

WHITE BOOK

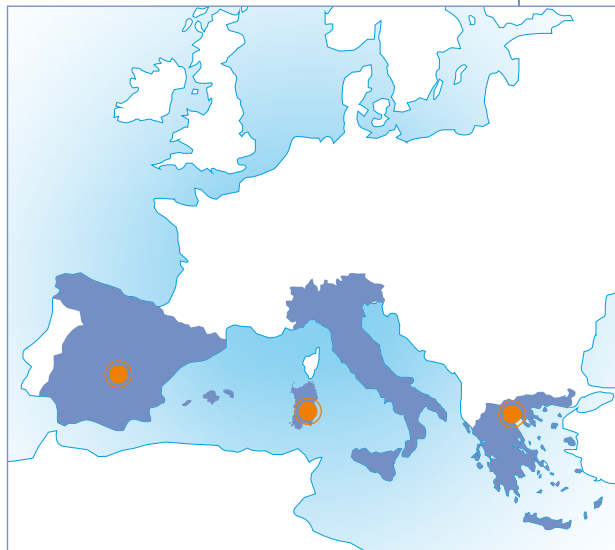
SAFFRON in Europe

Problems and Strategies

for improving the quality

and strengthen

competitiveness



PROJECT PART-FINANCED
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DIPUTACIÓN DE ALBACETE



REGIONE AUTONOMA
DELLA SARDEGNA



ERSAT
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Assistenza Tecnica in Agricoltura



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1 **PREFACE**



Saffron flowers (S. Gavino Monreale)

1 PREFACE

INTERREG IIC is a European Community program, aiming to strengthen the economic and social cohesion among European regions, through cross-border, transnational and interregional cooperation. It promotes information and empirical knowledge exchange by encouraging partnerships, mainly in the sector of regional development.

The SAFFRON project is a part of the INTERREG IIC program engulfing regional authorities and other institutions of the three largest European Regions specialized in the production and commercialization of saffron (*Crocus sativus*): Castile- La Mancha (Spain), Sardinia (Italy) and Western Macedonia (Greece). The technical team, mentioned in detail herein, has jointed its efforts during one year to produce an annual detailed analysis regarding the European production and commercialization of saffron. The project has successfully fulfilled its transformation to a meeting forum of all competent authorities and has enabled a reliable description of the current situation based on all information presented in the program.

The White Book of the European Saffron accumulates all information and knowledge supported by the INTERREG IIC program and aspires to become the map that describes the Eu-



Saffron flowers (Corongiu)

European Saffron landscape for the years to come. The applied means as well as all efforts made, will help establish and raise the competitiveness of the European saffron by adjusting it to the new consumption habits as well as to important socioeconomic changes imposed by the globalization of markets.

Thus, the White Book describes the actual situation and offers an in-depth evaluation of strengths and weaknesses of the saffron sector.

It proposes also a strategy plan on the basis of five priority objectives: framework and infrastructure of agricultural production – agricultural production industry – product differentiation, quality control and safety – further training, research and transfer of technology – commercialization and use. Furthermore, direct priority measures are proposed regarding the urgency of the strategy plan implementation.

The White Book uses a simple language, enabling all readers to obtain a clear picture of all issues involved. The book has been divided in six sections: documentation, objectives, reference framework, diagnostics, strategic plan and conclusions. The Annex, attached at the end of the Book, includes detailed information regarding cultivation, processing, storage and packaging, quality controls and commercialization in all three European regions mentioned above. Our analysis and conclusions are based on the working-out of the above detailed information.

Conclusively we hope that the White Book of the European Saffron will become a reference, enabling production enterprises as well as retailers to raise their competitiveness by applying innovations. Furthermore, it will help regional, national and European public authorities to plan efficient development policies and research support. The White Book aspires to become in the long run the basis of a veritable centre of the European saffron. Its goal is to establish European saffron on a global market level by outlining its high and consistent quality.

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2 DOCUMENTATION



Saffron flowers (ALTEA)

2 DOCUMENTATION

Europe has played always a significant role in the international production and commercialization of saffron. The cultivation of saffron has a very long tradition in the Mediterranean basin, as thousand-year-old archeological monuments remind us. Nowadays saffron production faces a crisis but all nations involved are traditionally related to saffron cultivation and preserve it actively.

Saffron cultivation methods are almost unchanged during the last centuries and the need in labor force is high due to low mechanization of farms.

In the Mediterranean basin the production of saffron has been decreased due to rising standards of living and, inevitably, due to the rise of labor costs. However, the Mediterranean saffron bears the best quality features worldwide, which is attributed to deep cultivation knowledge and careful treatment by all European producers.

Despite production decline, a large part of the global market of this sector is still controlled by European enterprises, which are perfectly aware of how to treat best quality saffron. Commercialization is performed by small and medium-size companies, controlling 80 to 90 % of the strong competitive global market.

The White Book is the outcome of all efforts made by the three largest European Regions regarding the production and commercialization of saffron, supported by INTERREG program of the European Union. It is a response to the various needs of saffron producers and traders. On one hand, information will help enterprises to analyze in depth the current market situation, not only on European level but globally as well. Information will allow companies to reorganize their innovation policies by sustaining or increasing their competitiveness.

On the other hand, it will offer a number of solutions to many producers and traders, who have limited capacity in research, development and innovation, in order to maintain Europe at the top position in global quality of saffron.

3 OBJECTIVES



Saffron flowers in traditional Sardinian baskets (Corongiu)

3 OBJECTIVES

3.1 GENERAL OBJECTIVE

The general objective is to work out a text providing exact knowledge of the existing situation regarding the European saffron, from the beginning of its production to the various phases of its commercialization. Furthermore, it aims at working out of a strategic plan on the basis of current issues and future challenges.



*Parts of saffron flower
(UCLM)*

3.2 SPECIFIC OBJECTIVES

Research and detailed documentation of the applied methods by the three regions involved, covering the various stages of the European saffron production: cultivation and harvesting, treatment, storage and packaging process for the food industry, quality control and finally product commercialization and promotion.

Implementation of a critical and comparative analysis of all methods applied by the three regions in order to promote best techniques, innovative ideas for exchange as well as to define common problems and weaknesses.

Formation of research guidelines for solutions on identified problems. Proposals for a current framework with reference to guideline adaptations, in order to ensure successful implementation of the solutions.

Presentation of all gathered information and aggregation of conclusions drawn in the White Book, which will become a reliable tool for all enterprises of the European saffron sector. The White Book should enable enterprises to find ideas and proposals, in order to raise their competitiveness. Furthermore, the White Book should help public authorities to improve their regional development policies and determine their priorities on research guidelines for the benefit of the European saffron sector.

4 REFERENCE FRAMEWORK



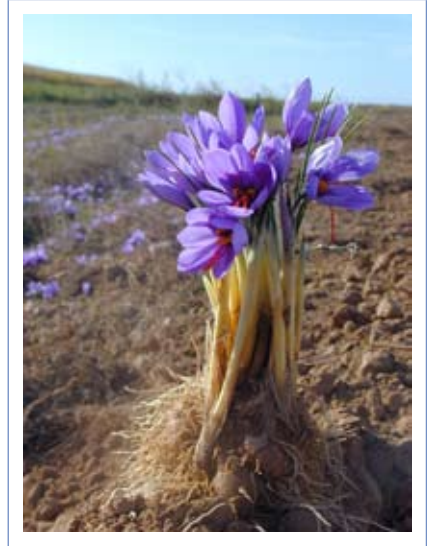
Fields with flowering saffron (photo Corongiu)

4 REFERENCE FRAMEWORK

4.1 SAFFRON CULTIVATION

The saffron plant belongs to the family of iridaceae. It is a perennial meadow grass that reaches 10 to 25 cm and grows from its bulbs. The bulb has a suboval shape, is small and thick, lightly flattened at the bottom and looks like an onion bulb. It has a massive structure, covered by multiple tunics. The bulb is an underground organ that gathers the necessary reserve substances needed for flowering and growth. The numerous roots are white with variable lengths (5 – 10 cm). The leaves, also called nomophyllus, vary in number from 10 to 15 for each shoot. They are very narrow and have a length between 1,5 and 2,5 mm. Their color is dark green with a white middle stripe in the inner side and a venation on the outside. The flowers have six petals, three on the inner side and three on the outer side joined on the long pipe that comes out of the upper part of the ovary. The form is regular and straight. The column separated from the top of the underground ovary ends in a sole stigma of three threads that have an intense red color. This is the interesting part of the plant regarding cultivation. One to three flowers are counted per bulb and two to three bulbs are counted per plant.

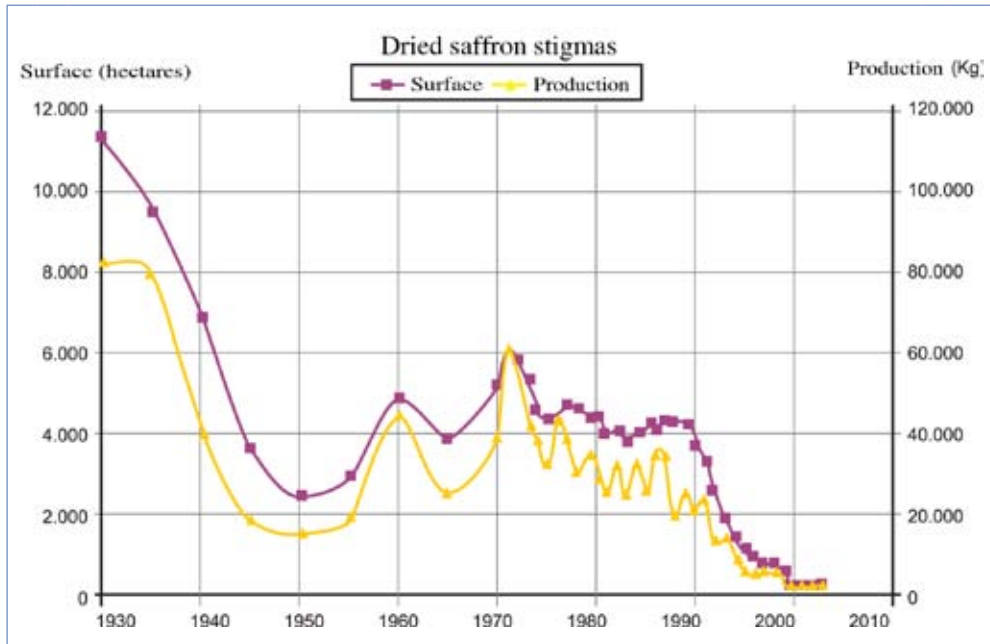
In 2004, the European saffron production reached 6.800 kg which is 4% of the international production, estimated



Saffron plant (photo UCLM)

at about 170 tones. The increasing need in labor force for this kind of cultivation, in combination with life quality improvement in all Mediterranean production countries, explain the reduction of cultivation land during the last decade of the 20th century. For instance, graph 1 demonstrates the cultivation land and production development in Spain that seems to have reached a stabilized level and indicates a slight inversion of this tendency. This phenomenon is much more obvious in Italy and especially in Sardinia.

Numbers show that since 1990 the cultivation surface reached 6 % and production 16% (graph 1)



Graph 1. Development of saffron cultivation surface (hectares) and dried stigma production (kg) in Spain (Source: MAPPA 2006)

As far as consequences of reduced saffron production in Europe are concerned, the socioeconomic repercussions are significant because 90% of the international commercialization of saffron is controlled by European enterprises.

4.1.1 TRADITIONAL SAFFRON CULTIVATION

In all three European production areas, Castile-La Mancha (Spain), Western Macedonia (Greece) and Sardinia (Italy), similar methods are used for saffron cultivation: indeed, there is poor improvement of the applied traditional cultivation techniques.

Following differences have been noted:

- in Sardinia, where producers have focused on organic cultivation, the selling price of the product is the highest in all Europe,
- in Spain, studies have examined the possibility of adapting saffron cultivation to current production systems, preparing thus the way for the mechanization of cultivation through modern production methods,
- in Greece, on the contrary, priority was given to organizing the producers into cooperatives.

All three regions share also similarities in the agronomic and environmental conditions. The cultivation of saffron requires Mediterranean continental climate with cold winters, warm and dry summers and a dry Mediterranean humidity regime. The plant is resistant to extreme temperatures in the summer as well as during winter.

