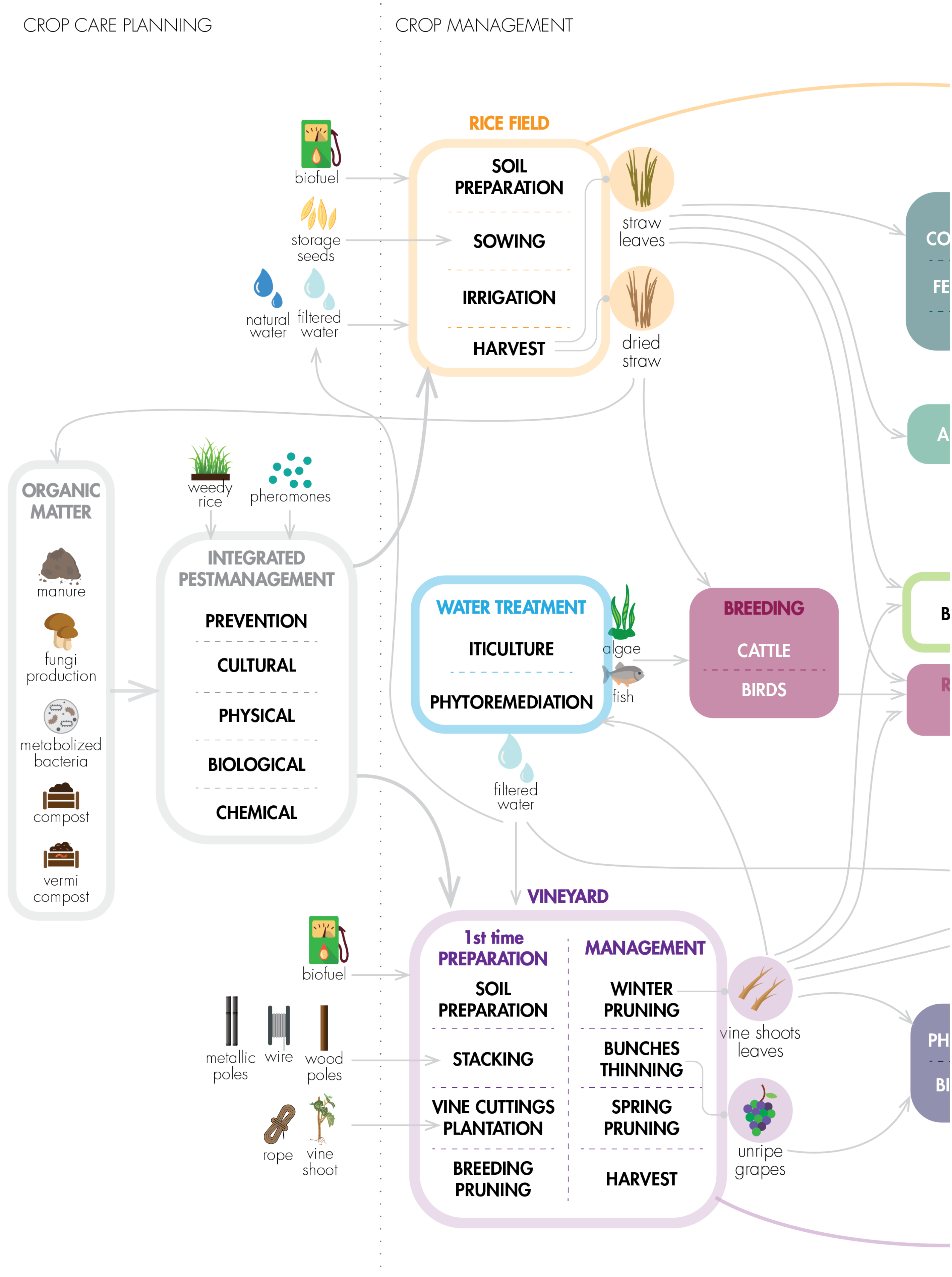
Producers are not taking into account that this organic loads could be filtered or treated in a way that they can clean the machinery and the containers but that this water instead of being waste, it goes to the fito-depurator mentioned before and that it could be used forward in the crops irrigation. In this way it will be created a cycle, where the water as output in vinification is being used as an input for the irrigation in the crop management.

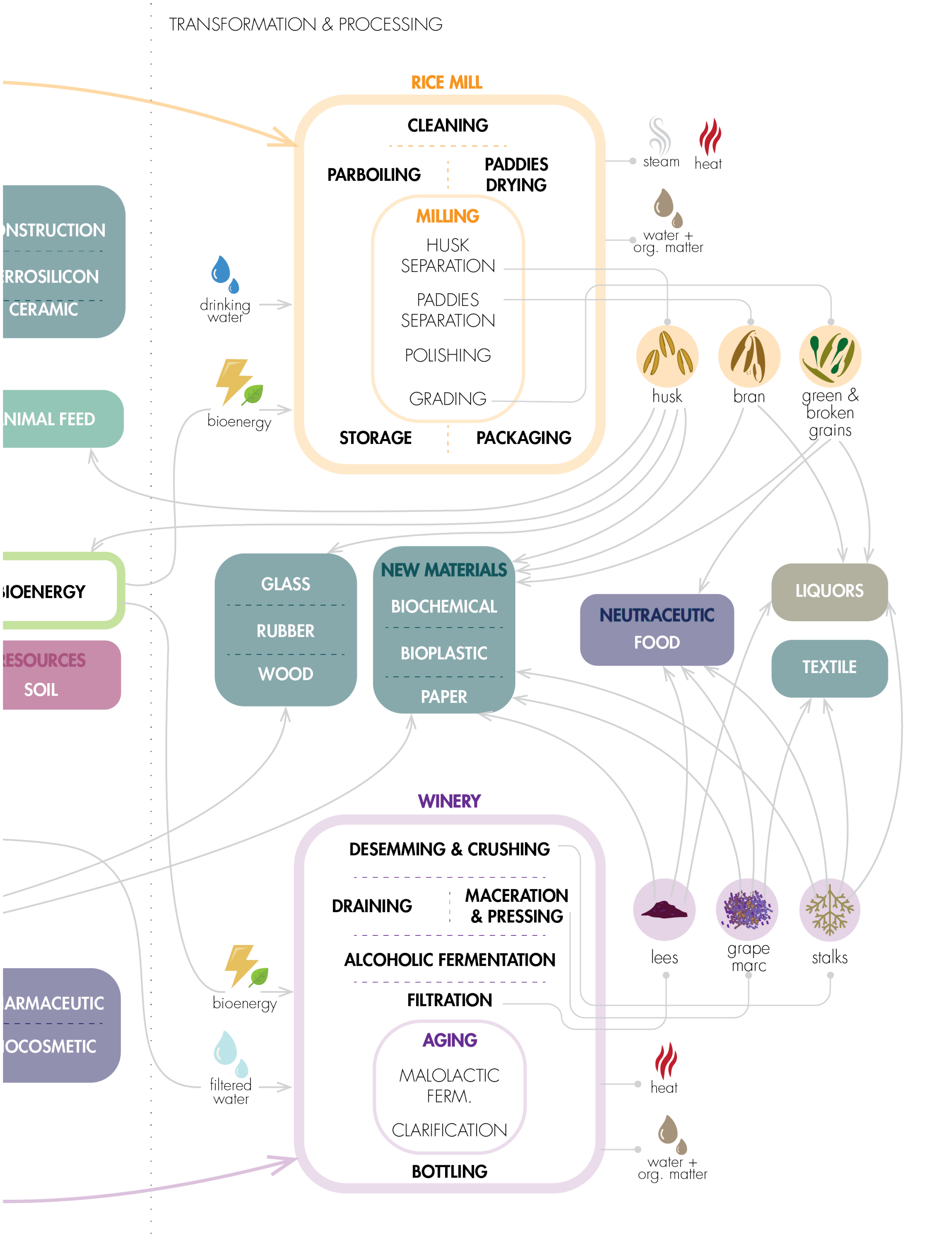
In addition, the pruning residues of the crop management will contribute to the filtration in this water thanks to the fact that the vine shoots have a great potential of removing different compounds from water when used as filter. Respecting to the main by-products of the wine value chain, these are intended to be reused on different industries. The pomace obtained after fermentation, not being able to be re introduced on the vinification process, is sent to the distillery, where the seeds are separated for the production of Grappa and the skin is used for compost production.



SYSTEMIC APPROACH PROCESS

Input/Output new value chain




TRANSFORMATION & PROCESSING
RICE MILL
CLEANING
PARBOILING
PADDIES DRYING
MILLING
HUSK SEPARATION
PADDIES SEPARATION
POLISHING
GRADING
STORAGE
PACKAGING
steam
heat
water + org. matter
drinking water
bioenergy
husk
bran
green & broken grains
NSTRUCTION
RROSILICON
CERAMIC
NIMAL FEED
IOENERGY
RESOURCES
SOIL
GLASS
RUBBER
WOOD
NEW MATERIALS
BIOCHEMICAL
BIOPLASTIC
PAPER
NEUTRACEUTIC
FOOD
LIQUORS
TEXTILE
WINERY
DESEMMING & CRUSHING
DRAINING
MACERATION & PRESSING
ALCOHOLIC FERMENTATION
FILTRATION
AGING
MALOLACTIC FERM.
CLARIFICATION
BOTTLING
bioenergy
filtered water
lees
grape marc
stalks
heat
water + org. matter
ARMACEUTIC
OCOSMETIC

6.2. New applications analysis

At the moment of propose a systemic process, it is important to have in mind the further applications of each of the significant by-products studied in Chapter 5. The two-main value chain have now the opportunity to self-regulate their crop management activities when reusing the matter to create enough energy for their processes and purifying the surrounding water bodies.

At the same time, with the introduction of biodiversity, specifically the bird breeding (because of the territory's characteristics, and the new activities that come with it (as well for regulating the soil's capacity to support such variety of ecosystems) the producers are not only focused on the revenue brought by the excellent quantity and authentic taste of their milled rice, but also can start developing new business models that integrate some other farms around, generating a larger net of co-working where the know-how is shared and the best way to offer profitable products and services is by creating associations between different actors within the territory.

During the second main stage of the new value chain, recognized as the transformation and processing phase, the system diverged between the rice mill located in the northeast part of the Piedmont region and the winemaking factory normally found in the southeast of the region. Each system generates the same kind of by-products, the big difference is the way they are treated in a new value chain.

All the by-products since the very beginning of the process are considered as raw matter that have to be taken care of and of course protect its quality all along the future applications and industries where new processes are going to take part.

One of the biggest strengths of both sectors in the territory is the importance they give to the professional, the continuous technological upgrading and the feasible investments in order to improve the process since the crop management until the distribution in the market. Taking this into account, it is worth to mention the new possibilities of intervention in eighteen different sectors of the local and global industry.

As shown previously in the systemic approach process, the new raw matters go to three five big categories recognized as potential hubs for innovative products. Remembering the iterations present in the development of this study, it has to be said that the background information for discovering and purposing these new usages come from the study of the current market and those pioneer projects who decided to change the paradigm and start innovating with the powerful qualities of these by-products in different countries integrated to the studies that try to give value to part of these by-products as well.

The five big categories are composed by "nutraceutical" which includes the production of food, pharmaceutic and biocosmetics. The second category is called "new materials" and it collected all the new elements of specialized industries as the biochemical bioplastic, textile, paper, wood, construction, ferrosilicon, rubber, glass and ceramic. The third category would be known as "resources" in which the soil care, the water purification -for the living ecosystems around the mill and factory – and the energy consumption and generation. As separated categories, it is possible to appreciate the "animal feed" and the "liquor" production as the last two ingredients of the new system.

By analyzing the new applications, it would be possible to compare how the small projects (trying to change the way of thinking of the consumers) can really mean a measurable change in the production of all the new products and services contemplated in every new possibility. The new applications, as an innovative way of using the former by-products is a mind settler that look forward to amplifying the business values of the local industry included the small and the large-scale business.

At the same time, it has to be said the importance of the growing know-how of each of the involved industries inside the whole system. When talking about a better rice or wine production, it is implicit that the final bottle of wine or the packaged white milled rice are not the protagonists of the process, but a very important axis of it.

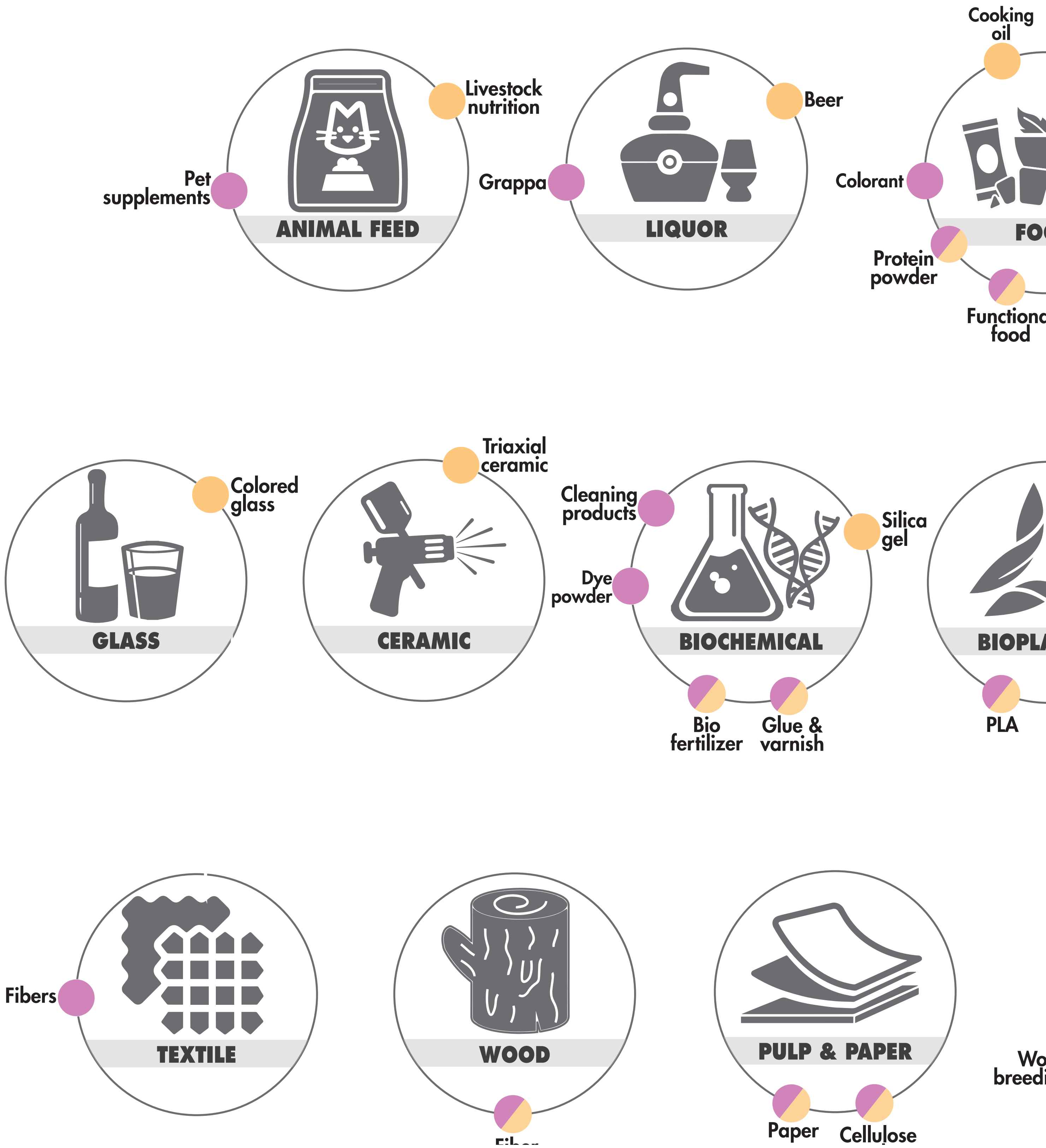
At the moment of giving value to all the materials, the entire chain is receiving an additional remarkable aspect which reinforce the actual quality of the product in a commercial context. Therefore, the strict care and treatment in the whole chain, not only for the main final product but for its by-products, has to be always present for do not damage the matter and ensure the normal performance of other value chains now operating in the territory. Additionally, the creation of a bigger net bounded by the territory's workers and the local community will enhance the current lack of communication and collaborative work between actor.