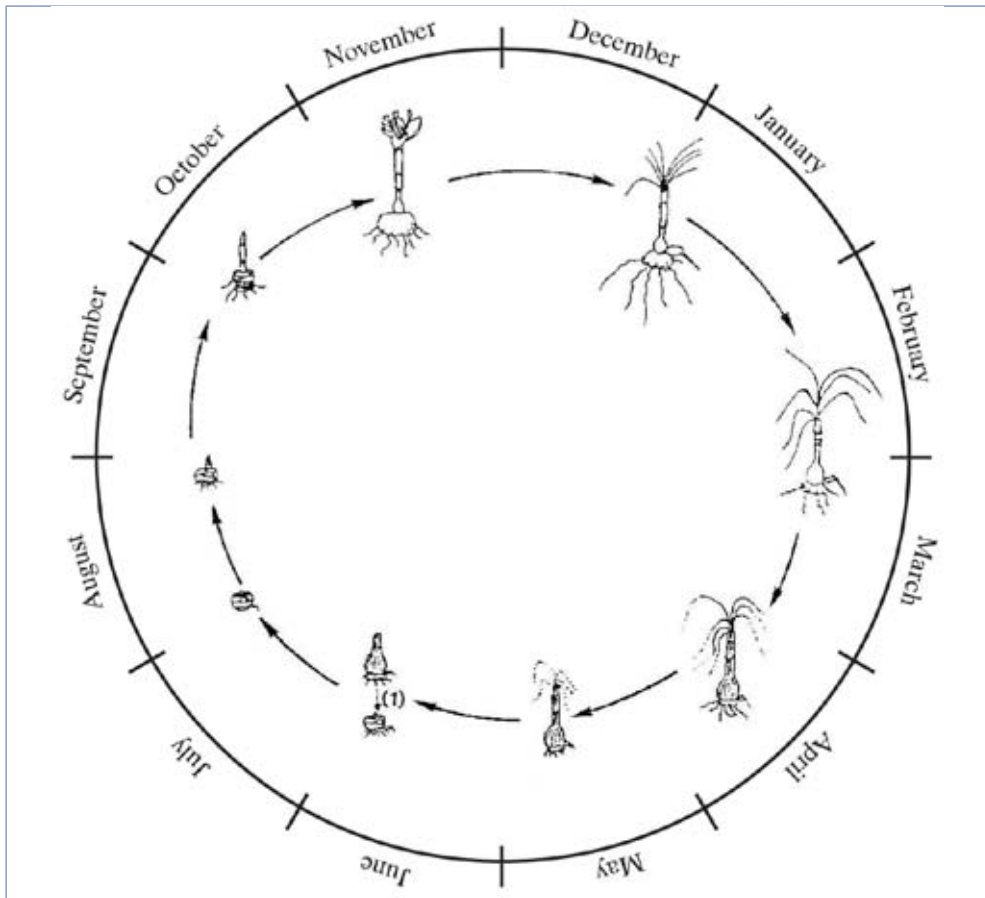
Saffron adapts very well to calcareous soils, which predominate in all production zones. It grows well on poor soil but it is more efficient on fertile ground. The most important edaphic limitation is the drainage, because puddle formation damages the cultivation, which is usually carried out on soils with light texture.

Spain is the only country implementing genetic improvement programs. Due to androsterility, this cultivation creates various problems in defining genetic selection methods.

4.1.1.1 Production cycles and periods

The cycle of saffron cultivation, as shown in picture 1, is characterized by two annual stages: activity period and dormant period. The activity period expands from August or/and September until April – May. At the beginning the plant regains its metabolism, roots, shoot, flowers, the leaves start to grow and a new growth period begins. During dormant period, the bulbs remain unchanged once they have reached maturity. Between those two periods there is a transitory period in which the bulb continues to produce mitoses and to differentiate itself, even if this tendency is gradually reduced, as the cycle evolves.

The production cycles in Castile-La Mancha and Sardinia are very similar and never last more than three or four years on the same field. In Western Macedonia, cultivation period lasts up to seven years.



Picture 1. Annual cycle of *Crocus sativus* L. (Lopez, 1989)

4.1.1.2 Soil preparation for saffron planting

The tasks needed for saffron planting are the usual tasks of a cultivation that will be carried out for many years on the same field. We begin with an in depth digging, afterwards we use a cultivation tractor, a harrow, a vibrating tractor or cylinder in order to achieve a flexible and loose soil. These tasks are carried out by machines even if some of the cultivators still use animals.

Fertilization of the cultivation begins normally by adding an organic fertilizer of 20 – 30 kg/hectare of matured manure, which is incorporated into the soil in due time. To complete, chemical fertilizers such as phosphor and potash are added afterwards. In Western Macedonia, cultivators prefer to use mineral fertilizers instead of organic material.



Traditional digging (ERSAT)

4.1.1.3 Planting

In all studied regions, large bulbs are planted while the smaller ones are left out (< 22 kg). The study carried out in Castile-La Mancha proved that the sizes of the bulbs have major impact on the first year yield due to their influence on the number of shoots. Later on, this factor loses its importance as soon as the first small bulbs start to appear and continue to reproduce. From the third flowering year (year 2) and on, the dry stigmas show no yield improvement in respect to the sizes of the planted bulbs.

The planting depth has a great influence on stigma yield. Generally, the bulbs are planted at a depth of 15 to 20 cm, depending on how many years they will remain in the soil. In Spain and Sardinia, where production period lasts 3 to 4 years, planting takes place at a depth of 15 to 20 cm, while in Western Macedonia, bulbs are planted at a depth of 25 cm.

The planting density has a great influence on the yield during the first year, while the importance of this factor diminishes as the plants become older. In Castile-La Mancha the normal planting density is 60 bulbs/m². In Sardinia, where bulbs are more expensive, planting density varies between 10 and 50 bulbs/m². In Western Macedonia, planting density is at average.

In Castile-La Mancha and Sardinia, planting takes place usually in furrows separated from each other by a space of 50 cm. In Western Macedonia, the planting distance between furrows varies from 10 to 20 cm. These conditions allow performing tasks such as grubbing and aeration of furrows with tractors. The distance between bulbs is 3,3 to 15 cm.

In Castile-La Mancha, another varying factor is the ground formation with variable width that depends often on the machine used for planting. Generally, land is divided in small terraces of 1,5 m width, separated from each other by a distance of 0,50 m. This requires a total distance of 1,70 m. A flat and homogenous surface enables mechanized harvesting.

In Western Macedonia, planting takes place from May to July. In Sardinia, it takes place from August 15th to September 15th. In Spain there are two differentiated planting periods: from the 2nd half of June to the 1st half of September. There are no agronomic reasons for justifying one period over another. It is more a question of resources availability.

4.1.1.4 Irrigation

In Sardinia and Western Macedonia, cultivation land is not irrigated. In Spain, 70% of the cultivating surfaces are irrigated. Three irrigation methods are used: flooding, sprinkler irrigation and drip irrigation. Flooding is the most common method applied on small-scale cultivations. On the other hand, sprinkler irrigation is assuredly the best method for such kind of cultivation.

Compared to other cultivations, saffron requires low quantities of water. Saffron is extremely resistant against drought and adapts very well to irrigation. If we consider the two critical periods of cultivation, which are flowering and bulb creation, then the first period is the most delicate one because it coincides with the irrigation period.

4.1.1.5 Fertilization

In Sardinia, apart from organic elements, some producers add small quantities of mineral nitrogen fertilizers. In Western Macedonia, the use of chemical fertilizers depends on the producer individually. Normally, a mixture of N-P-K is added pursuant to following formulas: 100kg/hect (11N-15P-15K) + 20 kg/hect (0N-0P-5K). In Castile-La Mancha, cultivators use following fertilizer dosages: 40-50 UF N, 80-100 UF P205 and 100-200 UF K20.

4.1.1.6 Weed eradication

In all mentioned regions, weeds are removed by hand. Recently, mechanical digging has been applied between the cultivation lines. One month after planting, and in case of weed presence, a surface grubbing is suggested, at 10 to 20 cm depth, but with caution so as not to damage the bulbs.

During September, surface grubbing between the furrows is taking place in order to break the crust of the soil, and a light weeding is applied in order to lighten and aerate the soil and remove the weeds.

In Castile-La Mancha, sometimes weed control is carried out with herbicides. Between June and August, during dormant period of saffron, two short-life carbamates are used, such as diquat and paraquat. During growing period, herbicides such as glyphosate, linuron, metribuzin, pentimethalene and bendazon are used pure or in mixtures. In Sardinia and Western Macedonia no chemical herbicide is used.

4.1.1.7 Phytosanitary protection

Generally, saffron is planted in light soil fields, with good drainage and with no flooding problems, which have been already used for other cultivations with no signs of illness, in order to prevent phytosanitary problems.

The most serious problems are those caused by the presence of *Fusarium oxysporum* fungus f. sp. *Gladioli*, *Rhizoctonia crocorum* and *Rhizoctonia violacea* Tul, as well as acarina *Rhizoglyphus*.

In Castile-La Mancha, bulb disinfection is carried out in various ways. The most common among them is immersion of bulbs into fungicide solution. Afterwards, the bulbs are dried by implementing forced ventilation. In Western Macedonia, the bulbs are disinfected using fungicides such as Brassicol or copper sulphide before planting.

In Sardinia, there is only one treatment, consisting in wetting the bulbs with copper-based products. In all three countries, the cultivation can also suffer from damages caused by rodents (mice, field rats), that are nourished with bulbs. Nowadays, rodent control is carried out using various methods such as setting traps or smoke bombs at the entrances of underground nests or by mechanical destruction of their underground tunnels. The leaves can also be damaged by rabbits, hares or mice.

4.1.1.8 *Harvesting*

In the three studied regions, one month before flowering (September) the soil is prepared. Traditionally, surface grubbing is carried out in order to break the crust, aerate the soil and remove the weeds. Digging is carried out by hand with rakes, if the surfaces are small, or mechanically with the rack attached on tractors.

The planning of flower harvest is a very important moment because the flowering period is very short and flowers lose their properties if they remain exposed in bad weather conditions for a long period of time.

In Castile-La Mancha and Western Macedonia, flowering begins between 15th and 25th of October. Generally, a flowering period lasts 10 days, even though 70% of the production is harvested during the first five days. In Sardinia, flowering begins during the first ten days of November and continues for almost 20 days.

Traditionally, flower harvesting is carried out by hand. The flower is cut at the lower part of its corolla and placed carefully in small baskets avoiding pressure. Harvesting is a difficult task due to unfavorable weather conditions and the uncomfortable body position the workers have to adopt.

Harvest yield varies greatly and depends on many variables such as the human factor, cultivation conditions or weather conditions. It is estimated that one person is able to collect approximately 8 to 16 kg of flowers in one day. The presence of leaves is an inconvenience in harvesting by hand because locating flowers in-between leaves, diminishes considerably the yield.

In Spain, in order to make this task easier, various mechanized harvesting methods have been tried out. Such machines allow workers to adopt a more convenient body position and to remain seated or to lie on the ground.

For the harvesting of saffron flowers, more or less complicated machine models are available. This system is based principally on the operation of a sharp blade that cuts the flowers very near to the ground. Afterwards, the flowers are transported on a moving belt to the various harvest containers or boxes.

Such a method increases yield and reduces production costs. Nevertheless it has also disadvantages: a great amount of dirt is collected together with the flowers, which smears the stigmas of the open flowers.



Saffron flower harvesting by hand (photo ERSAT)



Saffron flower harvesting by hand supported by machines (photo ITAP)



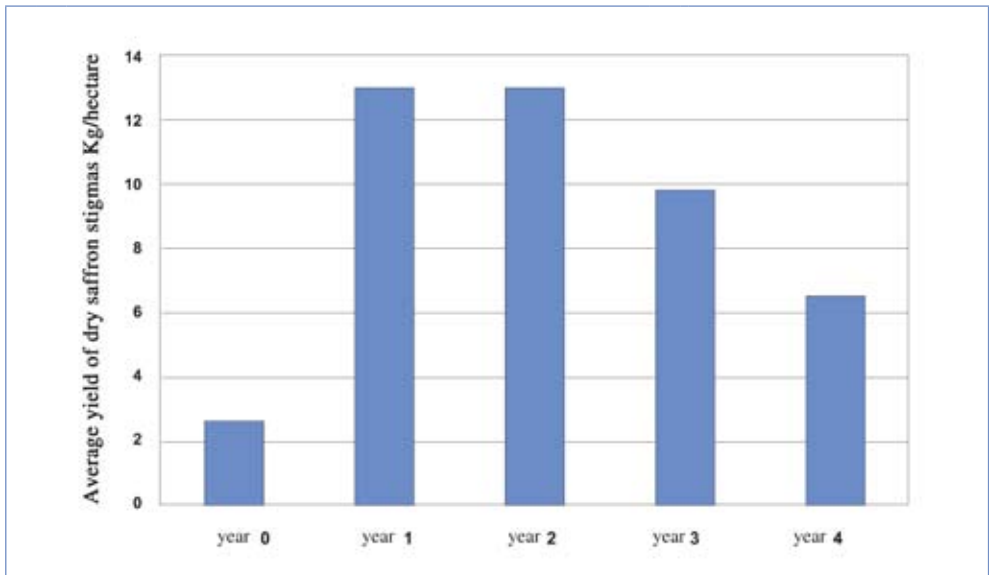
Saffron flower harvesting machine (photo ITAP)

4.1.1.9 Yield

In Castile-La Mancha, the average yield in dry stigmas, depending on cultivation year, is shown in graph 2. Maximum yield is reached during the first and the second year (i.e. the second and third flowering year). From the third year and on, yield starts to diminish.

In Western Macedonia, the average annual production is 10 kg/hectare and depends largely on weather conditions during the fall.

In Sardinia, saffron production varies during the four years of the cultivation cycle. In the first year a production of 5 kg/hectare is achieved, the second year production is raised to 10 kg/hectare, while in the third year it reaches 15 kg/hectare. In the fourth year production falls back to 10 kg/hectare.



Graph 2: Average yield of dry saffron stigmas in each cultivation year

4.1.1.10 *Bulb harvesting*

In Castile-La Mancha and Sardinia, this task is carried out normally between June and July, while in Western Macedonia, is carried out between May and June. The bulbs are removed using a breast plow and are collected by hand.