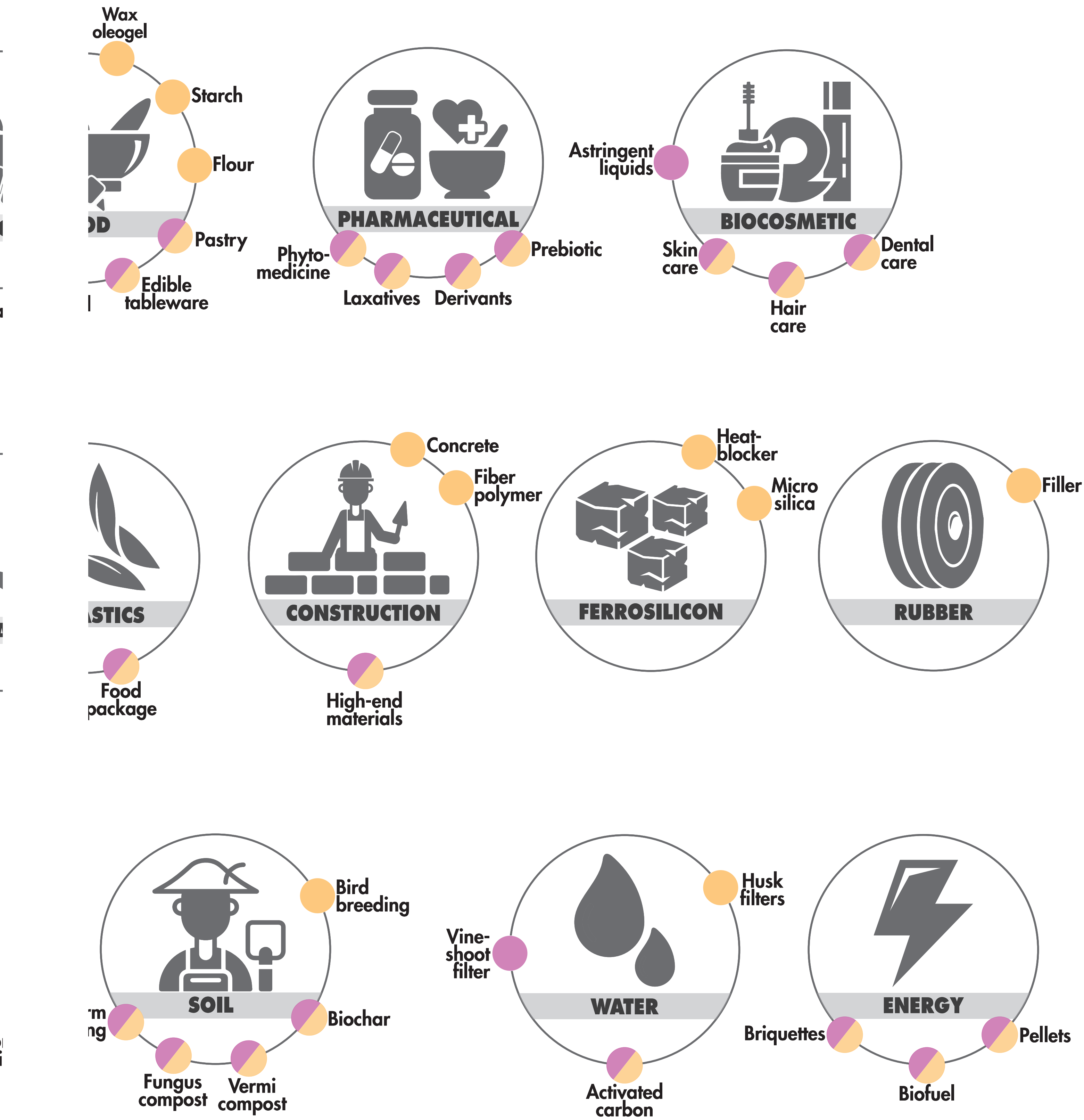
When the product has no need of being submitted to a long series of processes it means that quality has been indispensable for the producer. Then, the more natural is the material, the highest revenue could be obtained because less needed treatments.

At the moment the information was reviewed, it was time to make an analysis by clarifying the properties and characteristics that both rice and wine by-products can offer to the new market. The analysis was made by listing the experimental and the already existing products (it is worth to say that the existing products section enhance those new applications are being daily tested by the real market) of every category.

NEW APPLICATIONS

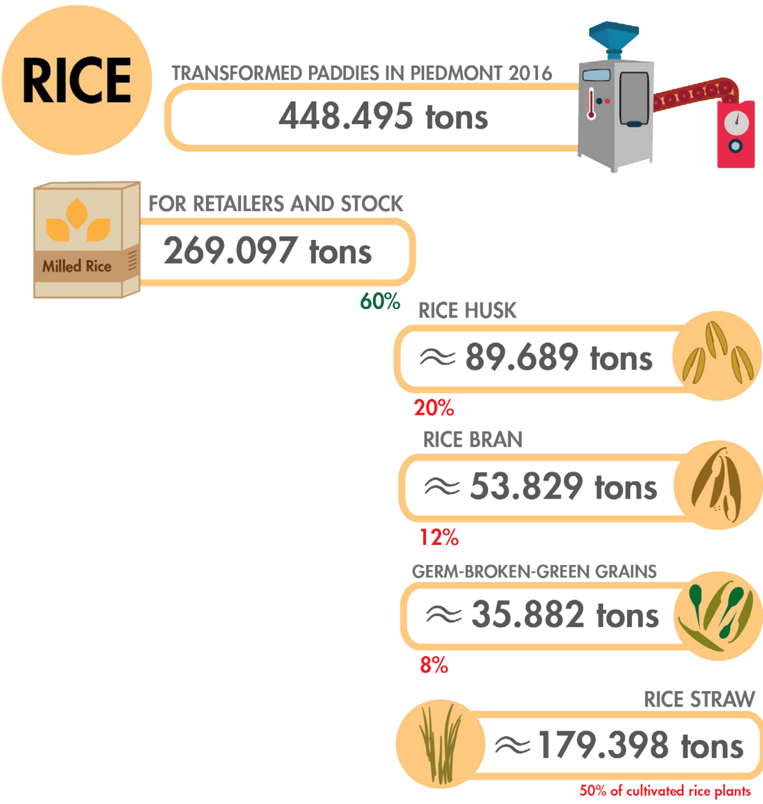
Innovative employment of new raw matter

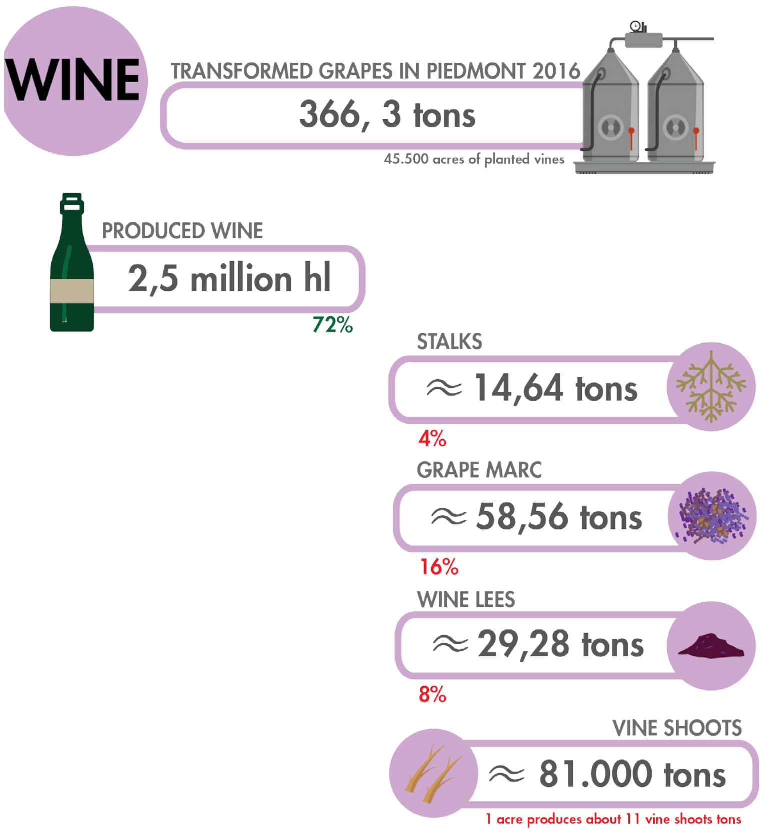



Wax oleogel
Starch
Flour
Pastry
Edible tableware
PHARMACEUTICAL
Phyto-medicine
Laxatives
Derivants
Prebiotic
Astringent liquids
BIOCOSMETIC
Skin care
Hair care
Dental care
Food package
CONSTRUCTION
Concrete
Fiber polymer
High-end materials
FERROSILICON
Heat-blocker
Micro silica
RUBBER
Filler
SOIL
Bird breeding
Biochar
Fungus compost
Vermi compost
WATER
Vine-shoot filter
Husk filters
Activated carbon
ENERGY
Briquettes
Biofuel
Pellets

MATTER SEEN AS WASTE

Circular flows reintroduce matter in new processes





EXPERIMENTAL APPLICATIONS

Innovative employment of new raw matter

NUTRACEUTICAL

EXISTING PRODUCTS [PIONEERS]

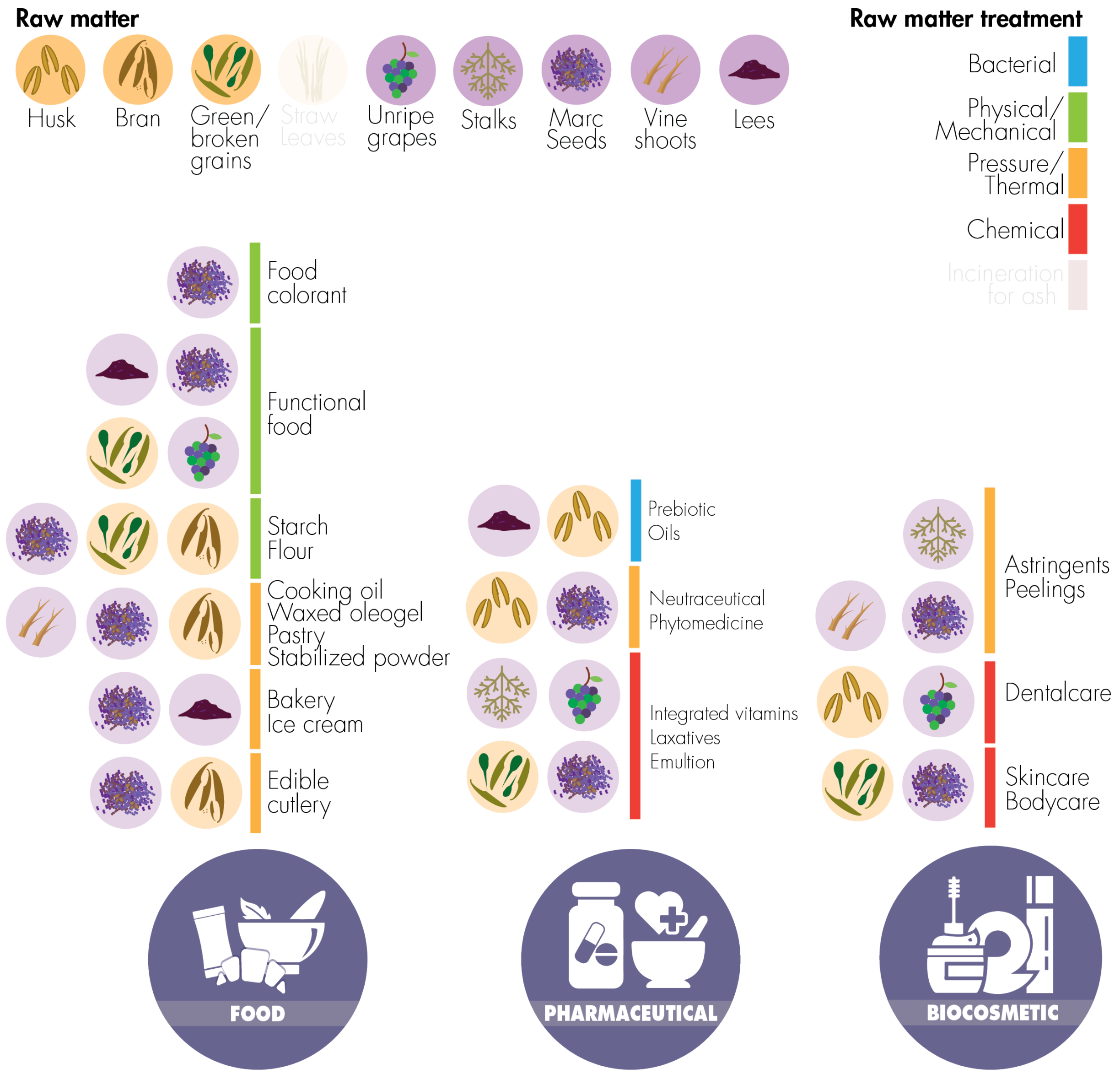
- Cooking oil
  - grape seed oil
- Functional food
  - soups
  - pasta
  - noodles
  - jams
  - verjuice
  - tea infusion
- Rice starch
  - biscuits
  - rollers
- Food colorants
- Flour
  - pastry
  - desserts
  - bakery
- Protein powder
- Edible cutlery
- Derivates
  - vitamin concentrates
  - emultion
  - food antioxidants
  - food additives
- Skincare
  - facial wipes
  - lipstick
  - powder
- Hair products
  - nourishing creams

EXPERIMENTAL PHASE

- Functional food
  - breakfast cereals
  - sauces
  - baby food
  - soups
  - pasta
  - noodles
  - juices
- Emulsifying agent
  - bakery
  - ice cream
  - salad dressing
- Rice starch
  - crackers
- Flour
  - desserts
  - cakes (sweet and salad)
  - muffins
- Wax oleogel
  - yogurt
  - ice-cream
- Derivates
  - mushroom oils
  - vitamin concentrates
  - dietary supplements
  - fiber for food
  - natural additive
  - meat preservation
  - diary preservation
  - protein supplement
  - flavorings
- Laxatives
- Phytomedicine
  - chemo preventive
  - blood pressure control
  - Ant inflammatory
  - cholesterol control
  - burn healing
- Prebiotics
- Skincare
  - serums
  - lifting
  - foundation
  - sun-screen
  - astringents
  - vitamin E extract
  - antiaging
  - antioxidants
  - peelings
  - exfoliants
  - lotions
- Hair products
  - shampoo
  - conditioner
- Body-care
  - deodorant

NUTRACEUTICAL

Raw matter quality after specific treatment



FOOD

COOKING OIL

Bran

Unripe grapes
Marc Seeds

- Very **stable** smoking point and does **not absorb** other flavours while cooking.
- High **neutraceutical** value: gamma-oruzanol / tocotrienols.
- Removal of **phytic acid** helps to prevent diabetes and kidney stones.
- Effective lowering blood **cholesterol**.

FUNCTIONAL FOOD

Bran
Green-broken-germs

Unripe grapes
Marc Seeds
Lees

- Improve health and **food security** in developing and developed countries.
- **Prevention** and **treatments** of carcinogenic cell in the colon, liver, stomach, esophagus, bladder.
- Antioxidant natural additives for food ingredients.
- **Verjuice** obtained fron unripe grapes helps to **boold pressure control** and is a source of polyphenols.
- *Cakes, breakfast cereals, desserts, sauces, baby food, soups, pasta, noodles, jams, juices, tea infusions.*

FLOUR

Bran

Marc Seeds

- Biscuits, with a 10% concentration of rice bran, do not affect **sensory quality**.
- grape seed flour contributes with the **antioxidants and proteins** for bakery production.
- *Pastry, desserts, muffins, pancakes, cereal bars*

PROTEIN POWDER

Bran

Marc Seeds
Lees

- **Stabilized** raw rice bran for direct **consumption**.
- Added to fruits, smoothies, soups or cakes.
- Protein obtained from the grape seeds provides nutrients and antioxidation qualities.
- **Potasium salts**, provides **hidratation agents** for protein powders.

EDIBLE CUTLERY

Bran

Marc Seeds

- Feed people with nutrients, vitamins and **dietary fibers**.
- **Reduce** contamination by plastic production.
- **No need** of preservatives, chemicals, additives, colouring agents, raising agents, trans fat.
- **Phenolic** acids in grape pomace provides antioxidation agents to the ingredients, and **cellulose** gives adherence to the different compounds.

RICE STARCH

Bran
Green-broken-germs

- Different extrusion methods that change matter consistency in short-time, starch gelatinization, denaturation of proteins, enzymes inactivation or microbes reduction to manage **appearance, colour, taste, crispness**.
- *Crackers, biscuits, rollers*

WAX OLEOGEL

Bran
Green-broken-germs

- Emulsion give **smoothness** and creamy **texture** when **fermented** by specific **bacteria**.
- Reduce trans and saturated fat intake.
- Solid **fat replacement**.
- *Yogurt, ice-cream, sauces*

EMULSIFYING AGENT

Marc Seeds

- **Biosurfactants** provide smoothness and helps to obtain certain textures in creamy products.
- Acts as a **natural additive** instead of chemicals.
- *Ice-cream, bakery, salad dressing*

DERIVATES

Marc Seeds
Vine shoots
Stalks
Lees

- **Phenolic compounds, tartaric acid, and proteins** extracted are useful for meat and diary preservation methods.
- The high sugar content allows the production of flavorings and food colorants.

PHARMACEUTICAL

DERIVATES

Bran, Green-broken-germs

Marc Seeds, Unripe grapes, Stalks

- **Isolated peptides** posses **antioxidant**, antihypertensive, anti-tyrosinase ans anti-inflammatory traits.
- Caffeic acid and ferulic acid **protect** from photooxidative damage.
- Treat **hepatophathy**, nephritis, hypertension, hyperlipidemia, arthritis, neurasthenia, insomnia, bronchitis, asthma, **gastric ulcers**, atherosclerosis, leukopenia, **diabetes**, anorexia and **cancer**.
- Lignocellullosic biodegradation for activating the **laccase** activity.
- Rich in **tocopherols**, **tocotrienols** and **oryzanols**.
- Improve **blood pressure** and glucose level.
- **Edible** and **medicinal** oils-production.
- *Mushroom oils, vitamins concentrates, emultion, dietary supplements,*

PHYTOMEDICINE

Husk

Vine shoots, Marc Seeds

- **Chemopreventive** mechanisms of fermented **bioactive** components.
- **Laxative** properties due to lactic acid components.
- Prevent **constipation** and **cardiovascular** risk.
- Action for **acne reduction.**

BACTERIA FOR PREBIOTICS

Husk

Lees

- Resistance to gastric acidity and **gastrointestinal** absorption.
- **Autohydrolysis** outcome could be oligosaccharides.
- Fermentation for **xylooligosaccharides** extraction.

SKINCARE

Green-broken-germs

Marc Seeds · Vine shoots · Stalks

- Ferulic acid and gamma-oryanzol give protective properties
- against UVA rays.
- High **derma-compatibility** for aspersorium powder, dermal paste and products for baby skin and delicate skin.
- Maintain **elasticity** and **tone**, preventing photo-aging.
- **Emollient** and **serum** restitutive properties.
- *Facial serums, sunscreen, foundation, lipstick, powder, astringents, peelings, exfoliants.*

HAIR PRODUCTS

Bran · Green-broken-germs

Marc Seeds · Unripe grapes · Stalks

- *Shampoo, conditioner, nourishing creams*

BODY CARE

Green-broken-germs

Stalks · Unripe grapes

- *Deodorant, shower gel, liquid soap*

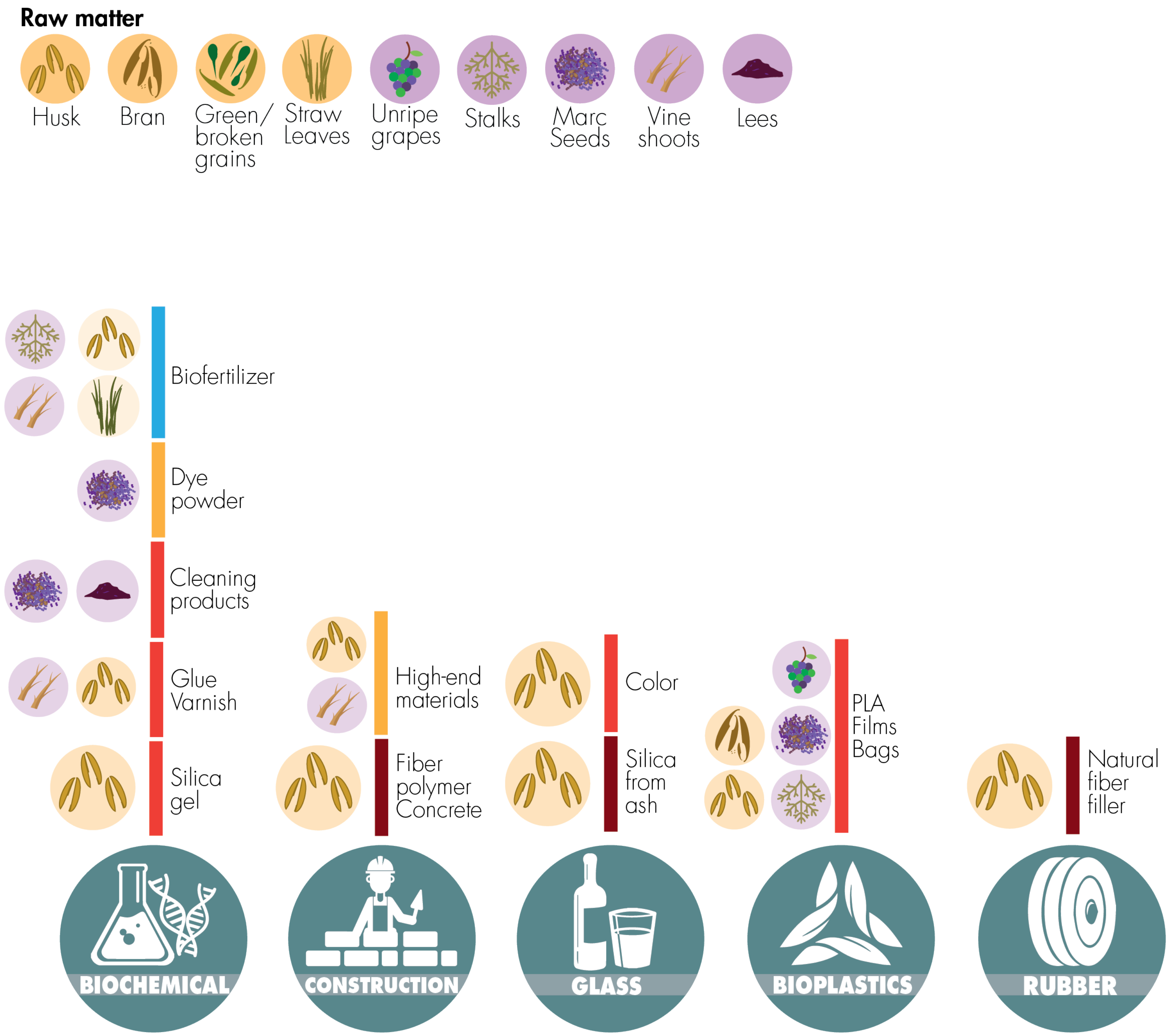
EXPERIMENTAL APPLICATIONS

Innovative employment of new raw matter

	NEW MATERIALS	
EXISTING PRODUCTS [PIONEERS]	**EXPERIMENTAL PHASE**	
• Silica gel sandpaper battery components • Fiberpolymer filler • Concrete	• Biofertilizer foliar fertilizer bioplaguicide • Cleaning products odorants • Silica gel aero-gel xero-gel insulators abrasives dessicants • Bioplastic Poly Lactic Acid films bags food packaging	• Paper • Cellulose pulp • Fiberboards • Ferrosilicon microsilica heat-blocker • Colored glass • Ceramic triaxial ceramics • Rubber filler • Dye powder • Textiles

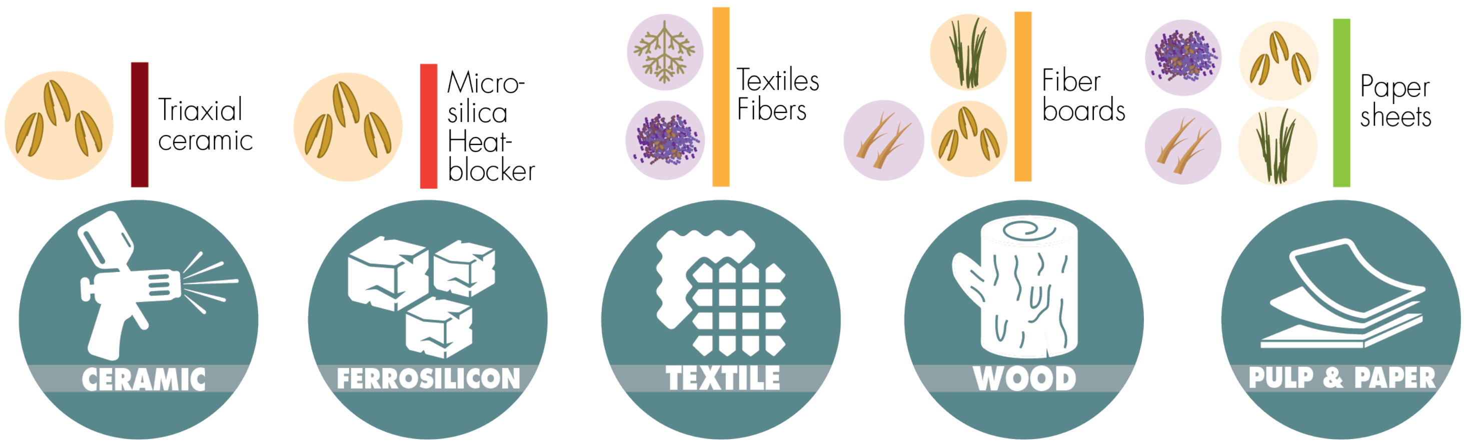
NEW MATERIALS

Raw matter quality after specific treatment



Raw matter treatment

Bacterial
Physical/ Mechanical
Pressure/ Thermal
Chemical
Incineration for ash



BIOCHEMICAL

SILICA GEL

Husk

- Thermal window **insulation**, **nontoxic** and nonflammable **Desiccant** to control humidity.
- **Pest control** agent.
- Acoustic barriers.
- **Abrasives** like sandpaper.
- *Aero-gel (solvent is removed), xero-gel (aqueous in pores is evaporated), sandpaper, window and door insulator*

BIOFERTILIZER

Straw

Stalks · Marc Seeds · Vine shoots

- Introduced with food waste for **vermicompost** with Eisenia foetida earthworms.
- High concentration of **macronutrientes** like nitrogen, potassium, phosphorus, iron, copper, zinc.
- Increases **porosity** and increases **permeability** of soils.

GLUE AND VARNISH

Green-broken-germs

Vine shoots

- Remarkable **fixation** of soft surfaces as paper or tissue. Its acids do **not degrade** the material.
- **Clear-finished**.
- Water-soluble.
- Handcraft applications.

BIOPLASTIC

BIOPLASTIC

Bran · Husk · Green-broken-germs

Stalks · Marc Seeds · Unripe grapes

- Acts as an ethylene **scavenger** and provide **protection** against physical damage.
- **Glucose** and **lactic acid** extraction from starch.
- Poly Lactic Acid plastic.
- *Films, bags, food packaging*

WOOD

FIBERBOARDS

Straw Husk

Vine shoots

- Open structure of the **bagasse** pores make easier the **penetration** of substances when being transformed.
- Mixed with active carbon, the **cellulose fibers** can produce a high-quality pulp.
- Contribute to reduce local **deforestation** and landscape degradation.
- Production of thin **medium- and high-density** fiberboards
- Obtain **natural resine for reach compaction**
- *Firewood*

RUBBER

FILLER

Husk

- Improve **hardness** but decrease tensile strength.
- Decreases rubber **cure time**.
- Natural filler as ash.

CONSTRUCTION

NATURAL FIBERPOLYMER COMPOSITE

Husk Straw

- Competitive mechanical properties in **straw-clay** composites.
- Low cost, **low density**.

CONCRETE

Husk Straw

- Mechanical properties and water **permeability**.
- Replacing **cement** based matter.
- **Ash** in its **natural** state.
- Sodium Silicate compound.

FERROSILICON

HEAT-BLOCKER

Straw Husk

- Silica extraction improve physical properties like **corrosion**. Increase **hardness** and steel **strength**.
- Silicon **semiconductor** in electric practices.
- High-temperature **resistance**.
- **Microsilica** production.
- Resistance to **abrasion**.
- *Stainless steel, carbon steel, cast iron*

CERAMIC

CERAMIC PIECES

Husk

- Decrease porosity promoting an improvement in **mechanical strength**.
- Reduce **fragility** reinforced with a steel fibre.
- **Silica** extraction from ash.

TRIAXIAL CERAMICS

Husk

- Ash is **raw material** for fluxing and **inert** materials as feldspar and quartz.

TEXTILE

TEXTILE & FIBERS

Marc Seeds Stalks

- **Textile and agro-food** production as part of of innovative fibers.
- **Less polluting** processes than synthetic fabrics.

PULP & PAPER

PAPER

Straw Husk

Vine shoots Marc Seeds

- Open structure of the **bagasse** pores make easier the **penetration** of substances when being transformed.
- Mixed with active carbon, the **cellulose fibers** can produce a high-quality pulp.

GLASS

COLORED GLASS

Husk

- Enough **refractive** index and **uv-visible absorption** spectra.
- Silica extraction.

EXPERIMENTAL APPLICATIONS

Innovative employment of new raw matter

RESOURCES

EXISTING PRODUCTS [PIONEERS]

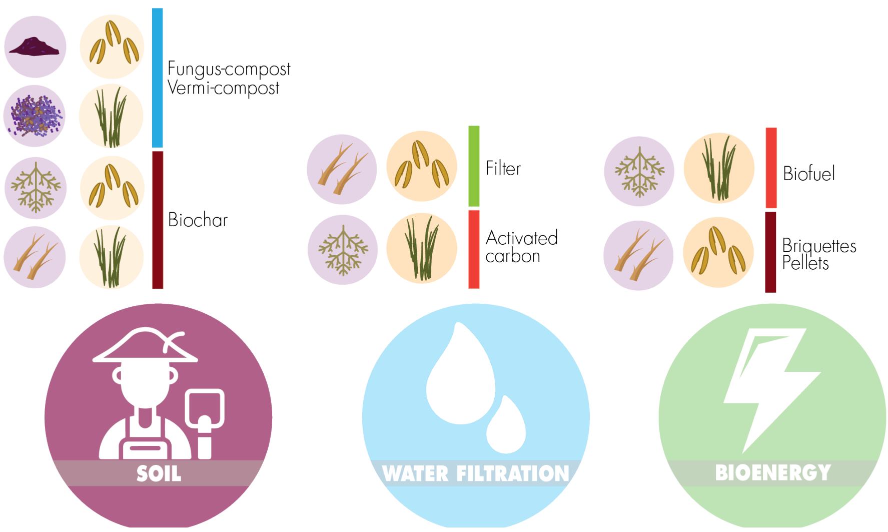
- Compost
- Vermicompost
  - hummus
  - earthworm breeding
- Biochar
- Water purificator
  - husk filter
  - activated carbon
- Briquettes
- Pellets
- Second-generation fuel

EXPERIMENTAL PHASE

- Mulching
- Fungus compost
  - cattle fodder

NEW MATERIALS

Raw matter quality after specific treatment



MULCHING

Straw Husk

Vine shoots

- Provide little or **no nutrients**. Weed seeds require available nutrients to establish.
- **Preserves water** it in the substrate.
- Get dry quickly after irrigation.
- Resist **decomposition**.

FUNGUS COMPOST

Straw

Vine shoots

- Stabilize **organic matter** to improve properties for animal **nutrition**.
- Recalcitrant compounds **degradation**.
- **Nutrients** release.
- Suitable substrate for **bacteria** growing.
- *Cattle fodder*

VERMI-COMPOST

Husk Straw

Vine shoots Marc Seeds Lees Stalks

- Contaminants and higher saturation of nutrients reduction.
- Prevent **nutrients** for washing away when watering.
- Added as **soil conditioner**, keeps **moisture** easier.
- Rich in **microbial** life.
- **Water-soluble** nutrients.
- *Hummus, earthworm breeding*

BIOCHAR

Husk Straw

Lees

- Porous charchoal in charge of water and nutrients **retention**.
- Holds **carbon** molecules resistant to degradation.

BIOENERGY

BRIQUETTES

Husk
Vine shoots

- Finer particles of the by-product assure greater **durability** because use less **water** for the transformation.
- Generate **heat** by combustion, gasification and/or pyrolysis.
- **Co-digestion** with food waste yield higher **biogas**.
- Dry under **ambient** conditions improve **hardness**.
- High silica concentration.

PELLETS

Straw
Husk
Vine shoots
Stalks

- **Compacted** matter improve rice husk handling and **storage**.
- Combustion treatments **reinforced** with other organic fibers.
- Feed **decentralized** energy systems.
- **Durable** and stable.

BIOFUEL

Straw
Husk
Vine shoots
Marc Seeds
Lees
Stalks
Unripe grapes

- Second generation **biofuels**.
- Biomass is **flexible** when being submitted to **chemical** processes for producing liquid fuels, electric power or **biobased** products.
- Intermediate **source** for hydrogen, methanol and synthetic hydrocarbon fuels.
- *Syngas, bioethanol*

WATER TREATMENT

FILTERS

Husk

Vine shoots

- Low-cost **adsorbent** of useful **phosphorus** that can be used in **soil preparation**.
- Removal of heavy **metals**, phenols and some **pesticides** compounds.
- Functional groups able to remove metals with **minimal** costs.
- Carbonization (**pyrolysis**) treat raises oil absorption capacity.

ACTIVATED CARBON

Straw

Vine shoots

Stalks

- Low-volume **pores** capable of oil and **substances** absorption.
- **Insoluble** in water and organic solvents.
- Metal absorption.

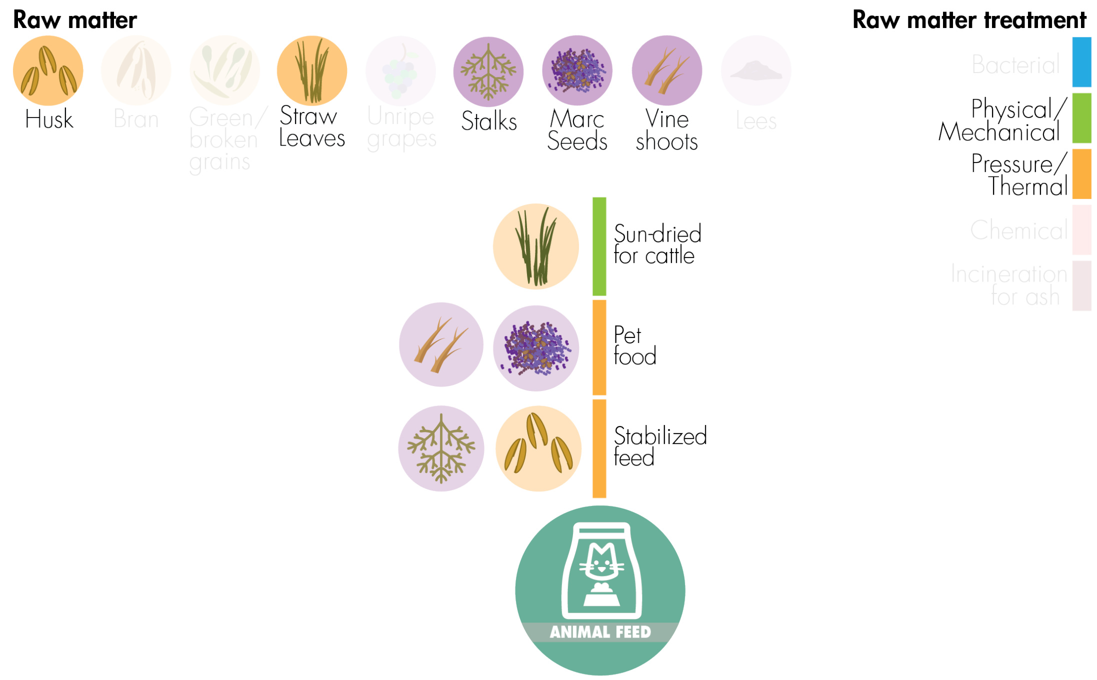
EXPERIMENTAL APPLICATIONS

Innovative employment of new raw matter

ANIMAL FEED	
EXISTING PRODUCTS [PIONEERS]	**EXPERIMENTAL PHASE**
• Animal feed cattle poultry pig	• Animal feed crackers biscuits

ANIMAL FEED

Raw matter quality after specific treatment



ANIMAL FEED

ANIMAL FEED

- **Defatted** bran (after removing phytic acid) contains high nutritional content for **animals**.
- Higher dry matter **digestibility** mixed with phytase addition.
- Extracting powder and crystal starch allows the obtention of **proteins**.
- High content of **proteins** and phenolic compounds as nutritional factors.