In order to clean the bulbs, it is necessary to remove all foreign material, such as soil, water and flower residues. Afterwards, all plant elements are removed such as outer tunics and bulbs from precedent cultivation cycles, which attached at the bottom of the new bulb. During cleaning, selection of the bulbs that will be used for reproduction is carried out.

4.1.2 MECHANIZATION OF SAFFRON CULTIVATION IN THE FIELD

The following methods are most common especially in Spain.

4.1.2.1 *Bulb planting*

The same technique, used for general bulb planting is applied also for saffron bulbs. The planting machine is suitable for different planting methods such as planting in lines with a distance of 20 to 50 cm between

the bulbs or planting in plateaus with a 1 to 1,5 or 1,6 m width, which is actually the distance between the wheels of a tractor. Another very common planting technique is wire netting, which makes bulb removing much easier. Manufacturers of wire nettings provide such specialized material in rolls, adjusted directly on the bulb planting machine.

The same machines used for potato, onion and garlic planting can be used for saffron bulb planting. Such equipment is adjusted in order to prevent damage on the planting material, since those cultivations are not so sensitive as the saffron cultivation.



Bulbs before cleaning (photo ERSAT)

4.1.2.2 Cleaning, sorting and disinfection of bulbs

Before classification, the material is treated according to standardized methods for bulb cultivation: the bulbs are transported on vibrating bars covered with plastic in order to remove the soil.

Afterwards, the material is transported on two moving bands, equipped

with caoutchouk fingers that rub the bulbs on different levels.

It is important for the bulbs to be transported on bands that are at least 3 meters long, so that workers can remove the remaining foreign material by hand.

Bulb classification is carried out on special vibrating sieves with different eye diameters. The eye diameter varies between 18 and 30 mm and depends on the size the cultivator desires to obtain.

Disinfection is performed by the use of a sprinkler system that wets the bulbs while transported on moving bands. This task can also be carried out by hand with the use of an easily absorbed disinfection solution.

4.1.2.3 Bulb grubbing

There are different methods for bulb grubbing, depending on whether nettings have been used during planting or not. If the bulbs have been planted by the use of nettings then the whole procedure is carried out in a single stage. The machine is equipped with a vibrating knife that goes 40 cm into the ground guaranteeing safe bulb grubbing without damaging the planted material.

On the contrary, if the machine has to remove also the nettings, then the procedure is carried out in two stages. The bulbs and the nettings are brought to the surface with the help of a knife that goes 30 cm in the ground. Afterwards, they are moved through a sieve with variable frame in order to remove the remaining soil. A second engine cuts and destroys the nettings through burners. The advantage of such method is that the only material that reaches the harvest containers is the bulbs.

In small-scale fields where the bulbs are planted in rows, we notice that cultivators use other adjusted machines, for instance those used for potato grubbing.

4.1.2.4 Harvesting of saffron flowers

Mechanization of flower harvesting is possible only when the field is appropriately prepared or only during the end of summer if it concerns cultivations from former years. Special machinery exists for such cases: it is a milling machine which tills the soil in a depth of 3 to 10 cm, depending on the distance between the bulbs. The soil must be free from weeds and plant residues. The machine for mechanized bulb harvesting is described in section 4.1.1.8.

4.1.3 FORCED CULTIVATION OF SAFFRON

Forced cultivation of saffron is a method developed in Spain and allows the extension of the flowering period by controlling the temperature, humidity and light conditions. This activity is carried out in storage rooms or macrotunnels. The following procedure is applied:

4.1.3.1 *Bulb production in the field*

Forced cultivation methods require large amount of planting material deriving from the fields. The bulbs should not bear any damages that could become an infection focus caused by microorganisms and at least two flowering periods should have already taken precedence.

4.1.3.2 *Cultivation in storage rooms under controlled microclimatic conditions*

Bulbs are kept in storage rooms at a temperature of 30oC and can rest for 150 days. Buds start to emerge when the temperature is between 23 and 27oC. Under such conditions, a hatching period of 45 to 60 days is needed before flowering reaches its peak. Relative humidity should be maintained at 70 and 80%.

It is very interesting to point put that the trays used for cultivation can be piled up. This allows handling of a large bulb amount even on small-scale fields. The average is 472 bulbs/m². Bulbs are covered with a layer of aggregate material such as micanite or perlite. The bulbs remain in the trays until the end of the flowering period. Afterwards, they are forwarded to the field for reproduction.

The bulbs must be kept at a temperature of 17 to 18oC for flowering to take place. At this temperature, the time needed for flowering is reduced gradually in proportion to the extension of storage period. Regarding lighting, the bulbs must be kept under light only as long as the flowering period lasts, in order to avoid chlorosis, namely the irregular development of leaves and column, which would possibly lead to exhaustion of reserves and hinder the bulbs from producing flowers.

The flowering period could last up to 100 days given the fact that the average flowering period of each piece of bulbs is 13 days.



Forced cultivation under controlled microclimatic conditions (ITAP)

4.1.3.3 Cultivation in macrotunnels or greenhouse tunnels

An alternative to forced cultivation is production in macrotunnels or greenhouse tunnels. By controlling temperature, relative humidity and lighting through special arrangements and covers, early flowering can be achieved in relation to traditional cultivation in the field.

4.2

SAFFRON TREATMENT

After completion of flower harvesting, flowers are subjected to a delicate treatment which will give the saffron spice. If possible, this procedure should take place on the same day of harvest because the stigmas lose much of their valuable properties as time passes by.

Treatment methods are the same in all three regions (separation, drying and cleaning) with only a few differences.

4.2.1 SEPARATION

It is one of the most traditional procedures that remain the same throughout the centuries. It consists of removing the stigma from the rest of the flower. Until lately, separation could only be carried out by hand. Nowadays, in Western Macedonia, some large scale producers use semiautomatic machinery that separates the stigma from the rest of the flower by using air streams produced by ventilators. At the same time, separation by hand is also applied, enabling thus the production of high quality saffron.

In Sardinia, traditionally, two methods are used for stigma separation: a) the flower is opened with both hands and the column is cut directly at the bottom of the three stigmas, very carefully, in order not to separate the stigmas. Finally, the white part of the column is removed; b) while the flower is still closed the column is removed with the fingernail or a scissor, while the other hand holds the stigmas.



*Separation of stigmas from an open flower (photo
ERSAT)*

In Castile-La Mancha, the flower is cut from the perianth with the fingernail of the right thumb and index finger. The three stigmas should not be separated. At the same time, a light pressure is applied on the flower in order to open slightly and to slide between the fingers, for the stigma to be removed completely. If the stigma is of a good quality then it protrudes slightly over the closed flower. The right hand removes the stigma while the left throws the flower into the apron of the worker.



Separation of stigmas from a closed flower (photo ERSAT)

4.2.2 DRYING

It is the most important and most delicate task during which the stigmas lose 20% of their initial weight and turn into the saffron spice. The drying methods vary slightly in the three studied regions.

In Sardinia, a process called “feidatura” takes place before drying, during which the stigmas are wetted with extra virgin oil (a quarter of a tea spoon for 100 gr of fresh saffron). It is presumed that the above method improves the natural appearance of the stigmas as well as their conservation.



*“Feidatura” method
(photo ERSAT)*

Regarding drying, the stigmas are placed on wooden boards and dry under sunlight or near to a fireplace during the night. Nowadays, electric dryers are used, equipped with thermostat for a constant temperature of almost 45°C.



*Drying of stigmas in Sardinia
(photo ERSAT)*

In Western Macedonia, the fresh stigmas are spread out in thin layers, placed on rectangular silk sieves and stored for 12 to 24 hours in a room with controlled temperature of approximately 25 and 30°C.

In Castile-La Mancha, thin layers (2cm) of fresh stigmas are placed on silk or metal sieves and are exposed to higher temperatures such as butane gas fire, or vine coals and heaters or coal operated stoves. As far as drying time is concerned, they prefer the shortest time of about half an hour and a highest temperature of 70°C.



Drying in sieves (photo UCLM)

4.2.3 SAFFRON CLEANING

Flower residues can be finally removed by hand in order to clean the product from dirt. Afterwards, saffron is kept in containers that protect its properties.

The Commercialization process of saffron consists of following stages: purchase, classification, storage, cleaning, homogenization and packaging as described below:

Within the general process frame, storage and packaging are the two most important stages in order for saffron to maintain its initial quality and reach the consumer in the best possible condition. These tasks are carried out by the producers who have collected the flowers, by the producer – trader or packer – distributor respectively.

4.3.1 Purchase

It is very common for traders to purchase the product in the villages directly from the producer or intermediate, who receive a commission. Sometimes the producer addresses the trader directly in order to sell his product.

Pursuant to the Greek law, saffron cultivators must sell their product directly to the cooperative.

4.3.2 Sorting

Purchased saffron lots are previously classified according to their quality, their age etc.

4.3.3 Storage

Nowadays, instead of storing saffron for a longer period of time, given the fact that saffron loses its properties as time passes by, the tendency is to sell the product within one year.

In Castile-La Mancha, storage time does not exceed twelve months after harvesting. When saffron reaches the storage facilities it is packed in plastic bags, in polyethylene containers or in carton boxes. In order to control the environmental conditions (humidity, temperature etc) thermo-humidity meters are used even if the most common practice is to store the product in dark and dry rooms. Some packers use cold store facilities.

The conservation temperature of saffron varies between 5 and 10°C and the relative humidity between 30 and 50.

In Western Macedonia, the producers, store saffron in 2,5 kg containers, in 10 to 15 kg barrels or in plastic bags for 1 to 2 months.

The longest conservation time is 5 years. The relative humidity of the product is about 10% while the environmental humidity varies between 40 and 60%. Storage temperature is at 4°C.

In Sardinia, saffron is kept in galvanized containers or opaque glass containers in order to prevent exposure to light and air. Generally, saffron is sold within twelve months since harvesting. No temperature or relative humidity control occurs.

4.3.4 CLEANING AND HOMOGENIZATION

Cleaning, humidity control and saffron lot homogenization takes place before storage. If saffron will be sold in powder, then it has to be grinded.

Cleaning allows all foreign objects such as leaves, stamens or stems to be removed. In Sardinia cleaning is takes place during separation. In Western Macedonia, saffron is placed on a special bench in order to detect any foreign object. Afterwards, saffron is sieved in order to remove pollen. In Castile-La Mancha no cleaning takes place because the received stigmas are free of flower residues. In other cases where cleaning is practiced, then stigmas are cleaned by hand in order to prevent any damages.

To avoid calculating water in the selling price of saffron, it is important to control the humidity percentage. The admissible amount is defined pursuant to the law of each country. Indeed, if humidity exceeds the defined limits, then funguses, ferments and bacteria could develop. Examinations taken place in Sardinia, show that saffron humidity does not exceed 10%. In Western Macedonia saffron humidity in the product delivered to the cooperative, does not exceed 11,5%. If the percentage is higher than this limit, then the product is dried in a special furnace owned by the cooperative.

In Sardinia, selection and product homogeneity are guaranteed during separation. In Western Macedonia, saffron deriving from various harvest regions, is put together in lots of 20 to 25 kg, placed on benches and mixed for homogeneity. In Castile-La Mancha, the separated product is selected and is mixed by hand in order to respond to the clients' demands regarding thread length, dye intensity and other quality defining parameters.

In Sardinia, saffron in powder is grinded according to traditional methods: using smoothing iron (the treads are ironed under a sheet of food paper) or coffee grinder. Larger farms use measurer-packaging machines.

In Western Macedonia, saffron is grinded using special machinery. In Castile-La Mancha, grinding is a fully automated or semi automated procedure depending on the type of grinder used. This procedure enables a precise distribution of the grain size.

4.3.5 PACKAGING

4.3.5.1 *Package material and presentation*

The best suitable storage containers are those that protect saffron from being exposed to light and humidity and those that do not transmit any smell or taste to the packed product.

In Castile-La Mancha, the producers use food packaging material responding to market demands such as gelatin, plastic (polyethylene, PVC, polypropylene, cellophane etc), glass, aluminum packages etc. Carton or metal boxes are used as secondary package. Packers use various containers but the most common package is the 1 g bag. Modern packages and methods are used such as conservation in controlled or inert environment.

In Sardinia, saffron is packed in glass, food paper or plastic containers. Small loam and cork packages are typical for Sardinia. The quantity of saffron contained in a package varies between 1 to 5 g.

In Western Macedonia, saffron is kept in 28 g metal containers as well as in boxes or plastic bags of 1 to 4 g. Organic saffron is kept in 1 g glass containers and in 0,5 g plastic bags, while saffron in powder is packed in bags of 0,125g, 0,25g, 0,5g or 1g.

4.3.5.2 *Packaging process*

In Castile-La Mancha, the producer – trader packs the product at a fully manual procedure – from container filling to tag attachment. Generally, an automated production line exists for filling bags with saffron powder. Some enterprises nowadays use packaging machines of high dosing accuracy.

In Sardinia, packaging is carried out mostly by hand. There are only two large enterprises owning dosing mills. In Western Macedonia, packaging and tagging is carried out by hand. Saffron powder bags are filled with an automated measurer machine.