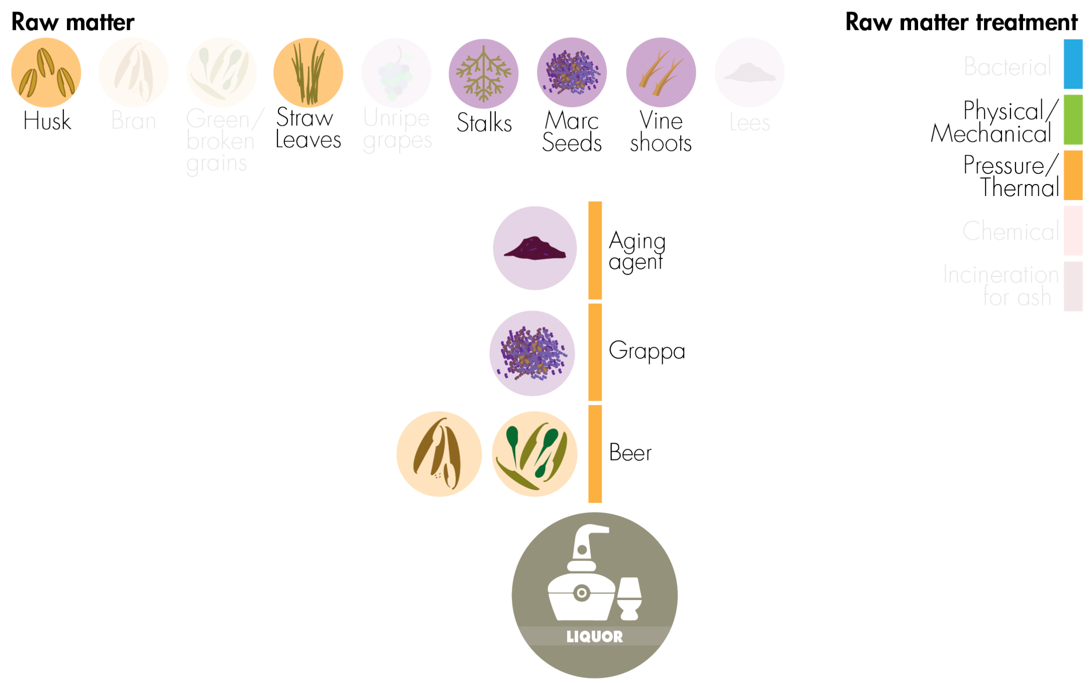
EXPERIMENTAL APPLICATIONS

Innovative employment of new raw matter

LIQUORS	
EXISTING PRODUCTS [PIONEERS]	**EXPERIMENTAL PHASE**
• Beer • Grappa	• Fermentation substrate aging agent

LIQUOR

Raw matter quality after specific treatment

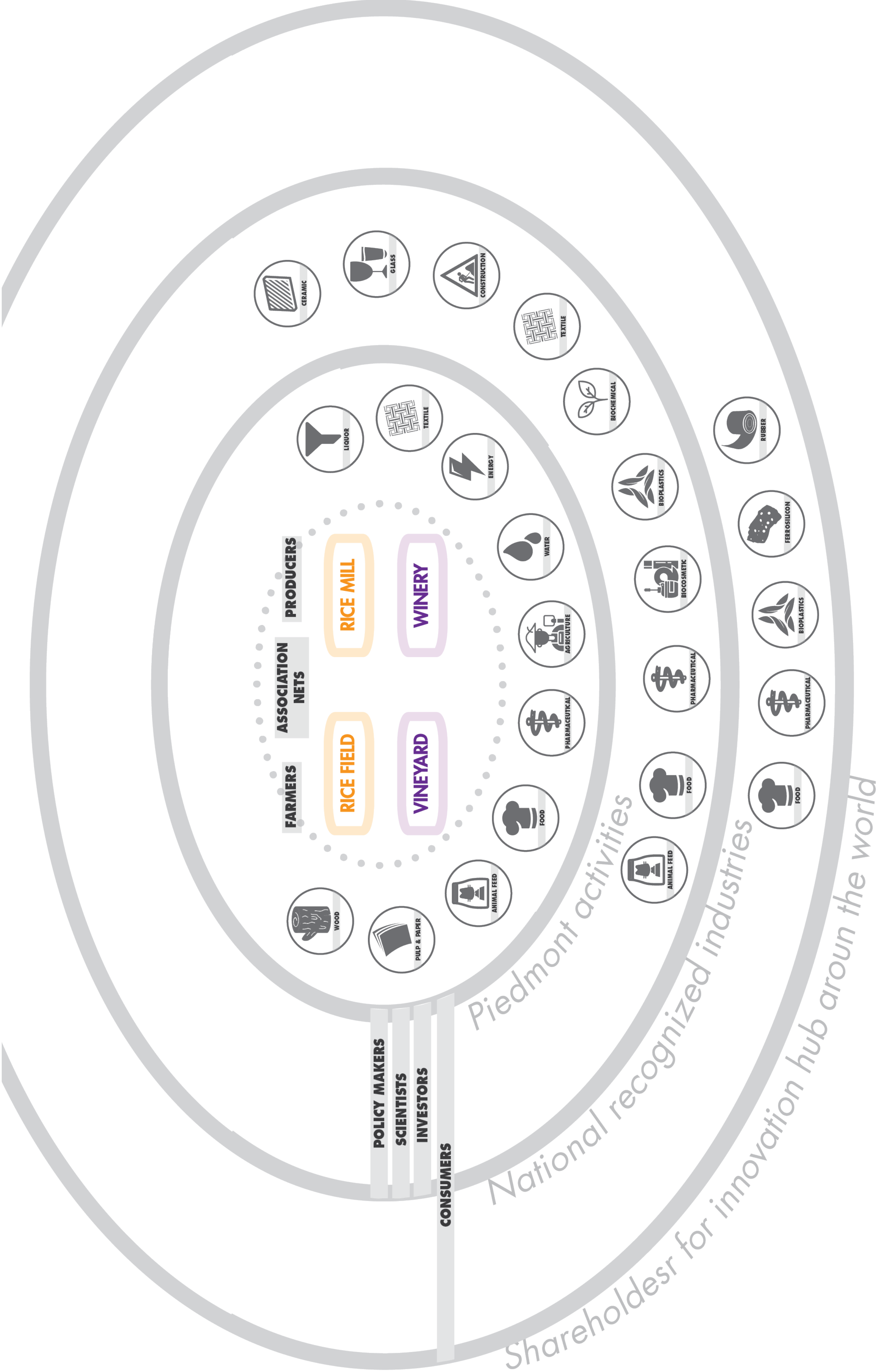


LIQUOR

BEER

- Replace existing **filters** with matter **fermented** by other microoganisms.
- Saccarose collection from starch **gelatinization** due to microbial activity during fermentation.
- Fermentation allowed by the high content of **carbohydrates**, protein and fat.
- Approximately 21 varieties of **amino-acids**, 9 of **organic acids**, **vitamins** and esters.
- High nutritional value.
- Adding lees to the wine fermentation process contribute to the **color and body** of the wine.
- Separation of **seeds** from the grape marc allows the pressing and distillation for the production of grappa.
- Stalks are new options for filtration after fermentation process

6.3. Stakeholders



7. Evaluating spaces for innovation

7.1. Simple Multi Attribute Rating Technique [SMART]

For doing an accurate evaluation of the analyzed applications, the decision-making tool recognized as SMART was the chosen instrument in order to value the real potential of each of the industries within the territory. With the SMART is possible to examine the entire group of alternatives or attributes, in this case the possible industries were the applications will get alive.

By giving qualitative criteria, at the end of the process it will appear an overall weight for each of the industries that represents the real percentage at the moment of perform in the different criteria aspects.

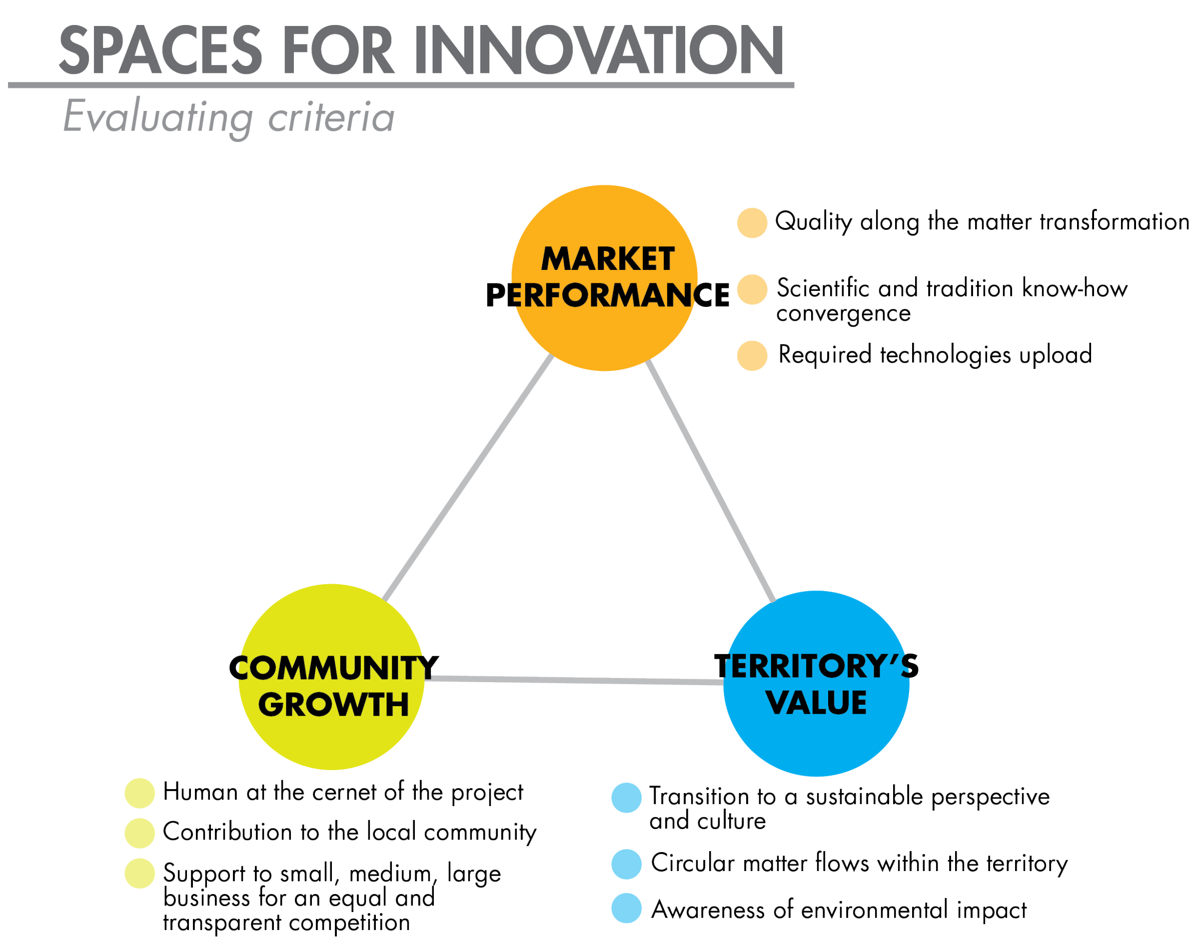
The value to every criterion was gave from the members of the groups after considerate the relevance of the evaluating statements at the moment of reaching the main objectives of this study. In this order of ideas, there were three spaces for innovation in which the sustainable applications can participate called "Market's performance", "Community growth" and finally "Territory's value". The mentioned before cover nine main statements considered as the goals that every industry had to satisfy.

The spaces for innovation were integrated with a in deep checklist not shown in this document where each of the possible industries had a level of importance depending the percentage they full-filled when being evaluated with requirements specially wrote from the systemic design and the circular economy principles.

It could be mentioned that the criteria weight was not a result of a quantitative rational process, but as a direct consequence of the project and the applications' satisfaction levels formerly presented.

After having the criteria weight, it was necessary to sum all the values and then divide it by the single grade, called the normalized weight. For this because when filling the matrix (Appendix 8) a new multiplication was required between the normalized weight and each single attribute of each category.

The second part of the process consist on summing up the totals of each industry and obtaining the big total of the attribute relevance when trying to appreciate in a numeric way



differences between the eighteen different new sectors of possible interventions for business.

As shown in the matrix, it is possible to perceive the individual performance and value given to the totality of the analyzed attributes during the entire document. At the end of the evaluation, it is possible to perceive that even if there are not high difference between the applications possibilities, the nutraceutical category leads the classification. Treating organic matter as fundamental raw material of all the new processes, a new world is open in everyone's kitchen, or at least of those who try to preserve their healthy and help with the social security problems.

The positive aspect of this data not being so different between themselves, is that in a systemic approach the creation of nods, nets and connections between people, matter and territory should try to be always equal and balanced.

SPACES FOR INNOVATION

Community Growth. Criteria evaluated requirements

HUMAN AT THE CENTER OF THE PROJECT	. Ensure **healthy lifestyles** and wellbeing. . Reduce the number of deaths and illnesses due to hazardous **chemicals** remains in the air, water or soil. . Protect **labour rights**. . Promote safe and secure working environments. . Make **informed purchases** about what people is buying. . Provide adequate information through quality **standarized** and labeled product. . Quality is paid but the product is still **affordable**.
CONTRIBUTION TO THE LOCAL COMMUNITY	. Quality of life and environment improve by new and local **industries growth**. . **Soil recovery** lowering surface and underground impact. . Promotion and diffusion of sustainable products with **local raw matter**. . Engange society through **awareness**-raising and **education** on sustainable consumption and lifestyles.
SUPPORT TO SMALL, MEDIUM, LARGE BUSINESS FOR AN EQUAL AND TRANSPARENT COMPETITION	. **Up-to-date** registers that show the needed, produced and sold product in the market. . Available information for planned stocks in order to diminish market's volatile **changes**. . Increase productivity of small-scale food producers by incluiding **equal** access to land, technology, know-how, investment capital and **opportunities**. . Allow **policies** creation supporting productive activities, entrepreneurship, creativity and innovation. . Sustain national **economic development** because of diversified products and technological effectiveness. . Promote inclusive and sustainable industrialization and job vacancies. . Affordable **access for all**, from producer to consumers. . Allow infrastructure investment capacity by individuals or **associated** producers. . Scalable use and maintainance of sustainable, like energy-efficiency technologies and techniques. . Promote the creation of **new business** spaces. . Support economical **competition**. . Aware **energy consumption** could be sponsored by public or private institutions.

SPACES FOR INNOVATION

Territory's Value. Criteria evaluated requirements

TRANSITION TO A SUSTAINABLE PERSPECTIVE AND CULTURE	. Contribute to the obtaintion of a affordable, **reliable** and sustainable **production system**. . Expand and offer job opportunities while not straining land and resources. . Propose a **quality of life** improvement.
CIRCULAR MATTER FLOWS WITHIN THE TERRITORY	. Respect **resilient ecosystems** without reducing productivity. . Recover **traditional** seed varieties and **diversity**. . Contribute to **nutritious diets** and/or lifestyles. . Support resilient **farming** systems and their surroundings communities. . Lighten up the pressure and land impact when getting the raw material.
REQUIRED TECHNOLOGIES UPLOAD	. Provide **quality products** for all the actors involved and create fair **income distribution** taking care of the planet. . Respect temperature, differenciation and emission control; according to the **Paris Agreement** resigned guidelines. . Value chains reduce desertification risks as part of the Italian new National Energy Strategy. . Use r**enewable energy** as part of a non-fossil fuel dependance. . Residues in resources capacity of being removed by natural flows. . Reduce released **emissions** to atmosphere.

SPACES FOR INNOVATION

Market Performance. Criteria evaluated requirements

Criteria	Requirements
QUALITY ALONG THE MATTER TRANSFORMATION	. Consider the actual **state** of raw matter in every moment of the process. . Discriminate production by environmental and social impact. . Products, services and processes are not hazardous for the **ecosystem actors**. . Processes ensure access to affordable, reliable and efficient materials from other activities in **external systems**. . Give **value** to the **treated matter**. . Describe consumption and production **new patterns**.
SCIENTIFIC AND TRADITION KNOW-HOW CONVERGENCE	. Scientific development does not handle the total quality of the seeds. Importance to **protect** the **genetic diversity** at every step of the chain. . Intensify scientific research without discriminate traditional varieties. . Make easier to understand that without a balanced traditional know-how and a correct use of new technologies the sustainable industrialization could not be done.
AWARNESS OF ENVIRONMENTAL IMPACT	. Lead to **prioritize investment** on energy efficient practices. . Open the dialogue to discern between the needed machines for individual **acquisition** (farmer or mill owner) and the opportunity to **share** a certain percentage of the machinery. . Enable **gradual introduction** of reliable and sustainable technologies for distributing the **economic** investment. . Adopted technologies increase yield and welfare along the lifecycle.

EVALUATING CRITERIA

Simple Multi Attribute Rating Technique
SMART

1 WORSE — 2 — 3 — 4 — 5 BETTER

CRITERIA	ANIMAL FEED	LIQUOR	FOOD	PHARMACEUTICAL	BIOCOSMETIC	GLASS	CERAMIC	BIOCHEMICAL	BIOPLASTICS	CONSTRUCTION	FERROSILICON	RUBBER	TEXTILE	WOOD	PAPER	SOIL	WATER	ENERGY
Human at the cernet of the project	1	1	5	5	5	1	1	5	3	2	3	1	4	3	2	4	4	3
Contribution to the local community	3	3	5	5	5	2	2	5	5	4	3	2	5	5	3	5	4	4
Support to small, medium, large business for an equal and transparent competition	4	4	4	3	4	3	3	5	4	4	3	3	5	4	4	5	5	4
Transition to a sustainable perspective and culture	2	3	5	4	4	3	3	4	4	5	5	3	4	5	4	4	4	3
Circular matter flows within the territory	4	4	5	5	5	3	3	5	5	4	5	3	5	3	3	4	5	4
Required technologies upload	3	3	4	3	4	2	2	2	3	3	3	3	4	3	2	4	3	2
Quality along the matter transformation	5	5	5	4	4	2	2	4	4	3	4	2	4	4	5	5	4	4
Scientific and tradition know-how convergence	5	4	4	2	3	1	1	2	3	2	2	1	4	3	3	3	4	4
Awareness of environmental impact	4	3	5	5	5	2	2	4	4	2	3	2	4	4	5	5	5	5
Overall Score	5.16%	5.05%	**7.25%**	6.43%	6.85%	3.27%	3.27%	6.38%	6.05%	4.95%	5.43%	3.47%	6.70%	5.72%	5.21%	6.79%	6.47%	5.56%

7.2. Intervention sectors ranking

After the evaluation of the characteristics of the different applications of the by-products on the individuated industries, it is possible the creation of a ranking that determines, according to the previous evaluation, which are the industries with biggest spaces for innovation, the ones with diversified production, the ones with less use of by-products for new applications and the self-sustainable production spaces.

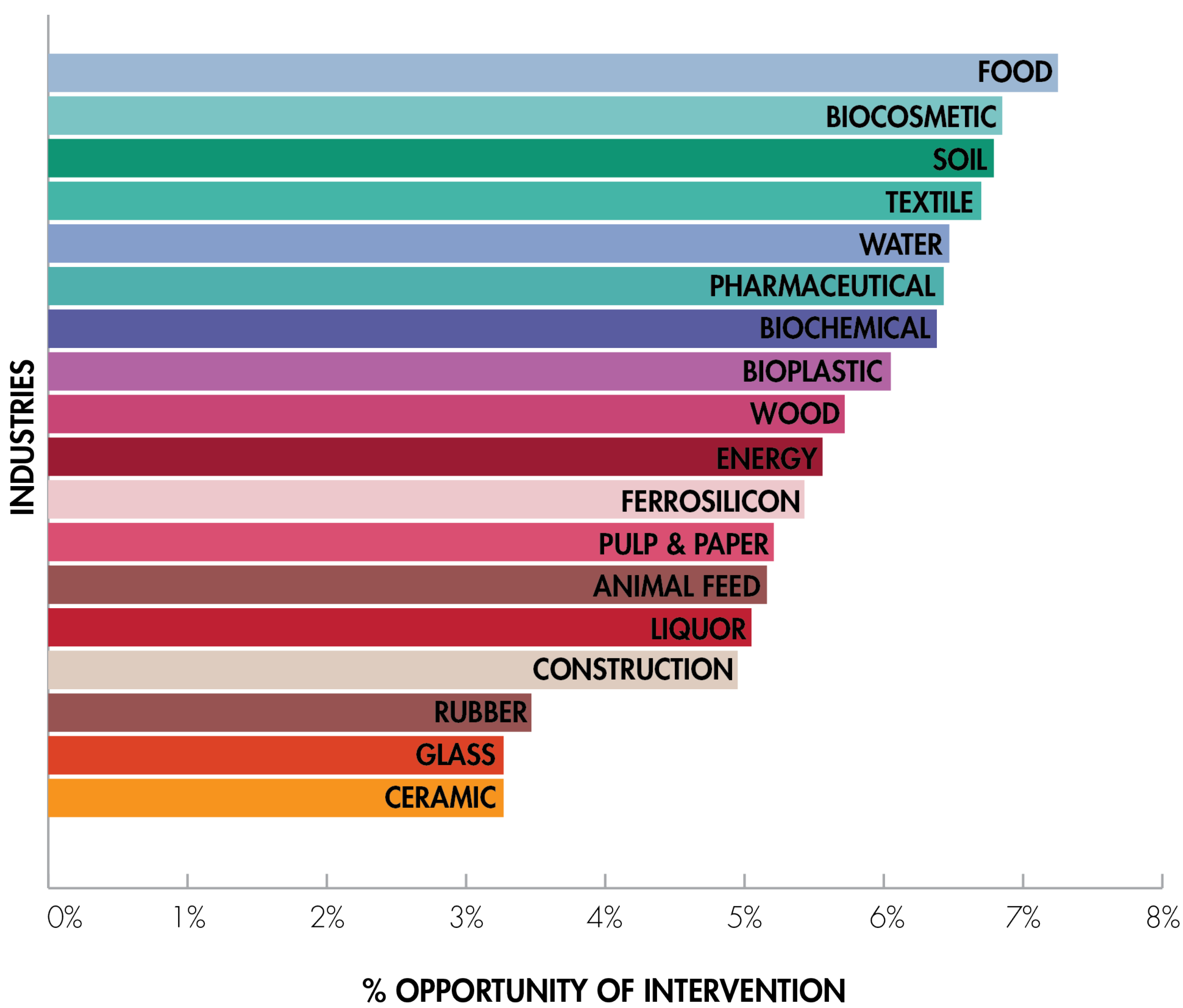
At the top of the ranking are placed the industries that, focused in sustainability, open the opportunity for innovation with a huge range of possibilities of generating new products and processes. Principally, the food industry is the one with the wider potential of intervention and where most of the by-products analyzed on this study can get a new value by exploiting in a positive way its components and characteristics. In the following level, are the industries where the application of the by-products is diversified, this means that there are possible interventions that can be done and that can have positive results, but in this level the raw material has to be treated in different ways or its content have to be decomposed for the derivation of secondary products.

At the bottom are present the industries where the minor quantity of by-products is used, are the ones that where suitable just for rice or for wine by-products, but there were no common aspects for possible new applications.

The last level, is conformed by the water and the energy resources, which are proposed as self-sustainable production spaces when introduced the systemic approach, in this way, the water can be used and filtrated in order to generate cycles and reduce the waste of it. Same occurs for the energy, which will be generated from the by-products obtained by the two systemic values chains.

NEW APPLICATIONS

Sectors' availability for local innovation
SMART evaluation results



EVALUATING CRITERIA

Criteria Ranking

7.3. New edible material experimentation

Taking into account the results of the evaluation of spaces for innovation, and with the obtained knowledge during this study, it has been done an experimentation that aims to open a new possibility of innovation and intervention in the food sector. The main objective of the experimentation was to elaborate edible dishes by using some of the main by-products of rice and wine value chains.

The first step was to investigate if there where some similar experimentations or products, and it was founded out a company in India, called BAKEYS, that produce edible cutlery with different cereals bran. BAKEYS (Figure 50) initiative started in 2010 as an alternative to disposable plastic and wood cutlery and today the have three different taste spoons. They don't only use the cereals, but they also add sugars and condiments in order to obtain different flavors and textures.

Figure 50: Edible spoons *Source: Bakeys*

After understanding the process that BAKEYS producers do for obtaining the edible cutlery, it was decided to officially experiment with the main by-products of this study. For the rice, it was selected the bran because of its nutritional properties and the possibility of stabilizing it at home with the use of the oven in order to make it suitable for consumption. By the other side, for the wine, the optimal by-product selected was the grape marc, also because of its high nutritional qualities and the presence of sugars for adding flavor and stickiness to the composition.

The rice bran used in the experiment was obtained from the Cascina Vigna in Vercelli, Piedmont. This farm has as one of its premises giving the best quality and experience to their clients. the bran provided was principally of three different types:

- Bran 1 obtained after paddy separation
- Bran 2 obtained after paddy separation
- Bran obtained after polishing milled rice

On the other hand, for obtaining the wine grape marc, it wasn't possible to obtain a minimum quantity of this by-product, because of this reason, it was decided to experiment with skins and seeds of commercial grapes, which properties are not exactly the same as wine grapes, but that can give a guide line for future experiments and procedures.

The process for obtaining the skins and seeds was by separating each berry from the stems, washing it and macerate them until all the juice and the pulp was completely extracted from the skins, which were strained and pressed in order to take all the liquids apart.

Once having ready the raw matter, it was done the experiment by mixing ingredients as follows:

Mixture 1:

120 g of Bran 3
100 ml of water (hot)
1 tablespoon of Vinegar
3 tablespoons of grape marc

Mixture 2:

100 g of Bran 2
50 ml of water (hot)
2 tablespoons of grape marc

Mixture 3:

100 g of Bran 3
50 ml of water (hot)
2 tablespoons of grape marc

Mixture 4:

100 g of Bran 1
70 ml of water (hot)
2 tablespoons of grape marc

For each mixture, the ingredients were all mixed up, placed in the mold and baked at 90°C for 20 minutes, then at 110°C for other 20 minutes and finally at 130°C up to the time when the consistence of each prototype was structured and dry.

After about 2 hours and a half, the prototypes where taken out from the oven and left for natural cooling and drying for one day. when the material was dried enough, the two best prototypes were polished in order to give them a better looking.

BRAN 1

BRAN 2

BRAN 3

GRAPE MARC

As a result, the best mixtures, taking into account the consistence, the flavor, the texture and the hardness of the material of the prototype, where Mixture 2 and Mixture 3.

Both of the prototypes present a good physical resistance, the have the proper hardness in order to be an edible material but also for resisting when placing other ingredients or objects on top of them.

In terms of flavor, both of the mixtures' flavor seems to be pleasant for the first bite, but later on, it gets slightly bitter. This could be fixed by the addition of other ingredients for the correction of flavors, as BAKEYS does on their cutlery.

Overall, the experiment was positive for proving that in fact there really are different and innovative options of creating new products with recuperated raw matter from different value chains.

Looking to the future of this experiment, it is important to mention the benefits that the edible cutlery can provide not only in environmental aspects, but also in social aspects. Being produced with rice bran and grape marc raw matter, and no needing such high interventions, it is estimated that the cost of this product shouldn't be very high. This is important because having an economic product with the nutritional properties that this one contains, can be a way of helping people in need of food.

Finally, i¬t is important to highlight that this experiment was done taking into account the literature obtained during all the study, but due to the fact, that the product from the tests are intended to be eaten, this experiment has to have deeper testing phases to prove that the components on it can be eaten safely.

Figure 51: Mixture 1 after seven days of being cooked.

Figure 52: Mixture 3 after seven days of being cooked.

Figure 53: Stackable dishes.

CONCLUSIONS

Agro-industries are always working because people eat every day. Also, because growing crops is an all year-round cycle that has to be labored in order to produce excellent commodities for handling matter transformation processes. Sadly, today's local rice and wine industries work under standardized parameters that focalize the attention in the quantity, thus quality is left as a dependent variable of the production's yield. Even so, the quality is apparently the reason of the purchase not only for the farmer who is cultivating the seed, but for who is buying the final product.

By precisely analyzing the matter flow in each of the studied chains, it was visible that a controlled process able to register how is treated the main input of the chain do not exist beyond monthly or biannual invoices. It means, apparently quality has been reduced to numbers, expenses and bill for being payed. And the tradition coming from centuries of making quality products in the territory is condensed in one or three organic or environmental friendly strategies without even knowing how these practices must be done.

After all the background study, it is necessary to recognize that small, medium and large companies have been preoccupied in finding new methods of being more sustainable, reason why the systemic approach designed for the rice and the wine chains results indispensable as a way of being more competitive. The three biggest conclusions of this work are:

Regeneration of the land in a natural flow. Allowing the creation of ecosystems that can regulate the stress caused by agro-industrial activities. Therefore, the main raw materials are going to be obtained, transformed and distribute in the territory, taking advantage of their properties in feasible and alternative processes. So, embracing the territory as a profitable scenario that holds the totality of the future exchanges and because of this, it deserves to be repositioned and managed as an indispensable resource of the process.

Quality is in the raw matter that producers are handling. By-products could be employed in a huge range of new applications because the amount of treated raw material is growing annually. With experiencing the changes proposed within time, the systemic approach seeks the investment in technology that increases the activities profit by giving a commercial value to material formerly used as waste. Market's recognition of what is produced locally gives value and reinforce the "Made in Italy" products. Then, every person during the process that had have contact with the raw material in any of the production stages will be appreciate. So, it is important to underline that the farmer should be seen as an agent looking forward for the consumers' welfare without living apart the network of business opportunities around his or her business hub, either it is wine or milled rice production.

Territory as a hub of new busisness and networks. Link the traditional sense of working the fields with the scientific advances is positive to increase yield and profits of all the properties and aptitudes of the raw material –or a high percentage of it, bringing in outstanding affordable products into the market. A step closer to getting into the new system is the proper integration of a new perspective, conceiving the local know-how and relations between farmers (and possible associates), as a collaborative economical strategy where all the involved actors are contributing and actively increasing the annual income by managing in a correct way dynamic living systems not only technical efficient monocultures.

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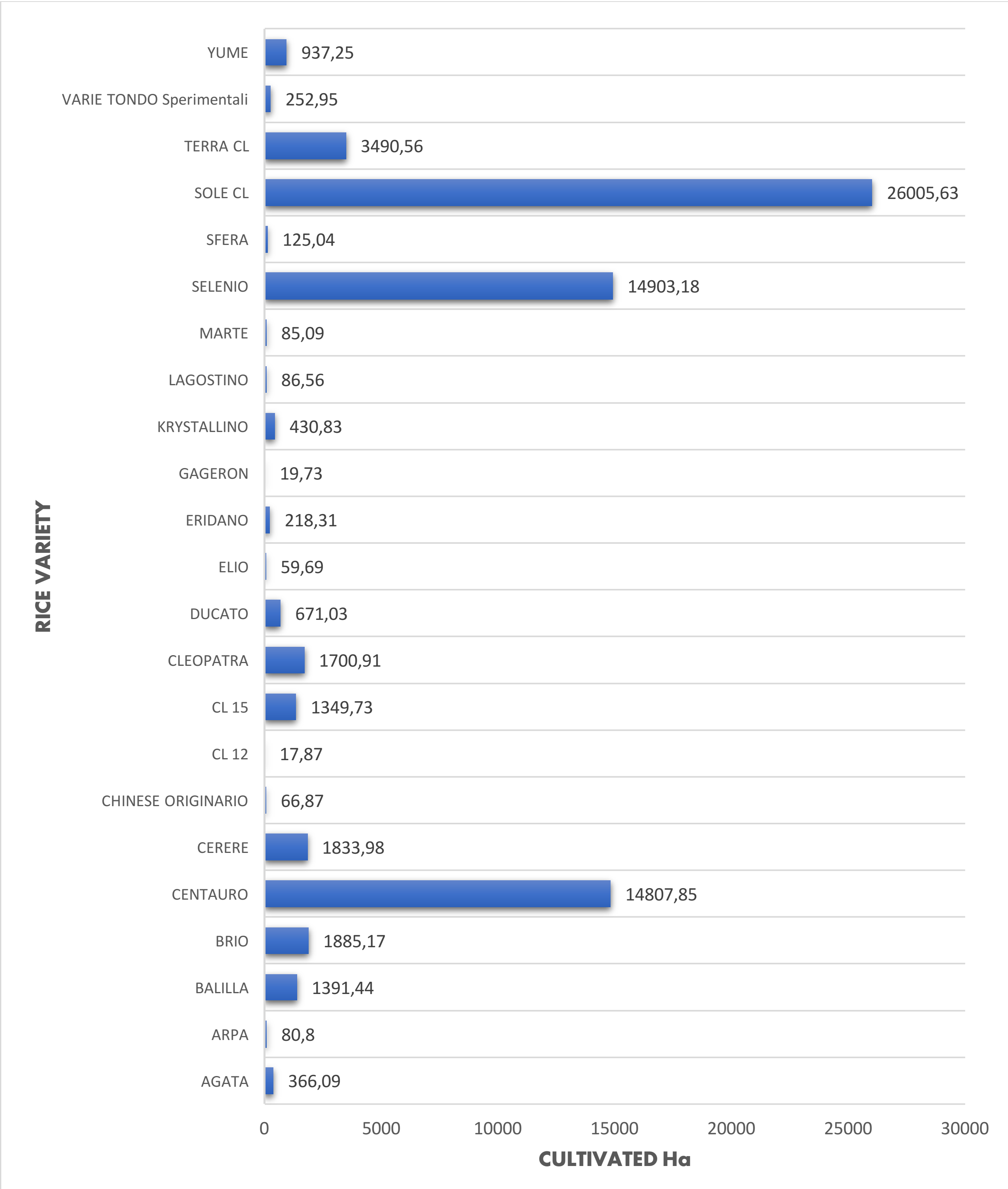
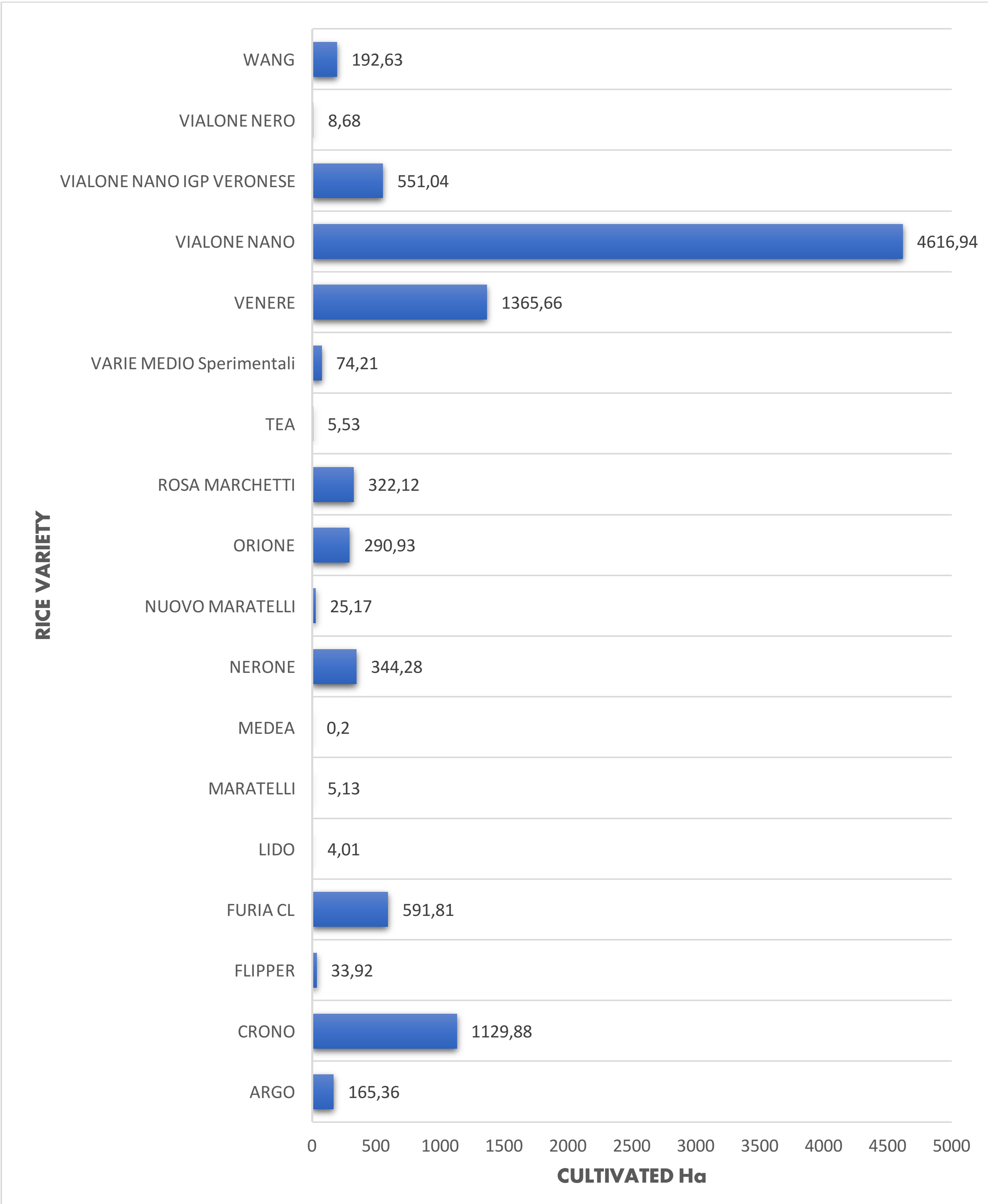
APPENDIX 1