4.3.5.3 *Shipment*

After packaging, it is recommended to keep the product in a cool, dry and dark place as long as the packages remain in the storage rooms. In all three regions, packaging complies with the customer demands. Product distribution takes place five days after packaging. Apart from shipment costs, following additional costs have been taken into consideration in this section:

I. Analysis

With reference to each market, more or less thorough analysis has to be conducted. Normally, 15 to 20 g of each lot is analyzed.

- a) Microbiological analysis: for bacteria detection such as *Salmonella* sp. and *Escherichia coli*.
- b) Chemical analysis: for defining the existence of artificial dye substances and crocine, picrocrocine and saffranal content.
- c) Phytosanitary analysis: for detecting pesticide, herbicide and fungicide residues.
- d) Radioactivity analysis.

II. Taxes and other costs

Costs for issuing of various certificates on a regional or national level, as well as all costs paid to certain authorities that testify the product's designation of origin.

4.3.6 COMMERCIALIZATION COSTS

All commercialization costs described for the different process stages in all three regions studied herein, are listed in brief in Table 1.

	SPAIN		ITALY		GREECE	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Purchase	0,00	13,22	-	-	-	-
Classification	3,01	3,01	0,00	0,00	2,50	2,50
Cleaning	9,02	18,03	0,00	0,00	7,50	15,00
Primary packaging	84,14	300,51	140,00	140,00	54,88	219,52
Secondary packaging	25,04	25,04	400,00	600,00	20,75	20,75
Tertiary packaging	0,83	1,60	50,00	50,00	0,68	1,33
Shipment	18,03	18,03	110,00	140,00	18,03	18,03
Analysis	6,41	8,01	65,00	65,00	5,30	6,65
Taxes and certificates	1,20	1,80	80,00	80,00	1,20	1,80
Subscription DO	0,00	60,10	0,00	0,00	0,00	50,00
Total	147,68	449,36	845,00	1.075,00	110,84	335,58

Table 1. Commercialization costs in Spain, Italy and Greece (€/kg)

4.4 QUALITY DETERMINATION

Saffron is the kind of spice that adds color, taste and aroma to various foods. Thus we could say that the best saffron is the one with high quality color, taste and aroma features. Regarding taste, the responsible substance is pricrocrocine. Color is provided by dye substances, the crocetine esters that belong to the carotene group. Safranal is a volatile substance contained at high amount in the saffron spice. Saffron aroma depends on the sweet aroma of flowers existing at the beginning of harvest as well as on all spicy and intensive aroma alterations that take place as time passes by. These features are the effect of volatile substance alterations.

Saffron quality is determined after a series of characteristic parameters for the spice itself (endogenous parameters) combined with necessary external or exogenous conditions (exogenous parameters).

4.4.1 ENDOGENOUS PARAMETERS

Physical and chemical parameters such as humidity, flower residue or foreign material and ashes content, soluble condensate, coloring power etc are considered to be endogenous parameters.

The methods for determining the physical and chemical parameters vary from region to region. Sardinia uses European pharmaceutical industry methods. On the other hand, Greece and Spain use methods defined by the ISO/TS 3632. In Spain, apart from the technical speci-

fications defined by the ISO several other laws and regulations are very important: Standard regarding saffron quality for export (NCCEA 1988, 1999), Regulation regarding spice hygiene, treatment methods, distribution and marketing (RTS 1984), technical specifications regarding the designation of origin “Azafrán de la Mancha” (DOP 1999), Technical Regulation regarding the use of names such as “Calidad Alimentaria” and “Safran d’ Aragon” (RT 2003). All regulations are described in the corresponding section.

For determining the organoleptic features, sensory analysis is applied in Sardinia and Castile-La Mancha for quality control and saffron type distinction.

In Castile-La Mancha, the Regulatory Council for the Designation of Origin “Azafrán de la Mancha” consists of a tasting committee that chooses each year the best saffron quality. For this purpose the committee fills out a survey card on the basis of a tasting handbook drawn up especially for this purpose. The survey card is divided in three sections: appearance, smell-taste and texture. The descriptors for appearance, texture and aroma are tested on saffron threads through water suspension. In Sardinia, sensory analysis is based on three saffron water solutions of 250 mg/l placed in glass containers covered with aluminum foil. First, the members of the committee appoint the descriptors, who will be tested and included in the tasting handbook. The descriptors are evaluated according to their appearance, taste and texture.

4.4.2 EXOGENOUS PARAMETERS

Exogenous parameter controls aim at determining the absence of alterations as well as guaranteeing that the levels of microbiological flora and pesticide residues are below the limits defined by the law.

4.4.2.1 Techniques of adulteration determination: TLC, HPLC, microscopic analysis

Due to its high value, saffron spice has been subjected to many adulterations throughout history. Saffron should be free of any kind of adulteration, namely metallic substances such as oils or molasses that increase its weight or even dyes that improve its appearance.

A number of adulterations detected on saffron throughout history, are set out in Table 2.

FORMS OF ADULTERATION	ADULTERATION CONSISTING IN:
Without the addition of foreign substances	Mixing with condensed or older saffron
Adding various parts of the saffron plant	Προσθήκη των στημόνων ή του κομμένου και βαμμένου περιγώνου.
Adding substances that increase weight	<ol style="list-style-type: none"> 1. Humidity percentage increase 2. Soaking in syrup, honey, glycerin or olive oil 3. Adding barium sulphate, sodium, calcium, calcium carbonate, potassium hydroxide, potassium nitrate, monopotassium tartrate, sodium borate, lactose, starch or glucose to the above syrups.
Adding parts from other plants	<ol style="list-style-type: none"> 1. Carthamus tinctorius flowers 2. Calendula officinalis. flowers 3. Stigmas from other saffron types that are shorter and have no dye properties (Crocus vernus, Crocus speciosus, etc.) 4. Papaver rhoeas L., Punica granatum, Arnica montana και Scolimus hispanicus, flowers cut in slices. 5. Perianths from certain spices such as carnations 6. Grinded red pepper 7. Herbaceous plants cut in pieces and colored in azoic dye substances 8. Small Allium porrum roots. 9. Sandal wood and Campeche wood powder. 10. Curcuma.
Adding animal substances	Salted and dried meat fibers
Adding artificial substances	Colored gelatin fibers
Adding organic dye substances	Martins yellow, tropeolina, fucsina, picric acid, tartrazine, erythrocin, azorubine, Cochineal A red, orange yellow, naphtanol yellow, rocelline, red etc.

Table 2. Most common saffron spice adulterations

Three different methods are used for detecting adulterations: Thin layer chromatography (TLC), high pressure liquid chromatography (HPLC) and microscopic analysis, described in detail in the Annex.

Thin layer chromatography has an average cost and is used for bacterial analysis even on large samples. If adulterations are detected by the TLC method, positive characteristics are detected through high pressure liquid chromatography (HPLC) which is a more sensitive detection technique. Nowadays, the ISO/TS 3632,2003 recommends the use of this method for identifying saffron dye substances as well as for

identifying acid water-soluble dye substances.

The HPLC method is used for the determination of three different elements:

- Identification of dye substances responsible for saffron's coloring intensity (crocin),
- Identification through artificial dye substances, water-soluble acid, pursuant to the ISO/TS 3632, 2003,
- Identification through fat-soluble dye substances.

4.4.2.2 Insecticide residue identification method

The European Union has not yet specified the maximum limits regarding pesticide residue in spices.

The Spanish law has established the HAR regulation (Highest Acceptable Residue) for a series of 430 pesticides in spices, in accordance with the unified law of April 2005. Fungicides and insecticides are among the defined pesticides with maximum limits varying from 0,01 mg/kg buprofezin to 400 mg/kg of inorganic bromide. Pesticide analysis takes place by applying the method of gas chromatography (GC) and preferably through mass spectrometry detection.

4.4.2.3 Microbiological analysis method

The microbiological method is not described in detail in the ISO/TS 3623,2003. The Spanish legislation is based on the Technical Health Regulation (RTS) for spice treatment, distribution and marketing because no specified standards exist for saffron spices. According to the RTS, the existing limits of pathogenic microorganisms and their toxins should be below following highest limits:

- *Escherichia coli* (1 x 10¹ col/g)
- *Salmonella* (absence of 25g)
- Sulfite reducing clostridia: seed production under anaerobic conditions (1 x 10³ col/g).

The microbiological methods applied on Greek saffron for microbiologic load determination as well as for detecting ferment and coliform organisms (*Escherichia coli*) are defined by the ISO 4833, ISO 7954 and ISO 16649-2 respectively.

In Sardinia, microbiological analysis takes place 30, 60 and 90 days after the sample is taken in order to determine a bacterial infection during conservation. One sample gram is being homogenized and separated in decimal solutions in order to tally the microorganisms that could be eventually present.

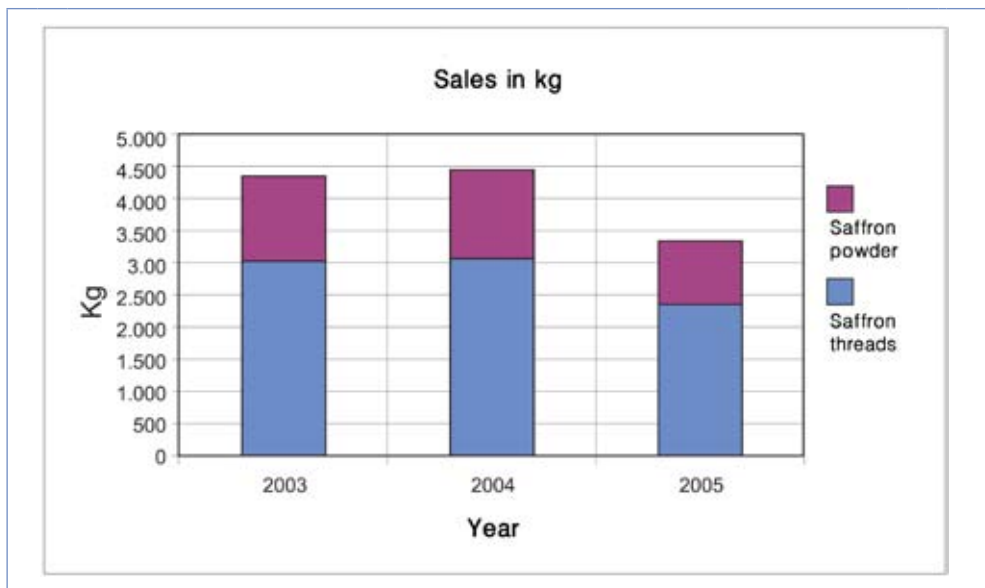
4.5 SAFFRON CONSUMPTION

4.5.1 FORMS OF CONSUMPTION

Saffron is consumed in threads or as powder. In Spain, saffron is used in flavoring tea, for the preparation of sweets and chocolates and as dye material. In Sardinia, saffron is added mainly to fresh pastry, to sweets and liquors. It is also used for dyeing silk scarves which is part of the traditional dress of the small village of Orgosolo located in central Sardinia. In Greece, saffron is part of powder mixtures, extracts or alcoholic distillates.

According to graph 3, in Spain, saffron is mainly consumed in threads. Due to high price of the product, the consumer wishes to buy saffron in threads in order to be able to control the quality of the spice.

In Sardinia, saffron is used mainly in powder form. During the last years, restaurant owners started introducing saffron threads in the preparation of traditional meals.



Graph 3. Comparing the quantities of saffron, consumed in Spain for the years 2003 – 2005 between saffron powder and saffron threads



Archive picture of flower separation (photo ALTEA)

4.5.2 CONSUMPTION PER REGION

In Spain, the region with the largest saffron consumption is Western Spain, located in the regions of northeastern Galicia, Astourias and Leon. This is indeed a bit peculiar, since the use of saffron is normally connected to traditional Mediterranean dishes such as Paella.

In Greece, the region with the highest consumption is Athens, representing 59% of the total saffron sales during 2005.

In Italy, the leading regions are the northwestern territories (Piemonte, Liguria, Aosta valley) representing 50% of the total sales. The corresponding Annex contains a detailed study of the market per region.

5 SITUATION ANALYSIS



5 SITUATION ANALYSIS

In the development of the European society we observe that the urban environment tends to prevail over the rural environment, a fact that leads to a progressive, however significant decrease of the agricultural activities and consequently, of the rural population. In that sense, the saffron sector, as a small component of the agricultural sector, is not an exemption to such crisis.

The objective of this chapter is to perform a diagnosis on the saffron sector in Europe and in particular, on the production regions of such spice: Castile – La Mancha (Spain), Sardinia (Italy) and Western Macedonia (Greece). Once this was obtainable, the other countries of the world were used as a reference in order to register the European saffron into a global context.

Following we mention the limits and problems noted and expected in the sector as well as the strong points and opportunities. Additionally, we point out the differences among the production regions or countries.



Saffron flowers (ITAP)

5.1 Cultural Tradition

The production system in Europe is the same in all regions with only few exemptions – in each zone under consideration. In Europe the saffron cultivation and the production of such spice remained unchangeable for hundreds of years. From the agronomic point of view, this is a negative fact. However, things look different once we consider that this fact allowed maintenance of a

production and processing system, which has been improved through out the years, being adapted to the soil and climate conditions as well as to the ethnic features. It's an inheritance carried to us by our ancestors, consisting of valuable and state of the art "good practices". To start with, we should point out the specific features of saffron in each region with regard to the tradition and production of such spice. In effect, as the European saffron represents the best in quality, range of the global production, such features enable us to distinguish between the saffron produced in a well-known region such as La Mancha and the saffron produced in Sardinia or in Kozani.