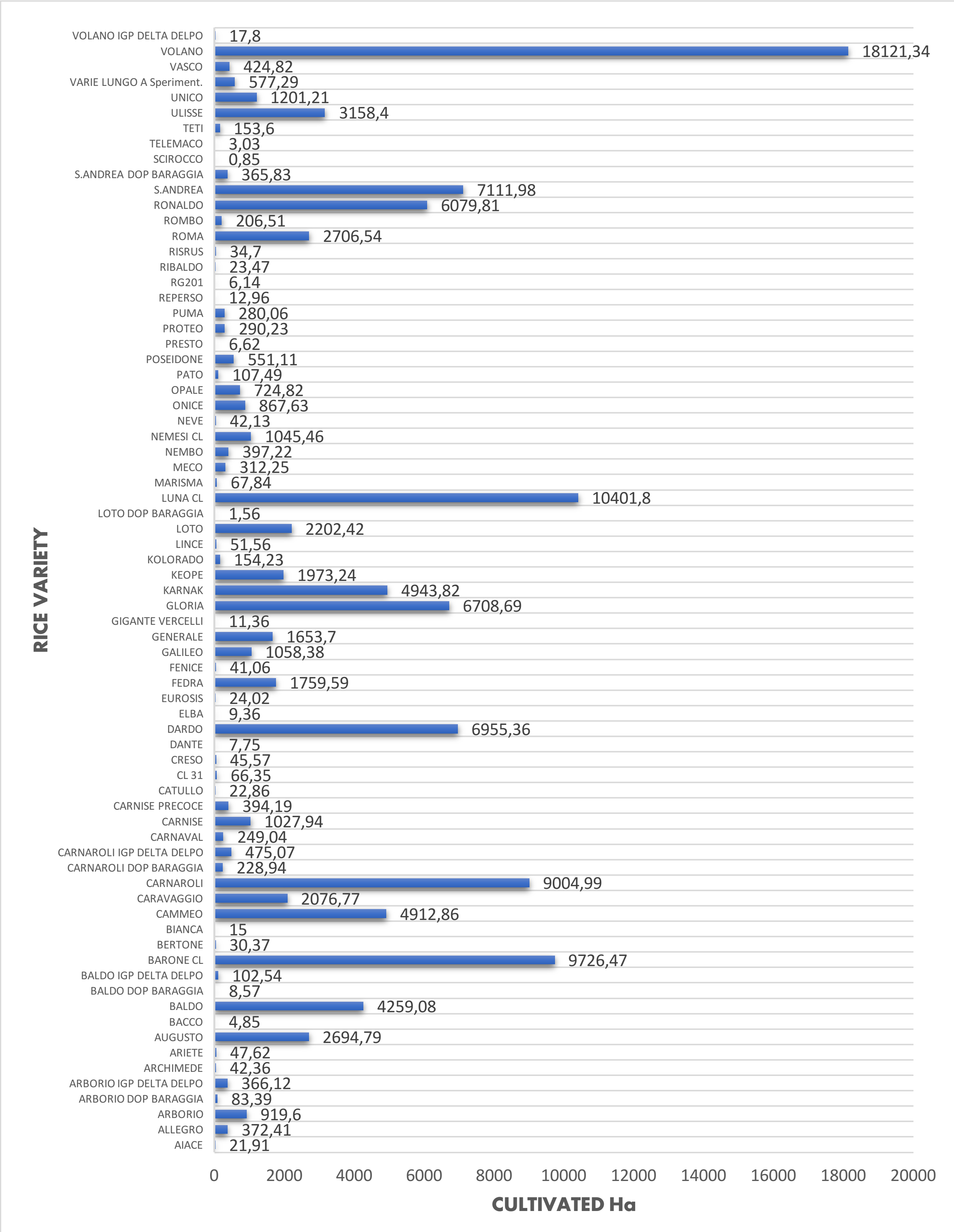
Italian "rounded" grain varieties cultivated area (ha) in 2016



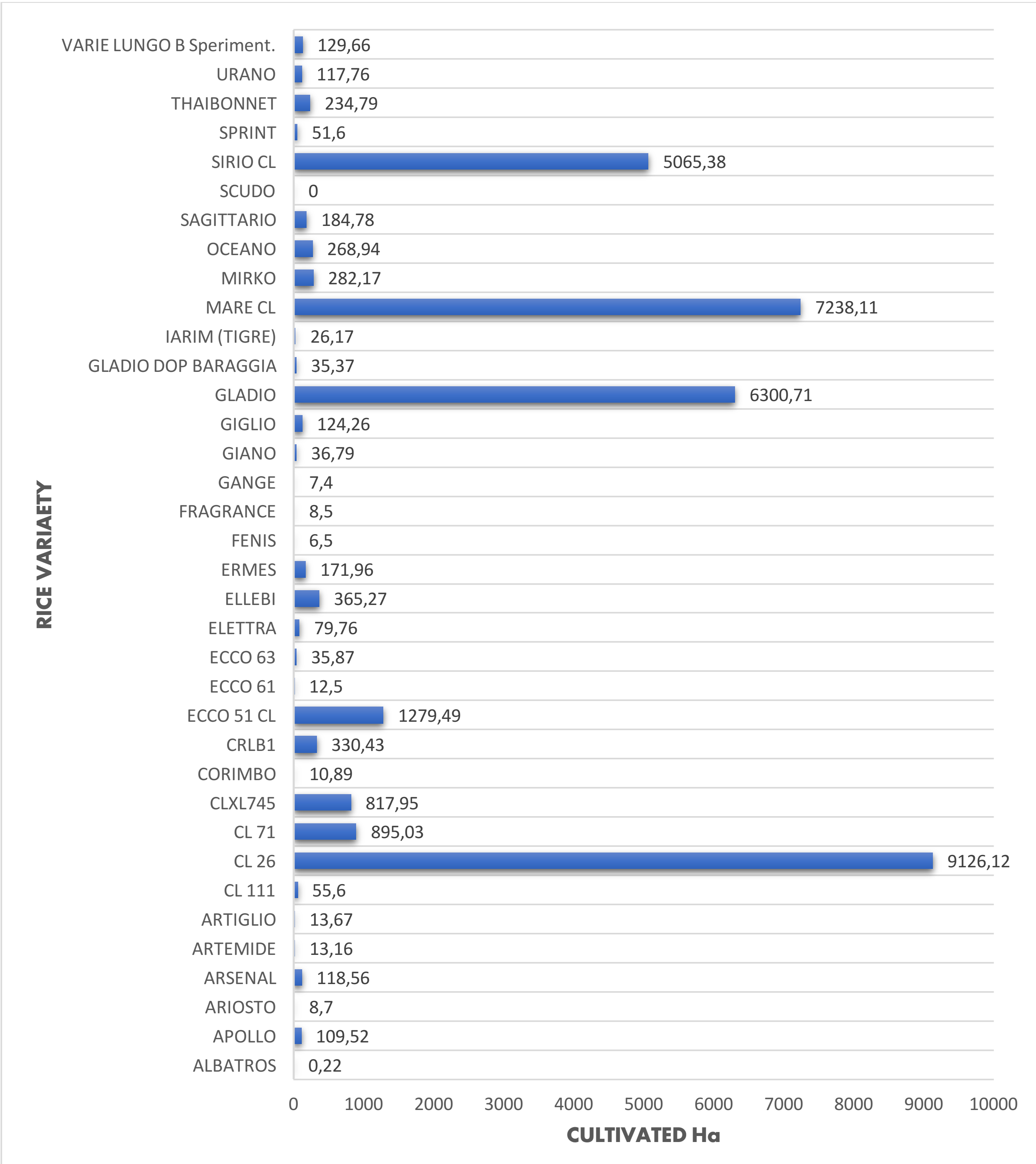
Italian "medium or semi-fine" grain varieties cultivated area (ha) in 2016



Italian “fine or Lungo-A” grain varieties cultivated area (ha) in 2016



Italian "super-fine or Lungo-B" grain varieties cultivated area (ha) in 2016



APPENDIX 2

Superfici investite a riso 2016 - dati espressi in ettari

Gruppo	Varieta	ALESSANDRIA	BIELLA	CUNEO	TORINO	VERCELLI	TOTALE SEZIONE VERCELLI	NOVARA	LODI	MILANO	Lomellina (A)	Pavese (B)	PAVIA (A+B)	CREMONA	TOTALE SEZIONE PAVIA
GRUPPO TONDO	BALILLA				3,39	166,58	169,97	183,70			1.013,77		1.013,77		1.013,77
	ELIO							59,69					-		
	SELENIO	473,51	126,09		25,00	1.395,82	2.020,42	1.772,41	129,78	458,95	8.963,47	758,91	9.722,38		10.311,11
	VARIE TONDO Sperimentali	37,00				73,28	110,28	38,34		6,99	90,68	0,26	90,94		97,93
	AGATA	32,92	5,72			54,61	93,25	39,09			228,16	5,59	233,75		233,75
	ARPA							58,80					-		
	BRIO	75,80	21,72			254,03	351,55	78,07		19,37	1.208,02	111,25	1.319,27		1.338,64
	CL 12									4,50	13,37		13,37		17,87
	CL 15	407,86	79,24			228,58	715,68	88,94		65,94	180,71	73,87	254,58		320,52
	CERERE	22,45	31,10			226,83	280,38	743,75	20,52	28,91	718,57	35,35	753,92		803,35
	CHINESE ORIGINARIO					23,83	23,83	2,01			41,03		41,03		41,03
	CENTAURO	326,80	184,17			6.896,65	7.407,62	4.320,03	24,48	135,81	2.792,02	72,78	2.864,80		3.025,09
	CLEOPATRA					96,18	96,18	1.090,61			483,33	30,79	514,12		514,12
	DUCATO	56,37			18,12	201,25	275,74	162,47			186,26	29,37	215,63		215,63
	ERIDANO					100,11	100,11	85,17			31,42		31,42		31,42
	KRYSTALLINO					414,73	414,73	0,78			15,32		15,32		15,32
	GAGERON					14,62	14,62	5,11					-		
	LAGOSTINO										84,56	2,00	86,56		86,56
	MARTE									85,09			-		85,09
	SOLE CL	828,41	352,27		26,83	7.630,23	8.837,74	5.243,64	15,24	1.174,86	10.072,91	594,82	10.667,73		11.857,83
	SFERA					49,19	49,19	23,65			16,70		16,70		16,70
	TERRA CL	151,01	27,00			958,23	1.136,24	824,23		34,50	1.390,45	43,73	1.434,18		1.468,68
	YUME	43,00				266,64	309,64	156,69			375,79	88,62	464,41		464,41
GRUPPO TONDO Totale		2.455,13	827,31		73,34	19.051,39	22.407,17	14.977,18	190,02	2.014,92	27.906,54	1.847,34	29.753,88		31.958,82
GRUPPO LIDO	CRONO	28,01	9,52			574,91	612,44	397,81			57,92	61,71	119,63		119,63
	FLIPPER					33,92	33,92						-		
	TEA							5,30			0,23		0,23		0,23
	LIDO												-		
	FURIA CL	7,33				214,35	221,68	59,76		17,69	292,68		292,68		310,37
	ROSA MARCHETTI		10,23			143,76	153,99	7,72			0,23	160,18	160,41		160,41
	WANG					162,74	162,74	28,80			1,09		1,09		1,09
GRUPPO LIDO Totale		35,34	19,75			1.129,68	1.184,77	499,39		17,69	352,15	221,89	574,04		591,73
GRUPPO PADANO	ARGO										28,31		28,31		28,31
	ORIONE		37,72			134,14	171,86	83,51				35,56	35,56		35,56
	NUOVO MARATELLI	4,00				21,17	25,17						-		
	MEDEA										0,20		0,20		0,20
GRUPPO PADANO Totale		4,00	37,72			155,31	197,03	83,51			28,51	35,56	64,07		64,07
VIALONE NANO Totale		26,33	11,45			80,37	118,15	110,46	16,03	116,01	1.582,86	613,44	2.196,30		2.328,34
GRUPPO VARIE MEDIO	VIALONE NERO											8,68	8,68		8,68
	VARIE MEDIO Sperimentali					59,67	59,67	6,62			3,99	3,93	7,92		7,92
	MARATELLI							5,13					-		
	NERONE					283,64	283,64	54,77			5,87		5,87		5,87
	VENERE					665,19	665,19	277,08		10,00	195,80		195,80		205,80
GRUPPO VARIE MEDIO Totale						1.008,50	1.008,50	343,60		10,00	205,66	12,61	218,27		228,27

Superfici investite a riso 2016 - dati espressi in ettari

Gruppo	Varieta	MANTOVA	BOLOGNA	FERRARA	MODENA	REGGIO EMILIA	PARMA	PIACENZA	PADOVA	ROVIGO	VENEZIA	VERONA	VICENZA	UDINE	GORIZIA	GROSSETO	SIENA	COSENZA	CAGLIARI	MEDIO CAMPIDANO	ORISTANO	SIRACUSA	ENNA	TOTALE SEZIONE CODIGORO	TOTALE NAZIONALE	Varieta
GRUPPO TONDO	BALILLA																				23,00	1,00		24,00	1.391,44	BALILLA
	ELIO																								59,69	ELIO
	SELENIO	27,47								11,20											760,57			799,24	14.903,18	SELENIO
	VARIE TONDO Sperimentali		1,40																	5,00				6,40	252,95	VARIE TONDO Sperimentali
	AGATA																								366,09	AGATA
	ARPA																			22,00				22,00	80,80	ARPA
	BRIO																		35,00		81,91			116,91	1.885,17	BRIO
	CL 12																								17,87	CL 12
	CL 15																				224,59			224,59	1.349,73	CL 15
	CERERE																				5,00	1,50		6,50	1.833,98	CERERE
	CHINESE ORIGINARIO																								66,87	CHINESE ORIGINARIO
	CENTAURO																	22,00			33,11			55,11	14.807,85	CENTAURO
	CLEOPATRA																								1.700,91	CLEOPATRA
	DUCATO		3,17																		14,02			17,19	671,03	DUCATO
	ERIDANO		1,61																					1,61	218,31	ERIDANO
	KRYSTALLINO																								430,83	KRYSTALLINO
	GAGERON																								19,73	GAGERON
	LAGOSTINO																								86,56	LAGOSTINO
	MARTE																								85,09	MARTE
	SOLE CL																				66,42			66,42	26.005,63	SOLE CL
	SFERA																				35,50			35,50	125,04	SFERA
	TERRA CL																				61,41			61,41	3.490,56	TERRA CL
	YUME		6,51																					6,51	937,25	YUME
GRUPPO TONDO Totale		27,47	12,69							11,20								22,00	35,00	27,00	1.305,53	2,50		1.443,39	70.786,56	GRUPPO TONDO Totale
GRUPPO LIDO	CRONO																								1.129,88	CRONO
	FLIPPER																								33,92	FLIPPER
	TEA																								5,53	TEA
	LIDO		0,20	3,81																				4,01	4,01	LIDO
	FURIA CL																								591,81	FURIA CL
	ROSA MARCHETTI																								322,12	ROSA MARCHETTI
	WANG																								192,63	WANG
GRUPPO LIDO Totale			0,20	3,81																				4,01	2.279,90	GRUPPO LIDO Totale
GRUPPO PADANO	ARGO			112,68						16,45			7,92											137,05	165,36	ARGO
	ORIONE																								290,93	ORIONE
	NUOVO MARATELLI																								25,17	NUOVO MARATELLI
	MEDEA																								0,20	MEDEA
GRUPPO PADANO Totale				112,68						16,45			7,92											137,05	481,66	GRUPPO PADANO Totale
VIALONE NANO Totale		776,87		71,19	45,00				33,74	32,98	6,08	1.597,87	31,30	16,00										2.611,03	5.167,98	VIALONE NANO Totale
GRUPPO VARIE MEDIO	VIALONE NERO																								8,68	VIALONE NERO
	VARIE MEDIO Sperimentali																								74,21	VARIE MEDIO Sperimentali
	MARATELLI																								5,13	MARATELLI