5.2 HUMAN RESOURCES

The depopulation of vast rural zones as well as the ageing of population are two major problems of the rural world. The solution to these problems lies in an adequate rural development policy, which motivates people not to abandon their land.

The shortage in labor force is a situation, causing trouble to those who seek field hands to carry out certain types of agrarian work. This problem aggravates due to the seasonality and the fact that the demand peak of labor force in the agro-alimentary industry is concurrent to the labor force demand in the agriculture, too. Consequently, the situation is difficult not only from the qualitative point of view, but in matters of training as well.

With regard to the human resources, the problems linked to the continuation are observed in the aggregate rural sector, but are emphasized in the saffron sector. The significant deficiencies noted therein, hindrance the continuation of the production and therefore they must be resolved:

- Depopulation of vast rural areas. The largest part of the European rural surface lies in communities, suffering from depopulation in the last twenty five years, as well as in the most disadvantageous rural regions, those situated afar from urban centers.
- Ageing of rural population. Nowadays the demographic development in Europe is poor or even negative in some countries. Thus, the rejuvenation of generations cannot be guaranteed. The rural world faces such grievous problem to a larger extent. With regard to the population potential in the rural sector, the rejuvenation of generations is in great danger, since only a small part of the active population is younger than 25 years. The saffron producers suffer from such problems as well.
- Shortage in agrarian labor force. For certain kinds of labor linked to saffron production, the shortage in labor force begins to become noticeable, since one has to search for workers from other regions or for emigrants, especially during harvest period and trimming.

- Lack of vocational training. It is particularly grievous in the primary sector and, just as the ageing problem, it discourages innovations in the sector. The vocational training level for cultivators and traders must be improved and upgraded.

- Shortage of women participating in the labor market. In the primary sector, the participation of women in all activity sectors is not significant, especially in the rural regions. The maintenance and development of saffron cultivation can lead to a social promotion of the female employment. Regarding saffron, the presence of female labor force prevails during harvest and trimming.

5.3

PRODUCTION SYSTEMS AND CULTIVATION TECHNIQUES

Nowadays, the cultivation of saffron is managed in the traditional way, almost in all cases. Generally, the tendency of reducing the production costs, does not lead to remarkable results and, consequently, the impact on the environment is limited. However, the idea of a sustainable agriculture does not cease to spread among many of the cultivators.

More over, the largest part of the saffron cultivation is carried out by small farm operators, generally in family farm operators and thus it is difficult to determine the cost structure beyond the direct costs. Besides, most of the times the labor hours of the family members are not calculated.

On the other hand, we have to point out the high development level of the forced production techniques. Its spread shall depend on the cost and benefit of the system in relation to other production systems.

Certain cultivation techniques are not very common, especially concerning their adjustment in the saffron cultivation. There are other techniques existing, but their use, though profoundly studied, has never actually flourished among the farmers.

The cultivation pathologies are complex and have never been an object of a profound study. This situation is aggravated by the limited number of diagnostic and plant protection services, necessary to all cultivations, and indispensable to those types of cultivation, endangered particularly, by one pathology. It is essential to improve the sanitary control in order to secure a longer plantation life: But in most cases such control is not put into practice, causing thus significant financial losses. Nowadays, *Fusarium* is the most serious plant pathology problem.

This kind of cultivation is mostly attacked by the common mouse or the field rat. (*Pitymys duodecimcostatus*). These harmful to the plants, animals are hold in check by burning baits imbued with sulphur. Such method is only partially efficient and cannot be applied on biological cultivations. In order to secure an optimal control system of such noxious agents, other methods should be analyzed in depth.

The weed eradication is very important on a local level and although it is considered insufficient, is indeed put into practice. In order to manage the production fall connected with the presence of weeds and to minimize the cost linked to the labor force employed for manual digging, we have to develop mechanical and chemical control systems.

The studies concerning the irrigation benefits linked to the production benefits in the agriculture, are not large in number and also lack of scientific basis so as to permit an analysis of the irrigation influence on the product's quality. It has been established that the use of irrigation water under low agrometeorological rain conditions and high evapotranspiration conditions can lead to higher production benefits and better quality. The climatic features of Sardinia and Western Macedonia do not demand an irrigation of the cultivation.

The selection of variety bears in itself a difficulty, intrinsic to the species. Due to the lack of improved material, the producers are obliged to use non standardized germplasmas and to copy with all the problems connected thereto, such as production efficiency, resistance to various diseases and weeds, as well as adjustment to the environmental conditions.

Regarding fertilizers, only few studies do refer to the substantial importance of nitrogen in the production of such flowers. In general, the quantity of fertilizers to be used, is decided on an arbitrary basis and is distant to the quantities recommended for a sustainable agriculture. The effects on the quality, caused by such products are barely known as well.

5.4

MECHANIZATION OF CULTIVATION

The labor force needed for the harvest, separation and drying of saffron is a handicap, that limits the profit margin of the European saffron producers. It is a double difficulty: On one hand, the cost for labor force is higher than the cost of labour in force in third countries. On the other hand, it is difficult to find an adequate number of workers needed for a limited period of time. Additionally, certain activities, such as harvesting of flowers or bulbs, are performed under unpleasant weather conditions, not to mention the discomfort posture the body adapts during work. All these make such task extremely difficult and ultimately, insignificantly profitable.

Consequently it is very difficult to compete with the costs of saffron produced in the third countries, and particularly in Iran, where the final price of the product is based on the hourly cost of labor force, which is much lower than the cost of labor force in Europe.

Generally, in the European agricultural sector, we have to take also into account that we are dealing with an old and worn out farm machinery. Also in the sub-sector of saffron, the question to enter into mechanization or not, is still an unsettled matter. There are many activities and works carried out today in the same way as they were carried out cen-

turies ago, due to the fact that the progress in the development of the saffron cultivation is poor compared to other intensive cultivations.

On the other hand, as such production systems depend on the manual labor, the size of the fields is small and therefore the mechanization is even more difficult to take place.

However, attempts, especially by private individuals, to mechanize certain activities have been partially successful, although endlong accompanied by a breeze of obscurantism concerning their distribution.

5.5

IMPROVEMENT OF THE STIGMA SEPARATION CONDITIONS

The separation of stigmas from the flowers as well as their collection is nowadays one of the factors limiting the expansion of the cultivation. The separation by hand is not a problem, as long as the regions producing saffron are small in size and well distributed within the entire territory. Thus it is easy to search for persons, available to carry out such task in the rural zones. Besides, this activity is considered to be pleasant by the majority of those engaged in such task, because it can be carried out in sheltered areas -unlike the harvest of flowers-, and can be combined at the same time with other activities such as watching television or discussing, which are habits, deep rooted in the adult rural population.

New generations discard these activities, which are, as a matter of fact, contrary to their hasty rhythm of life. However, it is not so much a generation problem as it is the fact, that within a scenario to expand the cultivation, the labor force needed for the separation of stigmas could be a limiting factor for the production.

We are also concerned about other minor problems connected to the current difficulty in distributing the saffron flowers that must be separated, at each home and in collecting the separated stigmas. The distribution of saffron flowers at each home, the delivery at the beginning of harvest as well as the collection of the separated stigmas, are factors that reduce significantly the efficacy of such activity and consequently increase the costs.

5.6

PRODUCTION OF BULBS

The production of bulbs is integrated in the cultivation of saffron flowers, but nowadays bulbs are not exclusively cultivated. The cultivators use flowers produced in the traditional saffron cultivation. At the end of the production cycle the cultivators are the ones removing the bulbs by their roots in order to use them in the next cultivation or in case of surplus, to sell them to other producers.

This approach has a number of disadvantages such as:

- The supply of bulbs is diffused in the entire territory and involves, in generally, only small quantities. Consequently it would be difficult for those who plan on starting a saffron cultivation to find bulb lots for creating new cultivations.

- Farmers are not equipped with suitable extraction tools and apply traditional methods. This is why, on one hand, a large number of bulbs cannot be extracted and secondly why the yield is very low. As a result the bulbs are sold at a very high price. Thus, starting a new production activity can be quite expensive.

- The lack of suitable tools for the extraction of bulbs has also other impacts such as bulb damage due to mycosis.

- After harvest, the bulbs are stored – for drying – most of the times under inadequate conditions and not in large covered areas. In this way bulbs are exposed to rodents.

- Generally, bulbs are not sorted out according to their diameter, because this would involve complex and expensive equipment for the farmer. The lack of variation based on the diameter does not allow a more efficient utilization of the bulbs. During manual cleaning, bulbs are placed in different baskets and sacks according to their dimensions.

- Phytosanitary treatment of bulbs involves machinery specifically used for spreading and drying of bulbs. Necessary treatment can thus not be performed and apart from the damages caused during harvest, bulbs are also exposed to diseases. This situation represents one of the major causes of low yield.

- The absence of official certifications to the cultivated plant does not offer official guarantees for purity, homogeneity and health.

5.7

HYGIENIC AND SANITARY PROBLEMS

Problems such as the presence of insects, larvae and microtoxins often observed in the saffron cultivation of the third countries, do not exist because during drying, high temperatures prevent from proliferation of insects, fungus and bacteria.

5.8

PRODUCTION EVOLUTION

The basis of the production chain is the cultivation and production of saffron. This chain encompasses a number of critical factors for the future and development of this kind of agro-industrial activity.

In Spain, production has been progressively decreasing over the last 15 years and today we can undoubtedly say that the sector faces a crisis. The situation is similar also in Greece.

Contrarily, the situation in Italy and particularly in Sardinia is different. The cultivating surface, though small, is increasing progressively due to the aid in plantation that the farmers receive, but mostly due to the high price set on the product.

Currently, the quantity of saffron sold in the international market is bigger than the one produced in Europe. This situation can not be sustained in the future.

5.9 COMMERCIALIZATION

Spain is the leading saffron supplier worldwide. According to the statistics of the Ministry of Economy and Finance, the primary saffron-importing nations are the Gulf countries, followed by the U.S.A.

5.9.1 *Producer price*

A critical factor in the production sector is the low income of the saffron producers, which leads to the difficulty of acquiring necessary tools and machinery. Consequently farmers turn to primitive cultivation methods. This problem is associated to the deficiencies of the product's market and although they relate to other vegetable cultures as well, the saffron sector is the most affected one. All these originate from the lack of education, training and information that should be offered to saffron producers. The existence of an oligopoly in the commercialization process is also another obstacle.

The price of saffron produced by Greek farmers is lower than the price of the Spanish producers. The aim is to adjust to a common price level similar to the prices of the producers in Sardinia.

Within the current system of saffron commercialization it is understood that the supply is lacking of necessary centralization and co-ordination. The number of producer organizations is limited and in some cases even inexistent. Consequently their influence on the commercialization process is very poor. Thus it is very important to improve such kind of production and commercialization structures.

5.9.2 *Lack of differentiation*

Due to strong competition in the international market, products and services offered by enterprises and especially by the smallest ones, have less chances to a successful commercialization. In the saffron sector this could force products or enterprises, of which the competition in the international market is based on the product price, to exit the market.

5.9.3 International Market

Historically, the saffron produced in La Mancha and Kozani is considered to be the best one in the world in terms of quality. The saffron produced in Sardinia bears the same excellent quality features but due to its limited production and commercialization, it is not yet widespread in the international market. The exceptional reputation of such saffron qualities goes back many centuries ago and given the fact that the production in these areas has decreased considerably, importers from all around the world demand that the saffron produced in the third countries should meet the quality standards of the European saffron. Certain traditional product types such as small saffron sticks or filaments, which are typical for India or Iran, are not any longer available due to their low demand in the market.

We were astonished to discover that although European saffron is highly acknowledged and appreciated by the international market, it is still a quite unknown product in the domestic market. European consumers know little about its origin, the protected designation of origin, its particular organoleptic features, beneficial properties and most appropriate utilization of saffron produced in the European Union.

The incorrect conception according to which saffron is expensive, is well-founded if we calculate it in an absolute value (€/kilogram) but not if we would take into consideration the necessary minimum doses. It has transformed saffron to a luxury that disappeared from the households as to be replaced by synthetic colourants, petroleum derivatives such as tartrazine on which scientists still debate about its potential harmful effects on health. However, a number of traditional activities such as handcraft manufacturing of wool and cotton, production of carpets and hats, began using this spice again to dye fibres. This demonstrates that despite its high price and due to its strong colouring effects, saffron is still an interesting product especially when used as an alternative to synthetic colorants.

5.10

EUROPEAN SECTOR SWOT ANALYSIS

5.10.1 Strengths

- **Production technology.** Compared to other producer countries, we are able to use technology that allows us to produce in an efficient manner and with upgraded cultivation techniques, including mechanization of cultivation.

- **Drying technology.** Drying methods performed in all European producer regions can guarantee for the preservation of all necessary organoleptic features of the product. After separation of the stigmas, saffron is dried rapidly in appropriate hygienic conditions.

- **Phytosanitary problems of saffron.** Problems such as the pres-

ence of insects, larvae and microtoxins often observed in the saffron cultivation of the third countries, do not exist because during drying, high temperatures prevent from proliferation of insects, fungus and bacteria.

- **Quality.** Appropriate care taken by the farmers, good hygienic conditions, the elaboration process and also high temperatures contribute to producing a homogenous saffron of the finest quality without risks in terms of food safety.

- **Quality certification.** Methods applied for quality assurance are widely known and enterprises are able to use the necessary technology in order to guarantee for the product quality to consumers.

- **European saffron certification.** Globally, saffron produced in La Mancha and Kozani and saffron produced in Sardinia, yet to a lesser extent, is considered as the best saffron by international importers and specialists.

- **Commercialization.** The excellent reputation of the European saffron and the competence of the production and commercialization enterprises enable an elaboration of 80-90% of the international saffron market.

- **Supporting infrastructures.** All three countries, which are the subject of this study, have established public consulting services addressed directly to the farmers. Technical institutes and universities are dealing since many years with issues concerning the saffron cultivation.

- **Food industry.** Existence of significant supplemental and diversified industry that can efficiently adapt to necessary changes.

- **Services.** Services are well structured. Good level of provision of services, technical support and training.

- **Diverse employment opportunities.** There is great tradition in the use of saffron for many purposes: saffron is used for example in gastronomy but also in other sectors due to its pharmaceutical and colorant properties.

5.10.2 Weaknesses

Weaknesses regarding the saffron sector are located in the fragility of the production chain, in interrelation mechanisms among the actors of production process, in the necessity to include technology and technical assistance within the process, as well as in the lack of common strategies for access in the markets.

- **Production fall.** Production has been decreasing for the past 15 years. Statistics confirm that saffron sector in Spain and Greece is facing today a crisis. In Sardinia the situation seems to be rather different due to the limited production but also because this region has managed to overcome the difficulties in the past.

- **Price.** A critical factor in the production sector is the low income

of the saffron producers, which leads to the difficulty of acquiring necessary tools and machinery. Consequently farmers turn to primitive cultivation methods. This problem is associated to the deficiencies of the product's market and although they relate to other vegetable cultures as well, the saffron sector is the most affected one. The price of saffron produced by Greek farmers is lower than the price of the Spanish producers. The aim is to adjust to a common price level similar to the prices of the producers in Sardinia.

- **Cost allocation.** It is still very difficult to calculate the costs in a realistic manner due to the features of the cultivation. The largest part of saffron production is, indeed, managed by small farm operators recruiting family members for labor force without calculating direct costs and working hours of the family.

- **Production systems.** Today saffron cultivation is performed in most cases according to traditional production methods, which are quantity rather than quality orientated. In general, farmers tend not to reduce economical costs and above all, they tend not to take into consideration the environmental impact on the cultivation. However farmers are getting more and more acquainted with the term of sustainable agriculture.

- **Cultivation techniques.** Assuming that advanced cultivation techniques, being part of the strengths mentioned in this list, do exist, they are barely known to farmers, especially those concerning the adaptation of techniques used in other productions as well as for appropriate irrigation use, if necessary.

- **Lack of coordination between producers and infrastructure,** resulting in misdistribution of resources disposed to the involved actors.

- **Mechanization of cultivation.** It concerns the unsettled major issue in the saffron production. Many activities and tasks are performed today in the same way as they were performed centuries ago. Saffron cultivation has been less evolved compared to other intensive vegetable cultivations. Attempts to mechanize certain activities have been made by private individuals: these attempts were partially crowned with success, although accompanied by a breeze of obscurantism concerning their distribution.

- **Dimensions of saffron fields.** Cultivating saffron fields are small in size, corresponding to manual production methods, obstructing thus the mechanization of process.

- **Labor force.** As certain cultivation activities are not mechanized, the need for labor force at certain periods of time is very big. For particular tasks the lack of labor force is becoming a major problem.

- **Ageing of saffron producers.** This problem has an impact on the entire agricultural sector, but in the saffron production sector the consequences are severe.

- **Lack of vocational training.** Lack of vocational training is a major problem in the saffron sector if we consider that along with the aging of population, it is a substantial barrier to innovations in the cultivation.
- **Production of bulbs.** Bulbs are never exclusively cultivated. Cultivators use the bulbs obtained from traditional flower cultivations. This practice leads to a series of additional problems.
- **Consumer's inability to distinguish quality.** Although distinction among several quality features is one of the strengths of the saffron sector at wholesale and purchase, the attained level is insufficient and does not allow the end consumer to distinguish various qualities of saffron and its origins.
- **Commercialization channels.** Apart from Greece, we observe an extreme fragmentation of supply in the current commercialization chain of saffron. On the other hand producers fail to orientate the commercialization channels and the production and commercialization organizations are not sufficiently developed.

5.10.3 OPPORTUNITIES

- **Tradition and tourism.** The long cultural tradition of saffron cultivation and use for various purposes opens the door to improvement and revaluation of this spice that could be promoted as tourism product within the production regions and become the starting point of agro-tourism development by emphasizing the archaeological sights, the European historical traces of saffron, the beauties of cultivation, the shops using this spice, as well as the gastronomy of the production regions.
- **Market demand.** Today the demand in natural food colors and additives is higher than the demand in synthetic colorants, flavor enhancers and aromas.
- **Complementary cultivation.** The cultivation of saffron is regarded as a complementary cultivation, since all necessary activities related to it are harmonized to all other cultivations of the production regions.
- **Promotion of female employment.** Social promotion of female employment is a substantial condition of sustaining the cultivation of saffron. In the case of saffron, the presence of women labor force predominates during harvesting of flowers and mostly during separation of the stigmas.
- **Applications in pharmacology.** Over the past decades scientific researches brought to light the pharmaceutical properties of saffron used in the antiquity for medical purposes. It would be a great opportunity to profit from the increasing interest of the Europeans in natural medicine in order to promote saffron consume in virtue of its pharmaceutical properties but for the health as well.

- **Other uses.** Over the last years the use of saffron as a dyeing agent for fabrics and colors in general, has been increased.

5.10.4 THREATS

- **Third countries low price policy.** The international price of saffron is substantially lower than the price of saffron sold by European producers. Although saffron from the third countries is poorer in quality, the lack of corrective and preventive actions will lead not only to the extinguishment of this cultivation but also to loss of competitiveness of the commercialization enterprises, which will be replaced by third country enterprises.

- **Depopulation of rural areas.** Traditionally, saffron is cultivated in the most disadvantageous rural regions, those situated afar from urban centers. The abandonment of this cultivation would lead to depopulation increase of these rural areas.

The table below, demonstrates a compound analysis of the European saffron sector as a whole but also with reference to each one of the regions studied herein.

Strengths	
Europe	<p>Resources</p> <ul style="list-style-type: none"> • Profound historical and cultural tradition of saffron production and consume. • Existence of supporting infrastructure and food industry and services. <p>Economy sectors</p> <ul style="list-style-type: none"> • Increased number of employment opportunities created in the saffron sector • Gravity of European sector at a global level • Advanced and accessible technology for the production of saffron <p>Organization system</p> <ul style="list-style-type: none"> • Producer association owning a Protected Designation of Origin registration • Presence of efficient technical institutes for the transfer of technologies <p>Commercialization</p> <ul style="list-style-type: none"> • European enterprises are in control of approximately 80 - 90% of global trade • Acknowledged quality product, which preserves its typical features • Guaranteed food product safety
Sardinia (Italy)	<ul style="list-style-type: none"> • Organic cultivation • High price paid to the cultivator • Product differentiation: designation of origin • Strongly linked to history, culture and environment of the production region
Western Macedonia (Greece)	<ul style="list-style-type: none"> • Increased production • Producers are well organized • Product differentiation: designation of origin
Castile-La Mancha (Spain)	<ul style="list-style-type: none"> • Medium size cultivations • Medium level of mechanization • Product differentiation: designation of origin

Table 3a. Strengths and weaknesses of the saffron sector located in each one of the European countries studied herein

Weaknesses

Europe	<p>Human resources</p> <ul style="list-style-type: none"> • Production areas with low demographic density suffering from depopulation • Ageing of agrarian labor force • Lack of labor force • Insufficient vocation training for producers <p>Agricultural sector</p> <ul style="list-style-type: none"> • Production decrease • Extreme fragmentation, small-size cultivations • Decreased productivity, low profit earning capacity • Difficulty in limiting economic costs and environmental impacts • Outdated cultivation techniques. Absence of mechanization • In need for more workers • Insufficient bulb production and supply • Lack of sector innovation and renewal <p>Commercialization sector</p> <ul style="list-style-type: none"> • Insufficient centralization of supply • In need of significant improvement in production and commercialization organizations • Consumer's inability to distinguish quality <p>Organization</p> <ul style="list-style-type: none"> • Weak and ineffective cooperatives • Lack of coordination between producers and supporting infrastructures
Sardinia (Italy)	<ul style="list-style-type: none"> • Low quantities • Small-size cultivations • Absence of mechanization • Fragmentation of production enterprises • Fragmentation of supply • High average age of producers • Difficulty in locating workers
Western Macedonia (Greece)	<ul style="list-style-type: none"> • Low level of mechanization • Small-size cultivations • Low product price • Outdated cultivation techniques
Castile-La Mancha (Spain)	<ul style="list-style-type: none"> • Low product price in relation to Italy • Low domestic consume ratio

Table 3b. Strengths and weaknesses of the saffron sector located in each one of the European countries studied herein

	Opportunities	Threats
Europe	<p>Agricultural sector</p> <ul style="list-style-type: none"> • Cultivation is well adjusted to the sustainable development policy <p>Economic activities</p> <ul style="list-style-type: none"> • High development potential in the services sector and particularly in tourism • Restructuring of cultivation, profit planning modifications • High cultivation potential through irrigation of marginal rural regions due to aridity <p>Organization</p> <ul style="list-style-type: none"> • Cooperation among European production countries • Well organized National and Regional administration <p>The market</p> <ul style="list-style-type: none"> • Increasing demand in organic products • Promotion of other uses apart from the uses in the food sector 	<p>Agricultural sector</p> <ul style="list-style-type: none"> • Abandonment of the European production • Inability to adjust to crisis in the trade <p>Economic activities</p> <ul style="list-style-type: none"> • Small-size cultivations • Decrease of European production, affecting the product's commercialization • Deregulation of agricultural markets and competition increase

Table 3c. Strengths and weaknesses of the saffron sector located in each one of the European countries studied herein

6 **STRATEGIC PLAN.**
INNOVATIVE SOLUTIONS



Mechanization of installations

6 STRATEGIC PLAN. INNOVATIVE SOLUTIONS

6.1 OBJECTIVES

The objective of this strategic plan is to offer solutions on the above difficulties and problems.

The strategic plan was drawn up on the strength of our belief, that the saffron sector has a remarkable development potential. Following, we set out a number of idea concepts – some of them may be older but many of them are rather innovative – that could be useful in increasing saffron cultivation areas in Europe, promoting production continuation, expanding commercialization and in increasing consumption on a global level. In short, all proposed concepts aim at supporting all information that could increase the potential of saffron sector.

The successful implementation of such innovations lies in the hands of public organizations and institutions as well as in the hands of private persons and enterprises. That is the reason why we should become more aware of how important is to maintain a tradition for a cultivation that has increased profit in the European agricultural sector.

All presented ideas are consistent with the general regional development objectives, namely:

1. Creation of new employment opportunities by improving regional competitiveness and



Fresh stigmas

- production network in order to support economical and social restructuring of rural areas.
2. Support of small and medium-size enterprises by promoting creation of new enterprises and helping increasing competitiveness of the already existing ones and finally for fulfilling the objective mentioned below
 3. Support for the development of the fragile and disadvantaged rural areas.

There are no magical solutions or only one solution to the issues of agricultural development. Rather necessary would be to combine small-extent measures, proposals and solutions to increase the income of farmers. The lack of labor force in specific production tasks cannot be solved unless we take necessary measures of restoring interest to the rural population in their territory and responding to demands for a better life quality. The cultivation of saffron could play significant role in achieving this goal. Traditionally, the cultivation of saffron was seen as a supplemental income source in relation to the income resulting from other more important cultivations. On the other hand, tasks demanding a large number on labor force, such as harvesting of flowers, separation of stigmas, are performed during seasons where no important activities take place in the fields.

Among the objectives – registered in the orientations of the European Agricultural Policy – the cultivation of saffron must contribute in:

1. preserving a minimum economic and social network of the rural population
2. enabling diversification of economy

The cultivation of saffron allows us to foresee possibilities of improving living standards in the most disadvantaged areas.

The reinforcement of the sector demands coordinated efforts performed by all production chain components, since improved competitiveness could result from a complex and dynamic interaction among state, intermediate authorities, enterprises and organizational capacities of a society. This complex organization model is based on a dynamic dialog among production sector, scientific and technological sector, intervening institutions and the public sector in view of achieving structural change.

6.2 PROMOTION OF AGRICULTURAL PRODUCTION

In Europe, cultivating fields and consequently production could grow significantly. For instance, names such as “Spanish saffron”, “Saffron from Kozani” and “Azafrán de La Mancha” achieve high penetration levels in the global spices market and large amounts of saffron products could be absorbed by the international trade.