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Gruppo	Varieta	ALESSANDRIA	BIELLA	CUNEO	TORINO	VERCELLI	TOTALE SEZIONE VERCELLI	NOVARA	LODI	MILANO	Lomellina (A)	Pavese (B)	PAVIA (A+B)	CREMONA	TOTALE SEZIONE PAVIA
GRUPPO LOTO - ARIETE	LOTO	5,50	328,34	120,17	18,68	1.201,27	1.673,96	170,43	-	-	240,48	23,58	264,06		264,06
	ARIETE					11,21	11,21				0,25		0,25		0,25
	AUGUSTO	124,51	47,40			600,68	772,59	1.118,34		196,70	594,94	12,22	607,16		803,86
	CRESO					45,57	45,57						-		
	DARDO	174,64	182,40	9,50		3.799,04	4.165,58	2.527,50			242,52	5,63	248,15		248,15
	EUROSIS												-		
	LINCE	43,80					43,80	7,76					-		
	NEMBO	79,71	20,57	16,89	3,43	168,98	289,58	57,61			50,03		50,03		50,03
	OPALE	27,77	174,10			212,00	413,87	116,56		15,86	126,03		126,03		141,89
	PUMA	19,17				61,00	80,17	57,11			142,78		142,78		142,78
	RONALDO	64,51	173,66			3.443,02	3.681,19	1.034,17			1.235,79		1.235,79		1.235,79
	SCIROCCO										0,85		0,85		0,85
	LUNA CL	1.172,98	62,73			3.384,80	4.620,51	704,23		403,42	3.508,49	373,27	3.881,76		4.285,18
	MECO		9,53			66,92	76,45	180,38		19,00	23,92		23,92		42,92
	ONICE	124,17				380,84	505,01	162,45			147,96	15,71	163,67		163,67
	PRESTO					6,62	6,62						-		
	ROMBO	34,32	23,48			54,70	112,50	73,26			20,75		20,75		20,75
	ARCHIMEDE	1,59				27,77	29,36					3,00	3,00		3,00
	CL 31	31,00				26,00	57,00				9,35		9,35		9,35
	NEMESI CL	90,00				251,76	341,76	6,00		151,86	468,82	77,02	545,84		697,70
	DANTE												-		
	CATULLO					22,86	22,86						-		
	UNICO	16,00	8,97			1.101,11	1.126,08	39,34			35,79		35,79		35,79
	FENICE	24,94				-	24,94	15,12					-		
	TETI					47,67	47,67	105,71			0,22		0,22		0,22
	RG201			5,35			5,35						-		
	RIBALDO		2,28			4,57	6,85	3,80		0,32	3,50		3,50		3,82
	VASCO		16,00			270,75	286,75	16,49			121,58		121,58		121,58
GRUPPO LOTO - ARIETE Totale		2.034,61	1.049,46	151,91	22,11	15.189,14	18.447,23	6.396,26		787,16	6.974,05	510,43	7.484,48		8.271,64
S.ANDREA	ALLEGRO	7,00	9,00			270,74	286,74	48,29			37,38		37,38		37,38
	S.ANDREA	140,11	867,48	-	-	2.416,84	3.424,43	658,55	-	100,46	3.085,69	207,18	3.292,87		3.393,33
S.ANDREA Totale		147,11	876,48			2.687,58	3.711,17	706,84		100,46	3.123,07	207,18	3.330,25		3.430,71
GRUPPO BALDO	BALDO	186,23	42,69	0,57	0,38	299,14	529,01	90,69	140,63	483,56	1.288,25	1.110,77	2.399,02		3.023,21
	BIANCA							15,00					-		
	GALILEO					489,69	489,69	291,99			157,56		157,56		157,56
	CAMMEO	245,14	30,12			1.348,44	1.623,70	262,75		467,47	851,06	373,86	1.224,92		1.692,39
	NEVE					42,13	42,13						-		
	PROTEO					88,54	88,54	32,25			119,64	6,80	126,44		126,44
GRUPPO BALDO Totale		431,37	72,81	0,57	0,38	2.265,94	2.771,07	692,68	140,63	951,03	2.416,51	1.491,43	3.907,94		4.999,60
GRUPPO ROMA	ROMA	18,60				520,39	538,99	173,14	34,27	121,60	892,48	946,06	1.838,54		1.994,41
	ELBA							9,36					-		
	FEDRA	49,20	6,86			814,89	870,95	808,47			80,17		80,17		80,17
	BACCO					2,85	2,85	2,00					-		
	BARONE CL	223,36	271,97		2,77	2.781,00	3.279,10	1.120,48	64,63	1.535,88	2.318,59	1.003,41	3.322,00		4.922,51
GRUPPO ROMA Totale		291,16	278,83		2,77	4.119,13	4.691,89	2.113,45	98,90	1.657,48	3.291,24	1.949,47	5.240,71		6.997,09
GRUPPO ARBORIO	ARBORIO	10,80	62,20		9,50	197,42	287,92	48,16	45,09	100,69	209,45	125,79	335,24		481,02
	VOLANO	98,00	-	-	-	224,54	322,54	99,51	731,23	5.041,51	3.955,65	6.345,92	10.301,57		16.074,31
	GENERALE	48,55				162,26	202,81	83,82	73,37	177,75	334,02	434,99	769,01		1.020,13
GRUPPO ARBORIO Totale		157,35	62,20		9,50	584,22	813,27	231,49	849,69	5.319,95	4.499,12	6.906,70	11.405,82		17.575,46
GRUPPO CARNAROLI	CARAVAGGIO	28,21				53,70	81,91	67,36	181,16	174,89	489,51	740,28	1.229,79		1.585,84
	CARNAROLI	68,20	186,26	27,52	33,73	1.222,04	1.537,75	600,18	377,25	1.030,66	2.092,42	2.420,74	4.513,16		5.921,07
	KARNAK	22,13				186,81	208,94	101,03	80,46	330,57	748,92	1.060,16	1.809,08		2.220,11
	CARNISE PRECOCE					14,48	14,48	27,22	42,22	93,86	33,86	164,12	197,98		334,06
	CARNISE	16,00				423,96	439,96	61,24	5,89	71,92	215,43	15,00	230,43		308,24
	POSEIDONE		19,18			202,57	221,75	12,00	26,96	42,54	54,24	13,00	67,24		136,74
	KEOPE	10,00				81,27	91,27	21,33	98,47	302,87	405,63	1.019,93	1.425,56		1.826,90
	CARNAVAL	6,47				72,26	78,73	45,00		22,68	40,69	11,50	52,19		74,87
GRUPPO CARNAROLI Totale		151,01	205,44	27,52	33,73	2.257,09	2.674,79	935,36	812,41	2.069,99	4.080,70	5.444,73	9.525,43		12.407,83
GRUPPO VARIE LUNGO A	AIACE					21,91	21,91						-		
	BERTONE					18,29	18,29	6,00			4,12	1,96	6,08		6,08
	VARIE LUNGO A Speriment.	49,10	6,20			260,34	315,64	54,21		20,36	82,89	39,82	122,71		143,07
	GIGANTE VERCELLI					0,15	0,15				9,71		9,71		9,71
	GLORIA	613,27	93,57			3.664,74	4.371,58	802,03		34,85	1.361,05	102,40	1.463,45		1.498,30
	KOLORADO					143,91	143,91				10,32		10,32		10,32
	MARISMA					31,51	31,51				36,33		36,33		36,33
	TELEMACO							3,03					-		
	PATO		48,99			58,50	107,49						-		
	REPERSO					12,96	12,96						-		
	RISRUS	1,65	2,50				4,15	7,76			22,79		22,79		22,79
	ULISSE	13,50				57,69	71,19	299,20	135,43	544,54	423,06	727,13	1.150,19		1.830,16
GRUPPO VARIE LUNGO A Totale		677,52	151,26			4.270,00	5.098,78	1.172,23	135,43	599,75	1.950,27	871,31	2.821,58		3.556,76

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Gruppo	Varieta	MANTOVA	BOLOGNA	FERRARA	MODENA	REGGIO EMILIA	PARMA	PIACENZA	PADOVA	ROVIGO	VENEZIA	VERONA	VICENZA	UDINE	GORIZIA	GROSSETO	SIENA	COSENZA	CAGLIARI	MEDIO CAMPIDANO	ORISTANO	SIRACUSA	ENNA	TOTALE SEZIONE CODIGORO	TOTALE NAZIONALE	Varieta
GRUPPO LOTO - ARIETE	LOTO	-	13,14	-	43,10	-	1,22	-	-	28,00	-	-	-	-	0,45	9,62	-	-	-	-	-	-		95,53	2.203,98	LOTO
	ARIETE																				36,16			36,16	47,62	ARIETE
	AUGUSTO																								2.694,79	AUGUSTO
	CRESO																								45,57	CRESO
	DARDO																				14,13			14,13	6.955,36	DARDO
	EUROSIS		1,10																		22,92			24,02	24,02	EUROSIS
	LINCE																								51,56	LINCE
	NEMBO																								397,22	NEMBO
	OPALE																				52,50			52,50	724,82	OPALE
	PUMA																								280,06	PUMA
	RONALDO																			53,26	75,40			128,66	6.079,81	RONALDO
	SCIROCCO																								0,85	SCIROCCO
	LUNA CL			182,31						53,00										26,45	530,12			791,88	10.401,80	LUNA CL
	MECO																				11,00	1,50		12,50	312,25	MECO
	ONICE																			36,50				36,50	867,63	ONICE
	PRESTO																								6,62	PRESTO
	ROMBO																								206,51	ROMBO
	ARCHIMEDE															10,00								10,00	42,36	ARCHIMEDE
	CL 31																								66,35	CL 31
	NEMESI CL																								1.045,46	NEMESI CL
	DANTE		0,35							7,40														7,75	7,75	DANTE
	CATULLO																								22,86	CATULLO
	UNICO																								1.201,21	UNICO
	FENICE		1,00																					1,00	41,06	FENICE
	TETI																								153,60	TETI
	RG201		0,79																					0,79	6,14	RG201
	RIBALDO									9,00														9,00	23,47	RIBALDO
	VASCO																								424,82	VASCO
GRUPPO LOTO - ARIETE Totale			16,38	182,31	43,10		1,22			97,40					0,45	19,62				116,21	742,23	1,50		1.220,42	34.335,55	GRUPPO LOTO - ARIETE Totale
S.ANDREA	ALLEGRO																								372,41	ALLEGRO
	S.ANDREA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,50		1,50	7.477,81	S.ANDREA
S.ANDREA Totale																						1,50		1,50	7.850,22	S.ANDREA Totale
GRUPPO BALDO	BALDO	-	-	668,09	-	-	-	-	-	51,79	-	-	-	-	-	6,40	-	-	-	-	-	1,00		727,28	4.370,19	BALDO
	BIANCA																								15,00	BIANCA
	GALILEO	19,33																			99,81			119,14	1.058,38	GALILEO
	CAMMEO		62,21	1.182,02						85,91			3,88											1.334,02	4.912,86	CAMMEO
	NEVE																								42,13	NEVE
	PROTEO			45,00																				45,00	290,23	PROTEO
GRUPPO BALDO Totale		19,33	62,21	1.895,11						137,70			3,88			6,40					99,81	1,00		2.225,44	10.688,79	GRUPPO BALDO Totale
GRUPPO ROMA	ROMA																								2.706,54	ROMA
	ELBA																								9,36	ELBA
	FEDRA																								1.759,59	FEDRA
	BACCO																								4,85	BACCO
	BARONE CL			261,62						33,10											109,66			404,38	9.726,47	BARONE CL
GRUPPO ROMA Totale				261,62						33,10											109,66			404,38	14.206,81	GRUPPO ROMA Totale
GRUPPO ARBORIO	ARBORIO	-	-	515,97	30,00	6,04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		552,01	1.369,11	ARBORIO
	VOLANO	42,79	7,41	1.357,09	-	-	-	58,09	-	78,76	-	84,95	7,69	-	-	-	-	-	-	-	6,00	-		1.642,78	18.139,14	VOLANO
	GENERALE	2,00		16,73						65,96		24,74				25,29		41,28			170,94			346,94	1.653,70	GENERALE
GRUPPO ARBORIO Totale		44,79	7,41	1.889,79	30,00	6,04		58,09		144,72		109,69	7,69			25,29		41,28			176,94			2.541,73	21.161,95	GRUPPO ARBORIO Totale
GRUPPO CARNAROLI	CARAVAGGIO		26,47	103,59						56,00						121,15		34,45						341,66	2.076,77	CARAVAGGIO
	CARNAROLI	261,56	-	548,88	10,00	-	-	0,44	37,72	80,36	107,62	505,86	60,37	-	-	-	-	-	-	17,00	20,19	-		1.650,00	9.709,00	CARNAROLI
	KARNAK	117,08		1.439,40	120,42					45,66	39,77	157,76	3,60			34,53		455,52						2.413,74	4.943,82	KARNAK
	CARNISE PRECOCE																				18,43			18,43	394,19	CARNISE PRECOCE
	CARNISE			138,25						43,00			6,75								30,50			218,50	1.027,94	CARNISE
	POSEIDONE			129,70																	50,92			180,62	551,11	POSEIDONE
	KEOPE			17,91												2,40		13,43						33,74	1.973,24	KEOPE
	CARNAVAL			24,78								18,00						7,66						50,44	249,04	CARNAVAL
GRUPPO CARNAROLI Totale		378,64	26,47	2.402,51	130,42			0,44	37,72	225,02	147,39	681,62	70,72			158,08		511,06		17,00	120,04			4.907,13	20.925,11	GRUPPO CARNAROLI Totale
GRUPPO VARIE LUNGO A	AIACE																								21,91	AIACE
	BERTONE																								30,37	BERTONE
	VARIE LUNGO A Speriment.		1,78	2,00								8,93								32,00	19,66			64,37	577,29	VARIE LUNGO A Speriment.
	GIGANTE VERCELLI											1,50												1,50	11,36	GIGANTE VERCELLI
	GLORIA																				36,78			36,78	6.708,69	GLORIA
	KOLORADO																								154,23	KOLORADO
	MARISMA																								67,84	MARISMA
	TELEMACO																								3,03	TELEMACO
	PATO																								107,49	PATO
	REPERSO																								12,96	REPERSO
	RISRUS																								34,70	RISRUS
	ULISSE			757,12				29,65		103,94		53,60	13,54											957,85	3.158,40	ULISSE
GRUPPO VARIE LUNGO A Totale			1,78	759,12				29,65		103,94		64,03	13,54							32,00	56,44			1.060,50	10.888,27	GRUPPO VARIE LUNGO A Totale

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Gruppo	Varieta	ALESSANDRIA	BIELLA	CUNEO	TORINO	VERCELLI	TOTALE SEZIONE VERCELLI	NOVARA	LODI	MILANO	Lomellina (A)	Pavese (B)	PAVIA (A+B)	CREMONA	TOTALE SEZIONE PAVIA
	THAIBONNET					75,74	75,74	116,29			42,76		42,76		42,76
	GANGE							2,72					-		
	GLADIO	177,36	3,31	15,58	-	3.965,46	4.161,71	1.056,85	-	-	936,20	15,90	952,10		952,10
	ALBATROS										0,22		0,22		0,22
	FRAGRANCE												-		
	VARIE LUNGO B Speriment.	11,00	5,35			30,76	47,11	40,78			40,47		40,47		40,47
	CLXL745	88,79				30,06	118,85	50,42	58,91	48,64	528,93	12,20	541,13		648,68
	APOLLO					89,74	89,74	7,07		0,33			-		0,33
	ARIOSTO					7,60	7,60						-		
	ARTEMIDE					4,16	4,16	9,00					-		
	ARSENAL		31,18			87,38	118,56						-		
	ARTIGLIO					2,29	2,29	11,38					-		
	CL 26	842,22	201,68			5.466,16	6.510,06	1.308,32		61,94	1.049,32	148,98	1.198,30		1.260,24
	CL 71	189,00				220,99	409,99	148,73			274,63	61,68	336,31		336,31
	CL 111					-	-	16,30			27,56		27,56		27,56
	CORIMBO					10,69	10,69				0,20		0,20		0,20
	CRLB1	66,12				181,74	247,86	57,72			22,51	2,34	24,85		24,85
GRUPPO LUNGO B	ECCO 51 CL	149,83	22,34			644,34	816,51	29,83		35,67	368,98	28,50	397,48		433,15
	ECCO 61					8,00	8,00				4,50		4,50		4,50
	ECCO 63					8,00	8,00				27,87		27,87		27,87
	ELETTRA		3,05			26,35	29,40	17,90		5,58	16,13		16,13		21,71
	ELLEBI	21,00				95,87	116,87	56,79			138,61		138,61		138,61
	ERMES					76,03	76,03	39,43			33,00		33,00		33,00
	FENIS	6,50					6,50						-		
	GIGLIO	2,00				64,64	66,64	35,63			20,99		20,99		20,99
	GIANO					36,63	36,63				0,16		0,16		0,16
	MARE CL	170,22	26,06			2.934,36	3.130,64	1.390,70		56,22	2.488,44		2.488,44		2.544,66
	MIRKO					187,93	187,93	57,05			37,19		37,19		37,19
	OCEANO					131,93	131,93	39,30			96,71		96,71		96,71
	SAGITTARIO					139,83	139,83				43,34		43,34		43,34
	SCUDO					-	-						-		
	SIRIO CL	197,57	41,58			2.716,03	2.955,18	811,62		39,42	1.202,16	32,86	1.235,02		1.274,44
	SPRINT					38,60	38,60				13,00		13,00		13,00
	IARIM (TIGRE)					22,17	22,17	-				4,00	4,00		4,00
	URANO					11,43	11,43	47,78		6,55			-		6,55
GRUPPO LUNGO B Totale		1.921,61	334,55	15,58		17.314,91	19.586,65	5.351,61	58,91	254,35	7.413,88	306,46	7.720,34		8.033,60
TOTALE COMPLESSIVO		8.332,54	3.927,26	195,58	141,83	70.113,26	82.710,47	33.614,06	2.302,02	13.898,79	63.824,56	20.418,55	84.243,11		100.443,92
Superfici 2015/2016		7.948,86	3.949,25	194,65	135,81	69.709,50	81.938,07	33.001,40	1.849,17	13.266,86	61.762,02	18.365,32	80.127,34	1,00	95.244,37
%		5%	-1%	0%	4%	1%	1%	2%	24%	5%	3%	11%	5%	-100%	5%
numero produttori		167	67	9	6	1.011	1.260	552	69	300	1.100	415	1.515		1.884