Furthermore, this specialized market needs to be supplied with European high quality saffron products. Consequently, the promotion of saffron production should become the priority objective of the strategic plan. On achieving this goal, the proposed solutions are indicated below:

6.2.1 MECHANIZATION OF CULTIVATION

Direct support to producers should be regarded as a high priority measure and initial encouragement to start a production activity that could be currently considered critical in a sector facing a crisis. The guidelines to such aid could be as follows:

- Direct support for prices within the frame of an agreement plan in order to achieve compromises in terms of a minimum selling price. This measure could be beneficial not only to the already existing producers but also to potential ones.
- Support initially for traders that could be included – if necessary – in different financing plans: this solution should be a transition solution, non definitive and should be removed as soon as other measures are introduced.

6.2.2 DIRECT SUPPORT TO PRODUCERS

All solutions, increasing productivity of labor force due to improvement of the working conditions and dilute of the most heavy work tasks, should be identified and reported.

A first step could be made in the mechanization of flower harvesting. Today, knowledge and experience disposed to us are sufficient to achieve this objective. There exist different types of harvesting machines and platforms that support manual harvesting (harvesting tasks are performed close to the soil by workers seating or lying on a platform. Among other tasks, these platforms are used for cabbage lettuce, chicory and asparagus harvesting) or scissors used for fence clipping or at integrated flower harvesting machines.

A second step could be the mechanization of bulb planting and eradication. Various mechanized systems exist nowadays combining these two tasks. For instance, a harvesting machine can be integrated in the planting system, which is considered as the most adequate one. All machinery taken into consideration can significantly increase efficiency of the above tasks compared to manual labor.

Adapting some of the above measures will lead to partial or even total mechanization of the cultivation, helping thus farmers to increase cultivating fields and decrease production costs that are currently rather high.

Some of the progress made in the saffron sector due to technological research and development, is difficult for a sole producer to adapt. However, this could be much easier for an agricultural exploitation partnership.

In particular, cooperatives or similar establishments could be created for the purchase of heavy task farm machinery. The size of cultivation fields nowadays cannot support the purchase of such machinery given the fact that limited annual use of such machine, could not depreciate the cost of purchase.

A joint utilization of such machinery involves the ability to employ in groups, skilled workers for handling more complex or delicate machinery.

A joint property on machinery permits:

- planting, eradication, selection, classification and disinfection of bulbs,
- formation of ridges
- harvesting of flowers
- automatic separation of stigmas from the flowers
- integrated stigma drying

Services provided by such associations could embrace also other activities, tasks or infrastructure such as:

- large storage areas equipped with tables for the separation of stigmas
- cooling rooms for flower conservation
- workers employed to work on the fields
- suitable areas for spice storing, that guarantee conservation, safety against theft as well as against various other problems involved in the storing of saffron at home
- signing of collective insurance contracts against bad weather, theft or other disasters.

The current saffron production could be considered as organic or ecological cultivation, given the fact that cultivation methods are approved by quality control organizations for biological products. This means that this kind of production does not involve the use of fertilizers, preservative substances, genetic altered organisms and that the cultivation is friendly to the environment. The only required condition would be a certification issued by the control institution concerning the origin of the product. The necessary time of such conversion would be three years, namely one year for commence of production and two years for the necessary conversion.

In Europe, production, treatment, labeling and organic product control, are regulated in virtue of the directive 2092/91/EEC. Each country has own institutions responsible for control and certification in accordance with the European Union law regulations. In Spain each autonomous community has its own control institutions, which perform periodical controls in order to guarantee compliance with organic cultivation regulations.

Nevertheless, we have to outline from the economical point of view, that organic cultivation means increase of product prices. On the other hand, some regions offer support to a small or even larger extent in organic cultivation. Consequently, the upgrading of fields for organic cultivation could be an alternative for introducing modern cultivation techniques.

6.2.5 Cooperative cultivations

Another innovative solution is represented in planting in municipality areas. In short, the idea is this: in all regions of traditional European production, the municipalities could define a small area (one hectare for instance) for saffron cultivation. Part of the field (100 or 200 m²) could be taken care by those who wish to harvest and separate flowers while their only obligation would be to deliver part of the production to the municipality. A corporation authority would be responsible for technical direction and maintenance of field homogeneity in terms of planting and other cultivating tasks.

Accordingly, all who wish to work in the planting and separation (either because they have done it in the past or because they think that it is pleasant task) will not be discouraged due to the difficulties linked to the cultivation of small fields.

6.2.6 Irrigation of cultivation

The need in water for a saffron cultivation is restricted as long as it grows during average temperature and humidity periods. The larger part of such need is satisfied by meteoric water, especially in Sardinia and Western Macedonia.

Saffron adapts very well to various irrigation systems (rain, local irrigation etc) so it would be interesting to trial a saffron production in dry or semi-dry areas. Irrigation water availability increases not only efficiency but provides also necessary visual quality and production regularity, regardless of weather conditions during the cultivation period.

6.2.7 Promotion of bulb production

The development of bulb production through specialized farms, registered as seed and steckling plants producers, would be an important step towards promotion of saffron cultivation.

These enterprises could supply the market with sufficient amount of reproduction material suitable for homogenous results and in accordance with health regulations in order to avoid plant disease spreading. In short, the existence of a certified material would be secured as it the case with other regular garden products.

Such benefits justify the establishment of new enterprises but the most important aspect to this is that these specialized enterprises could offer bulbs at lower prices.

6.2.8 Protected cultivation

Protected cultivation could be the alternative solution to the current production system. Various solutions – less or more recherché – permitting among other, scaling the flowering of saffron, are set put in the following section.

The first solution proposes coverage of open air cultivations with plastic canvases. Rotating periods when the field is covered or not covered in combination with the covering material, influent flowering in different ways. This method stalls flowering. The delay can be up to five weeks but this may be critical due to high frost risks in traditional production regions. Consequently it would be more appropriate to double harvesting with three weeks extension in order not to endanger cultivation.

The second alternative would be a green house covered with plastic of 2,5 m high, in order to enable tractor plowing (tractor without cabin). Apart from flowering scaling, the goal is to offer protection against bad weather such as rain, cold etc, providing thus solutions to some of the disadvantages of the first alternative and allowing a more extended flowering period. The third method is based on the formation of restricted zones such as greenhouses or air conditioned zones for soil or tray cultivation. This would allow seeding at least three times per year, achieving thus a density that would be three times higher than in a traditional cultivation. The only hindrance would be the high costs involved in this kind of cultivation.

6.2.9 Improvement of separation conditions

The solution to this problem involves mechanization of the separation task. Semi automatic separation machinery exists since few years. Such machines separate the threads from the other parts of the flower.

Nevertheless, there are certain problems that need to be analyzed and solved. These problems are:

- a) flowers for separation should have their petals and stems partially cut off. This task is performed manually nowadays. Although such task is not so difficult as the separation of stigmas, it is still a limiting factor.
- b) Residuals of stigmas and perianths, remaining in the machine, could cause problems such as:
 - b1) necessity for manual separation even though it is possible to develop machinery for this special task
 - b 2) pollen stains from the perianths, reducing the organoleptic quality of saffron.

Prototypes of such machinery have been perfectly developed by private enterprises in Greece and Spain but must be further improved in order to operate continuously. Anyway, the machinery is rather simple and inexpensive and could be purchased and used by any medium or large-size farms. Small-size cultivators could form cooperatives in order to afford purchasing of such machines and could share them with other cultivators for the separation of stigmas.

6.3 FOOD INDUSTRY

The central link of the saffron production chain is represented by the commercialization enterprises or industries for product storing and commercialization. It concerns areas of large product and technological know-how concentration. This also the reason, why all important financial actors of the sector, are gathered therein. They are in possession of the main technological capacity and management capacity of the entire production processes.

Saffron production enterprises maintain relations to all factors in every stage of the production process. Therefore, food industry should take up the role of an encouraging organizer and become the key factor for production development and improvement in all stages. This role is played by treatment and trade enterprises due to their higher level of technological development.

In order to preserve their leading position, they should continue innovating within the frame of food health and safety in respect to environmental laws.

6.3.1 BEST PRACTICES IN HEALTH SECTOR

The conditions of food product treatment, from the farm to our table, are responsible for defining quality and innocuousness of the products that we consume.

During the initial stages (harvesting and separation) producers are engaged in providing lifelong educational and health training to their employees, priority is given to issues of food hygiene and safety. This issue could make the difference from other production countries.

6.3.2 HAZARD ANALYSIS AND CRITICAL CONTROL POINTS

During industrial treatment, all basic regulations for hygienic treatment, storage, distribution and final food preparation along the production chain are governed by laws and regulations respectively.

Regulations include industrial plant planning and construction, task control, equipment maintenance, personnel hygiene and personnel qualification. Health regulations are an essential element to all production systems and guarantee for food safety by offering a system of hazard analysis and critical control points (HACCP).

6.3.3 IMPROVEMENT OF STORAGE CONDITIONS

Another important quality factor – already mentioned before – is the storage conditions. The use of appropriate structure for product storage has direct impact on product quality as it reduces the spreading of insects, fungus and other pathogenic organisms. Proper storage preserves crocine, picrocrocine and safranal content in saffron.

6.4 QUALITY, TRACEABILITY AND FOOD SAFETY

Actions aiming at distribution policies improvement should be taken by intensifying quality guaranteeing activities, traceability and food safety.

6.4.1 OFFERING IMPROVED QUALITY PRODUCTS

European saffron is considered the best in the world due to its chemical, physical and organoleptic features as measured by certain parameters. Due to its increasing market demand, new high quality verification standards and new evaluation methods (HPLC – High Pressure Liquid Chromatography and GC) should be introduced in order to determine accurately color, taste and aroma features. These standards should also define the exact methods applied in order to prevent fraud.

Using of such new quality verification tools, exact production procedures can be traced aiming at a better quality supply and protection of the attributed origin features.

The legislative authorities must be forced to release new standards for the saffron sector, inviting for maintenance of product purity in order to avoid adulteration and fraud.

6.4.2 TRACEABILITY

Compliance to traceability standards should be pointed out in order to avoid fraud in respect to the product's origin.

6.4.3 SERVICES OF LABORATORY ANALYSIS AND QUALITY ANALYSIS

It would be an opportunity to support laboratory analysis services for typical quality saffron spice features, performed by public or private laboratories in the sector.

6.5 RESEARCH, TRAINING AND KNOWLEDGE TRANSFER

Improvement of vocation training and information transfer, are two most important issues of the European saffron sector. Europe already possesses an important and strong training sector, good primary section education as well as vocation and academic training with efficient knowledge transfer authorities in agriculture.

Additionally, among other, in order to increase competitiveness against prices of third countries, the cultivators should have access to all new European saffron research developments.

6.5.1 PROMOTION OF APPLIED RESEARCH

The saffron sector adapts very well to the general goals of research promotion and knowledge transfer programs (even if the technology of the sector is not at pace with other agricultural sectors, given the fact that saffron production regions are located among the disadvantaged ones). Priority should be given to research and development activities that are closely connected to regional economic development, both in public and in private sector, focusing on new technologies and innovative byproduct development. These efforts should be able to count on the support of the public sector as well as private enterprises through collaborations for technology transfer from public to private sector and by adapting advanced technologies by enterprises.

Technology based enterprises and creation of new enterprises must be further promoted.

Our great interest lies in promoting the capacity of the employees to adapt to the changes occurred in the production sector.

6.5.2 TRAINING AND INFORMATION FOR PRODUCERS

Training is crucial for new producers given the fact that saffron cultivation is not so widely spread, compared to other grass plant cultivations in the region. This training should also address the existing producers due to the fact that many among them show potential and entrepreneur

spirit even if they still use outdated cultivation methods. It would be an opportunity to organize activities such as:

- a) **Introductory lessons** for cultivators and producers that are interested in such a new activity without any prior knowledge in saffron cultivation and its methods. Experienced cultivators could be chosen to share their knowledge and experience, provided they have overcome all initial problems, whose cultivations are an example to imitate.
- b) **Advanced lessons** for cultivators and producers with little experience in saffron cultivation, who must cope daily with cultivation problems. These lessons should be planned in collaboration with the sector's researchers, specialists and traders in order to mutually satisfy the various interests involved.
- c) **Publications.** Publication of research papers and information leaflets should be priority for agricultural research and experiment organizations. These publications should enlighten cultivation methods in order to improve training and information.
- d) **Websites.** The website of each organization as well as our website should contain information on certain methods for the promotion of the producers. At the same time, internet should respond to various demands of experienced producers such as: regulations, financial support, general methods, agricultural fairs, contests, distribution paths, relations between traders and research and knowledge transfer centers.
- e) **Meetings, seminars etc.** Meetings and informative seminars should be organized periodically in order to allow producers to contact with each other, to support communication, creating thus a critical level of activities enabling the team to maintain its operation.

6.5.3 TECHNICAL SUPPORT AND CONSULTING FOR PRODUCERS

These actions should be coordinated and supported by the qualified authorities of each country or region. Consulting, organized by experts of the sector should provide support for other advisory services, specialized in different areas such as plant health, weed research, production quality etc. These experts could be directly related to producer organizations.