Superfici investite a riso 2016 - dati espressi in ettari

Gruppo	Varieta	MANTOVA	BOLOGNA	FERRARA	MODENA	REGGIO EMILIA	PARMA	PIACENZA	PADOVA	ROVIGO	VENEZIA	VERONA	VICENZA	UDINE	GORIZIA	GROSSETO	SIENA	COSENZA	CAGLIARI	MEDIO CAMPIDANO	ORISTANO	SIRACUSA	ENNA	TOTALE SEZIONE CODIGORO	TOTALE NAZIONALE	Varieta
	THAIBONNET																								234,79	THAIBONNET
	GANGE																				4,68			4,68	7,40	GANGE
	GLADIO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	139,00	-	-	-	26,42	-		165,42	6.336,08	GLADIO
	ALBATROS																								0,22	ALBATROS
	FRAGRANCE																			6,50	2,00			8,50	8,50	FRAGRANCE
	VARIE LUNGO B Speriment.		1,30																					1,30	129,66	VARIE LUNGO B Speriment.
	CLXL745																								817,95	CLXL745
	APOLLO																				12,38			12,38	109,52	APOLLO
	ARIOSTO		1,10																					1,10	8,70	ARIOSTO
	ARTEMIDE																								13,16	ARTEMIDE
	ARSENAL																								118,56	ARSENAL
	ARTIGLIO																								13,67	ARTIGLIO
	CL 26																				47,50			47,50	9.126,12	CL 26
	CL 71																								895,03	CL 71
	CL 111																				11,74			11,74	55,60	CL 111
	CORIMBO																								10,89	CORIMBO
	CRLB1																								330,43	CRLB1
GRUPPO LUNGO B	ECCO 51 CL																								1.279,49	ECCO 51 CL
	ECCO 61																								12,50	ECCO 61
	ECCO 63																								35,87	ECCO 63
	ELETTRA																				10,75			10,75	79,76	ELETTRA
	ELLEBI																			25,00	28,00			53,00	365,27	ELLEBI
	ERMES																				23,50			23,50	171,96	ERMES
	FENIS																								6,50	FENIS
	GIGLIO		1,00																					1,00	124,26	GIGLIO
	GIANO																								36,79	GIANO
	MARE CL																		25,00		147,11			172,11	7.238,11	MARE CL
	MIRKO																								282,17	MIRKO
	OCEANO															1,00								1,00	268,94	OCEANO
	SAGITTARIO		1,61																					1,61	184,78	SAGITTARIO
	SCUDO																								-	SCUDO
	SIRIO CL																				24,14			24,14	5.065,38	SIRIO CL
	SPRINT																								51,60	SPRINT
	IARIM (TIGRE)																								26,17	IARIM (TIGRE)
	URANO																			52,00				52,00	117,76	URANO
GRUPPO LUNGO B Totale			5,01													1,00	139,00		25,00	83,50	338,22			591,73	33.563,59	GRUPPO LUNGO B Totale
TOTALE COMPLESSIVO		1.247,10	132,15	7.600,37	248,52	6,04	1,22	88,18	71,46	802,51	153,47	2.453,21	135,05	16,00	0,45	210,39	139,00	574,34	60,00	275,71	3.144,23	6,50		17.365,90	234.134,35	TOTALE COMPLESSIVO
Superfici 2015/2016		1.281,16	129,70	7.204,39	266,09	2,98	-	-	93,50	1.102,74	183,63	2.403,30	109,80	11,50	-	325,10	135,72	465,08	-	314,50	3.112,09	-	4,00	17.145,28	227.329,12	Superfici 2015/2016
%		-3%	2%	5%	-7%	103%		#DIV/0!	-24%	-27%	-16%	2%	23%	39%		-35%	2%	23%		-12%	1%			1%	3%	%
numero produttori		67	3	230	15	1	1	3	3	19	1	105	11	1	1	10	1	7	1	5	83	1		569	4.265	numero produttori

APPENDIX 3

Main world vineyards[1,a]

thousands of ha	2012	2013	2014	2015	2016	Variation 2016/2012 in kha
Spain	969	973	975	974	975	6
China	706	757	796	830	847	141
France	792	793	789	785	785	-7
Italy	713	705	690	682	690	-22
Turkey	497	504	502	497	480	-17
USA	430	449	448	443	443	13
Argentina	222	224	226	225	224	2
Iran	226	223	223	223	223	-3
Chile	206	208	213	214	214	8
Romania	192	192	192	191	191	-1
Portugal	231	224	219	199	190	-41
Australia	162	157	154	149	148	-15
Moldova	142	137	140	140	140	-2
South Africa	135	133	132	130	130	-5
Uzbekistan	121	122	127	127	127	6
India	120	119	120	120	120	0
Greece	110	110	110	107	105	-5
Germany	102	102	102	103	102	0
Brazil	91	90	89	85	85	-6
Algeria	74	74	74	74	74	0
Egypt	71	69	69	69	69	-2
Hungary	52	56	62	68	68	16
Bulgaria	67	68	66	67	67	0
Russia	62	62	63	63	63	2
Serbia	44	54	54	54	54	10
Morocco	48	49	49	49	49	1
Georgia	48	48	48	48	48	0
Austria	44	44	45	45	46	2
New Zealand	38	38	38	39	39	1
Peru	26	28	32	32	32	6
Mexico	29	29	29	30	32	3
World	7463	7 523	7 533	7 515	7 516	53

Sources: OIV, OIV Experts, Trade Press

a): Countries with area under vine of more than 32 kha

APPENDIX 4

Wine production

million of hl	2012	2013	2014	2015[b]	2016[c]	2016/2015 Variation in volume	2016/2015 Variation in %
Italy	45.6	54.0	44.2	50.0	50.9	0.9	2%
France	41.5	42.1	46.5	47.0	43.5	-3.5	-7%
Spain	31.1	45.3	39.5	37.7	39.3	1.7	4%
USA[d]	21.7	24.4	23.1	21.7	23.9	2.2	10%
Australia	12.3	12.3	11.9	11.9	13.0	1.1	9%
China	13.5	11.8	11.6	11.5	11.4	-0.1	-1%
South Africa	10.6	11.0	11.5	11.2	10.5	-0.7	-6%
Chile	12.6	12.8	10.0	12.9	10.1	-2.7	-21%
Argentina	11.8	15.0	15.2	13.4	9.4	-3.9	-29%
Germany	9.0	8.4	9.2	8.9	9.0	0.1	1%
Portugal	6.3	6.2	6.2	7.0	6.0	-1.0	-15%
Russia	6.2	5.3	4.9	5.6	5.6	0.0	0%
Romania	3.3	5.1	3.7	3.5	3.3	-0.3	-8%
New Zealand	1.9	2.5	3.2	2.3	3.1	0.8	34%
Greece	3.1	3.3	2.8	2.5	2.6	0.0	2%
Serbia	2.2	2.3	2.3	2.3	2.3	0.0	0%
Austria	2.1	2.4	2.0	2.3	2.0	-0.3	-14%
Hungary	1.8	2.6	2.6	3.0	1.9	-1.2	-38%
Moldova	1.5	2.6	1.6	1.7	1.7	0.0	0%
Brazil	3.0	2.7	2.7	3.5	1.6	-1.9	-55%
Bulgaria	1.3	1.7	0.7	1.3	1.2	-0.1	-8%
Georgia	0.8	1.0	1.1	1.3	1.1	-0.2	-16%
Switzerland	1.0	0.8	0.9	0.9	1.0	0.1	18%
World	**258**	**290**	**270**	**276**	**267**	**-9**	**-3%**

Sources: OIV, OIV Experts, Trade Press

a): Countries with a wine production of more than 1 mhl

b) 2015: provisional data

c) 2016: forecasted data

d) OIV estimate (USDA basis)

APPENDIX 5

Wine consumption[a]

million of hl	2012	2013	2014	2015[b]	2016[c]	2016/2012 Variation in volume	2016/2012 Variation in %
USA	30,0	30,2	30,4	31,0	31,8	1,8	5,7%
France	28,0	27,8	27,5	27,2	27,0	-1,0	-3,7%
Italy	21,6	20,8	19,5	21,4	22,5	0,9	4,4%
Germany	20,3	20,4	20,2	19,6	19,5	-0,8	-4,1%
China*	17,1	16,5	15,5	16,2	17,3	0,2	1,1%
United Kingdom	12,8	12,7	12,6	12,7	12,9	0,1	0,9%
Spain	9,9	9,8	9,9	10,0	9,9	0,1	0,9%
Argentina	10,1	10,4	9,9	10,3	9,4	-0,6	-6,2%
Russia	11,3	10,4	9,6	9,3	9,3	-2,0	-21,1%
Australia	5,4	5,4	5,4	5,3	5,4	0,0	-0,4%
Canada	4,9	4,9	4,7	4,9	5,0	0,2	3,5%
Portugal	5,0	4,2	4,3	4,8	4,6	-0,4	-8,4%
South Africa	3,6	3,7	4,0	4,2	4,4	0,8	18,1%
Romania	4,3	4,6	4,7	3,9	3,8	-0,5	-13,5%
Japan	3,1	3,4	3,5	3,5	3,5	0,4	11,2%
Netherlands	3,5	3,5	3,4	3,5	3,4	-0,2	-4,4%
Belgium	2,9	2,9	2,7	3,0	3,0	0,1	4,3%
Brazil	3,2	3,5	3,5	3,3	2,9	-0,3	-9,8%
Switzerland	2,7	2,7	2,8	2,9	2,8	0,1	4,5%
Austria	2,7	2,8	3,0	2,4	2,4	-0,2	-9,7%
Serbia	2,3	2,3	2,4	2,4	2,4	0,1	3,8%
Sweden	2,3	2,4	2,3	2,4	2,3	0,0	0,2%
Greece	3,1	3,0	2,6	2,4	2,3	-0,8	-32,1%
Chile	3,2	2,9	3,0	2,1	2,2	-1,0	-45,6%
Czech Republic	1,8	1,6	1,6	1,9	2,0	0,2	11,3%
Hungary	2,0	1,9	2,2	2,2	1,9	-0,1	-2,3%
Denmark	1,5	1,6	1,6	1,6	1,6	0,1	4,2%
Croatia	1,4	1,4	1,2	1,1	1,2	-0,2	-21,4%
Poland	0,9	0,9	1,0	1,1	1,1	0,2	17,0%
Bulgaria	1,0	0,8	0,9	1,0	1,0	0,0	1,4%
World	**244**	**242**	**239**	**240**	**241**	**-3**	**-1,1%**

Sources: OIV, OIV Experts, Trade Press

a): Countries with a wine consumption of more than 1 mhl
b) 2015: provisional data
c) 2016: forecasted data

*Apparent consumption calculated by "Production + Imports - Exports" data for 2015 and 2016

APPENDIX 6

Exports in terms of volume in 2016

million of hl	2012	2013	2014	2015	2016	2016/2012 Variation in %
Spain	20.7	18.4	23.0	24.7	22.9	10.6%
Italy	21.2	20.3	20.4	20.1	20.6	-2.8%
France	15.0	14.5	14.3	13.9	14.1	-6.3%
Chile	7.5	8.8	8.0	8.8	9.1	21.3%
Australia	7.2	7.1	7.0	7.4	7.5	3.3%
South Africa	4.2	5.3	4.2	4.2	4.3	2.7%
USA	4.0	4.1	4.0	4.2	3.8	-5.3%
Germany	4.0	4.0	3.9	3.7	3.6	-9.5%
Portugal	3.4	3.0	2.8	2.8	2.8	-18.2%
Argentina	3.7	3.1	2.6	2.7	2.6	-28.9%
New Zelande	1.8	1.8	1.9	2.1	2.1	18.8%
Moldova	1.2	1.2	1.2	1.2	1.2	0.0%
World	**103**	**101**	**103**	**105**	**104**	**1%**

Exports in terms of value in 2016

billion of €	2012	2013	2014	2015	2016	2016/2012 Variation in %
France	7.8	7.8	7.7	8.3	8.2	5.3%
Italy	4.7	5.0	5.1	5.4	5.6	19.8%
Spain	2.4	2.6	2.5	2.6	2.6	9.1%
Chile	1.4	1.4	1.4	1.6	1.7	20.2%
Australia	1.5	1.3	1.3	1.5	1.5	1.4%
USA	1.1	1.2	1.1	1.4	1.4	31.4%
New Zealand	0.8	0.8	0.8	1.0	1.0	32.5%
Germany	1.0	1.0	1.0	1.0	0.9	-5.0%
Portugal	0.7	0.7	0.6	0.7	0.7	3.7%
Argentina	0.7	0.7	0.7	0.7	0.7	3.7%
Hong Kong	0.2	0.2	0.2	0.6	0.6	242.3%
South Africa	0.6	0.6	0.6	0.6	0.6	6.5%
World	**25**	**26**	**26**	**28**	**29**	**14.3%**

APPENDIX 7

Imports in terms of volume in 2016

million of hl	2012	2013	2014	2015	2016	2016/2012 Variation in %
Germany	15.4	15.3	15.4	15.3	14.5	-5%
UK	12.8	11.8	13.4	13.6	13.5	6%
USA	11.7	11.0	10.8	11.0	11.2	-4%
France	5.4	6.0	6.9	7.6	7.9	45%
China	3.9	3.8	3.8	5.6	6.4	62%
Canada	3.8	3.7	3.8	4.1	4.2	10%
Russia	4.9	4.9	4.7	4.0	4.0	-18%
Netherlands	4.0	3.6	3.8	3.8	3.8	-3%
Belgium	3.1	3.2	3.1	3.1	3.1	0%
Japan	2.6	2.6	2.7	2.8	2.7	4%
Sweden	2.0	2.1	2.3	2.2	2.2	7%
Switzerland	1.9	1.8	1.9	1.9	1.8	-3%
Denmark	1.9	2.0	1.9	1.8	1.8	-3%
Portugal	1.3	1.6	2.3	2.2	1.8	41%
Italy	2.8	2.7	2.8	2.8	1.7	-38%
Czech Republic	1.6	1.5	1.6	1.6	1.6	2%
Poland	1.0	1.0	1.1	1.1	1.2	23%
World	99	99	102	104	104	4.3%

APPENDIX 8

CRITERIA	CRITERIA WEIGHT	NORMALIZED WEIGHT	ANIMAL FEED	LIQUOR	FOOD	PHARMACEUTICAL	BIOCOSMETIC	GLASS	CERAMIC	BIOCHEMICAL	BIOPLASTIC	CONSTRUCTION	FERROSILICON	RUBBER	TEXTILE	WOOD	PAPER	AGRICULTURE	WATER	ENERGY
Quality along the matter transformation	10	0.145	1	1	5	5	5	1	1	5	3	2	3	1	4	3	2	4	4	3
Scientific and tradition know-how convergence	8	0.116	3	3	5	5	5	2	2	5	5	4	3	2	5	5	3	5	4	4
Awareness of environmental impact	7	0.101	4	4	4	3	4	3	3	5	4	4	3	3	5	4	4	5	5	4
Transition to a sustainable perspective and culture	5	0.072	2	3	5	4	4	3	3	4	4	5	5	3	4	5	4	4	4	3
Circular matter flows within the territory	10	0.145	4	4	5	5	5	3	3	5	5	4	5	3	5	3	3	4	5	4
Required technologies upload	9	0.130	3	3	4	3	4	2	2	2	3	3	3	3	4	3	2	4	3	2
Human at the cernet of the project	10	0.145	5	5	5	4	4	2	2	4	4	3	4	2	4	4	5	5	4	4
Contribution to the local community	3	0.043	5	4	4	2	3	1	1	2	3	2	2	1	4	3	3	3	4	4
Contribution to the local community	7	0.101	4	3	5	5	5	2	2	4	4	2	3	2	4	4	5	5	5	5

APPENDIX 9

CRITERIA	ANIMAL FEED	LIQUOR	FOOD	PHARMACEUTICAL	BIOCOSMETIC	GLASS	CERAMIC	BIOCHEMICAL	BIOPLASTIC	CONSTRUCTION	FERROSILICON	RUBBER	TEXTILE	WOOD	PAPER	AGRICULTURE	WATER	ENERGY
Quality along the matter transformation	0.14	0.14	0.72	0.72	0.72	0.14	0.14	0.72	0.43	0.29	0.43	0.14	0.58	0.43	0.29	0.58	0.58	0.43
Scientific and tradition know-how convergence	0.35	0.35	0.58	0.58	0.58	0.23	0.23	0.58	0.58	0.46	0.35	0.23	0.58	0.58	0.35	0.58	0.46	0.46
Awareness of environmental impact	0.41	0.41	0.41	0.30	0.41	0.30	0.30	0.51	0.41	0.41	0.30	0.30	0.51	0.41	0.41	0.51	0.51	0.41
Transition to a sustainable perspective and culture	0.14	0.22	0.36	0.29	0.29	0.22	0.22	0.29	0.29	0.36	0.36	0.22	0.29	0.36	0.29	0.29	0.29	0.22
Circular matter flows within the territory	0.58	0.58	0.72	0.72	0.72	0.43	0.43	0.72	0.72	0.58	0.72	0.43	0.72	0.43	0.43	0.58	0.72	0.58
Required technologies upload	0.39	0.39	0.52	0.39	0.52	0.26	0.26	0.26	0.39	0.39	0.39	0.39	0.52	0.39	0.26	0.52	0.39	0.26
Human at the cernet of the project	0.72	0.72	0.72	0.58	0.58	0.29	0.29	0.58	0.58	0.43	0.58	0.29	0.58	0.58	0.72	0.72	0.58	0.58
Contribution to the local community	0.22	0.17	0.17	0.09	0.13	0.04	0.04	0.09	0.13	0.09	0.09	0.04	0.17	0.13	0.13	0.13	0.17	0.17
Contribution to the local community	0.41	0.30	0.51	0.51	0.51	0.20	0.20	0.41	0.41	0.20	0.30	0.20	0.41	0.41	0.51	0.51	0.51	0.51
INDUSTRY SUM	3.36	3.29	4.72	4.19	4.46	2.13	2.13	4.16	3.94	3.22	3.54	2.26	4.36	3.72	3.39	4.42	4.22	3.62
OVERALL SCORE	0.0516	0.0505	0.0725	0.0643	0.0685	0.0327	0.0327	0.0638	0.0605	0.0494	0.0543	0.0347	0.0670	0.0572	0.0521	0.0679	0.0647	0.0556