6.5.4 EUROPEAN RESEARCH CENTER FOR SAFFRON PRODUCT AND BYPRODUCT USE

Apart from research, a link should be established between successful results in research and the market sector, in order to maintain domi-

nant position of saffron in the European scene. Thus it is important to establish a European center responsible for collecting, accumulating all information regarding saffron research and seceded results. The work of such center would constitute in improving analyses and experimentation (this could be performed by a sub-contractor) and in putting into practice the achieved results.

A number of possible research areas that could improve trade in the saffron sector are set out in section 6.6.

6.6 Commercialization

The key word nowadays is the word “sales”. The problems are evident less in the production stages but more in supplying the market with saffron products. In the standard food production chain (alteration/ distribution), power is centralized in the final stages, namely in the hands of those who are closer to the consumer.

The future of saffron runs through an improved interconnection among producers, traders and distributors as well as through modernization of trading channels as a consequence.

6.6.1 REINFORCEMENT OF COMMERCIALIZATION

Reinforcing the commercialization of the quality of European saffron, is a great and ambitious goal and an interesting aspect regarding subsistence of saffron cultivation in Europe.

The main objective of such improvement plan would aim at easier access to national and international markets for those who produce and elaborate this product. The partial objectives are set out below:

1. promotion of saffron produced and treated in Europe
2. food quality improvement
3. promotion of brand name creations and use
4. support of human resources training and specialization in the marketing sector and food technology
5. encourage formation of large producers corporations
6. support of distribution of innovative products that could satisfy market demand through research and development support in the food sector
7. encourage of internationalization of commercialization enterprises and products
8. consumer information and training (consumer organizations, housewives, schools for tourism)
9. information and training for large and small-size distributors as well as for retailers

10. information and training for distributors in order to become familiar with import methods of large commercial chains.

6.6.1.1 CULTIVATORS AND PROCESSORS

It is likely that the development of commercial activities by the cultivators will continue to show the same positive trend as in the example of Sardinia and Greece. Nevertheless, entrepreneur spirit of those who are involved agricultural exploitations, should grow further.

The majority of the producers nowadays sell their product individually. The absence of organization aiming at a collective commercialization has direct negative impacts on the price achieved. If the producers of one or more neighboring regions could manage to create an association, they would be able sell their product direct to enterprises and negotiate more favorable conditions than the current ones. They could also achieve access to retail trade.

We could picture, for instance, the creation of cooperatives specialized in commercialization or service cooperatives as described, that could directly sell the product (like the Greek cooperative “Krokos”) or sign trade agreements with distributors.

6.6.1.2 INTERNATIONALIZATION OF ENTERPRISES

The goal is to support internationalization efforts of all enterprises, by reinforcing export activities and support to small-size enterprises on individual and collective level. National and regional markets, though out Europe, are not so interesting as the global market.

For the achievement of such goal we propose following actions:

- offer assistance to entrepreneurs that participate in international fairs abroad
- support groupings and enterprise promotion teams
- support trade delegations of small companies
- locate opportunities in foreign countries based mainly on information from expert consulting and engineer offices and implementation of international projects abroad
- implementation of promotion actions in order to open new markets and to create new products

6.6.2 DIFFERENTIATION

The key to success of the excellent commercialization of Greek or Spanish saffron in international markets, but also of the Sardinian products in the Italian market is differentiation.

A product is differentiated when its varieties share common features

even if each one of them is different from the others disposed in the market. Product differentiation could refer to the existence of different quality levels for the same product or even to the distance in a certain geographical location, or to consumer preferences or simply to the fact that the variety of a certain brand name bears features that are different from other brand names.

Each type of saffron contains a common component but at the same time it bears also distinctive features, especially appreciated by the consumers. Certain results are achieved through price definition methods performed by enterprises in local and international markets. The proposed solution aims at creating the highest consumer appraisal and consequently, larger demand for a certain product. It is indeed a difficult task but it is important to know that techniques for achieving the desirable result are available: one of these techniques is the differentiation. Consumers, nowadays, are confronted to a large variety of brand names and presentation of the same product. The choice for the “best” product – namely purchase decision – is very complex and is influenced by:

- the product price in relation to the consumer buying capacity
- tangible and intangible features
- product differentiation.

The first two points are studied in other sections hereof. The third point, namely differentiation, is a concept transforming the product to something unique, that makes it different from all the other products of the same category, creating thus the buying impulse for the consumer.

We can differentiate a product in various ways and imagination. Here are some examples:

1. **identifying the specific desires of consumers.** Clients buy a product in order to satisfy a certain need but to satisfy specific desires as well. For instance, a consumer buys flavorings, dye substances, spices etc. If he/she finds a product among them that has a breeze of finesse it is very likely that he/she will chose it among others. It is very important to define the customer’s specific desires.
2. **finding new selling forms.** We can sell a product in many ways, in older or updated packages. The key is to sell a product in different forms and different ways leading the consumer to abandon innovation fears.
3. **rich variety offer and differentiation.** Rich variety is an advantage that distinguishes a certain brand name from another, preserving the interest of consumers.
4. **new presentation concepts.** Redesigning presentation of products could contribute to the increase of sales. Any kind of innovation incorporated in a product, could transform it into a dif-

ferentiated product and help it obtaining a dominating position in the market.

Competition exists only when differentiation is available. Otherwise the only selling argument is the price, a fact that can promote neither small enterprises, nor the European saffron, which enjoys high quality and prices.

6.6.3 BRAND NAMES

Currently the sector goes through a global phase of strong competition, where sales become very difficult to manage. Anticipations in the trade sector are not very prospective. Nevertheless, in Europe the current the objective is nothing else rather than the creation of a mass production that promote the competitiveness of saffron in relation to products from other countries with lower production costs.

The average European consumer is more informed and possesses a more significant buying capacity. Exposed to a large offer on food products, he would normally chose quality instead of quantity.

It is not easy to define the term “quality” as discussed in section 6.3, but as far as food is concerned, quality is strongly correlated to health, which is the basis for the promotion of saffron in relation to alternative spices such as tatzarine.

The distance between necessary minimum quality pursuant to current regulations, and the quality found in the gastronomy market, that sets higher quality standards, we encounter a huge variety gamut.

The final objective is to sell at a good price as presented in the Sardinian example. For fulfilling this purpose, we should form a distinguished production for high and consistent quality but for fast product distribution as well. This is where brand names could play an important role.

Below we set out some of the proposed options, avoiding mentioning details, that would not be part of the objective of the present study:

- brand name
- collective brand name
- guaranty label
- protected geographic indication (PGI)
- protected designation of origin (PDO)

6.6.4 DEVELOPMENT PERSPECTIVES OF THE SAFFRON SECTOR IN THE EUROPEAN AND INTERNATIONAL MARKET

All enterprises involved in the commercialization of saffron share the opinion that the international market demand for saffron is stable. Consequently, within the current globalization economy frame quality is more important than quantity. In that sense, demand for better quality is a reference element to local markets with a more sophisticated clientele, well aware of its needs,

which forces enterprises to improve constantly their products and to find thus new markets for differentiation. These gaps in the market represent the best opportunities for the European saffron development.

The domestic European market has the possibility to grow. In this market, high quality coexist next to average quality products consumed by clients that scarcely use this kind of spice and have thus low expectations regarding its quality. This market is threaten also by alternative products – new or established ones – that could easily satisfy low expectations of such clientele.

6.7 NEW WAYS OF USE AND NEW ACTIVITIES

6.7.1 NEW PRODUCTS

Apart from the supplemental actions proposed above, the structural condition of this balanced and stable sector, would suggest that the key factor for future development would be the promotion of saffron by-products.

The largest part of saffron existing currently in the market, has been the object of a very elementary treatment i.e. drying, which brings low added value.

Following, we propose a variety of alternatives regarding traditional use and products:

- selling bulbs for gardening, decoration or embellishment (possibility offered to the buyer to perform harvesting, separation and drying in his own kitchen.)
- Animal food products deriving from leaves, bulbs and dried flowers, with combination and differentiation related to the existing saffron
- Beverage production such as horchata de chufa, made of soaking the bulbs in water and adding sugar
- Use of the plant in floriculturist centers, parks and gardens. Use by florists during the months October, November and December
- Introduction of saffron in the traditional cheese preparation, typical for each region
- Use of the flower for phenolic dye substances

6.7.2 RURAL TOURISM

In search for new activities in the leisure sector, demand is orientated to a kind of tourism that is not addressed to the masses, with certain financial level standards and emphasizes on the rural environment, its traditions, nature, landscapes etc.

The exploitation of the huge tourism potential (rural and cultural tourism) of various saffron production regions could help create a more sustainable socioeconomic network. Reference is given to the creation and improvement of new compatible activities with cultivations beginning with offering even lodgings, or selling local products.

The key is to take advantage of the enormous charm of nature during saffron flowering, attracting a significant number of visitors to the rural areas. Indeed, the cherry blossom flowering in the Jerte valley could be an example to follow, due to large number of similarities. For instance both saffron and cherries have only two flowering periods during the entire year that last only few days. Instead of this being a weakness, it spreads an aura of fragility and uniqueness. As described in the advertising slogans “this wonder is one of nature’s most precious gifts given to us every year”.

Communities should develop various activities with reference to this occasion such as:

- Exact information through mass media in terms of dates and periods of flowering
- Observation and participation of “rural tourists” in the harvesting, separation and drying activities
- Marked routes and visits to fields with blooming saffron
- Saffron routes with excursions in the fields and in other areas of interest
- Recreation of sales and purchase activity scenes according to traditional customs
- Production of television, radio and other programs for national broadcast, transmitting from the production areas
- Excursions for tasting of saffron products and byproducts
- Organizing gastronomy seminars

In conclusion, we welcome any activity that could contribute to the fundamental objective of rural tourism i.e. differentiation of rural activities in order to increase cultivation profits and offer a supplemental income.

6.7.3 INTER-PROFESSIONAL ORGANIZATION IN THE SAFFRON SECTOR

The objective of a inter-professional organization would be to support the development and interests of the sector in all its various aspects. It could also form the ground on which collective actions could take place and new ideas could be created.

This initiative should integrate all different elements of saffron sector in order to gather the efforts made by all involved parties. This integration organization would be responsible for:

- acting as a correspondent on behalf of third parties: European

organizations, ministries of agriculture, International Standards Organizations etc. or to act as representative of the saffron professionals aiming at exercising its lobbying power and capacity

- defining objectives for research groups
- expanding cultivation and promote alternative methods
- supporting saffron consumption as described in section 6.5
- performing constant technical control through experts. In order to cope with the changes taking place in the saffron sector, a control should exist in legislation and documentation that affect the sector, in order to maintain a contact network that allows information gathering directly from its source.
- selecting important information and forwarding it to all members, saving thus management time for enterprises
- negotiating and defending the profession on all general issues as well as on more specified technical areas, maintaining presence in national and international level and influencing planning
- collective action: supporting producers, encouraging regulation enforcement and common plans, creating a collective brand name and/or quality label, propagation through mass media, forecast management regarding employment, planning and drawing up of strategic action plans including identifying financial resources
- organizing meetings and professional exchange in order to terminate isolation among producers, marketing enterprises, entrepreneurs etc and to encourage collaborations and exchange of ideas
- intervening in research and experimentation of the sector, unifying the efforts of national and international corporations aiming at coherence and integration. Active participation in technical comities that share the same goals, creating a lobby in order to translate the needs of the sector in experimental projects
- participating in training programs.

Participating organizations could be for instance:

- various organization responsible for European names of origin
- regional administrations and regional rural representations
- farmers organizations and agricultural delegations of the region
- saffron commercialization enterprises
- universities, university departments, research centers and teams
- technical institutions and other training organizations
- small supermarket representatives as well as large-size distribution representatives
- consumer associations

For the creation of such an inter-professional organization, it is nec-

essary that human and technical resources are available. Human resources should be coordinated by a person capable of establishing collaborations. This person should be elected by the members. He would be assisted by an agriculturalist, a certified public accountant and an administrative official. Regarding technical resources, there would be no important change, provided this organization would have no executive, controlling or research obligations.

6.7.4 SAFFRON PROMOTION CENTER

An interesting initiative would be the creation of a center, established anywhere in the European Union, aiming at the promotion of saffron. For this purpose a mass media expert who is familiar with statistics, international exhibitions and other events with reference to the saffron sector.

This organization center could be involved in preparing mass media marketing campaigns for saffron or its byproducts (liqueurs, perfumes, medicine etc). It could play the role of a permanent consultant to gastronomic schools, a saffron ambassador in Europe by supporting and searching for new consumer potentials.

It could be also possible to create European offices (financed by distribution enterprises) providing information on enterprises and proposed products, presented in a sample package (to increase reliability). Various points of reference could be thus created with the possibility of offering a wider, more reliable and modern range of saffron product variety.

6.16.5 TECHNICAL BUREAU OF SAFFRON

Another initiative could deal with the possibility of contacting experts qualified in the saffron sector, employed in a regional community (such as the Regional Agricultural Service). This person could offer free advice to the cultivators on saffron cultivation questions.

In this way, it would be possible to evaluate if technical advice can really influence the current trend of field decrease, destined for saffron cultivation.

7 CONCLUSIONS



Flower separation (phot. UCLM)

7 CONCLUSIONS

The saffron sector in Europe has taken top position in the international ranking. The cultivation of such spice represents an important support to the economy of the production regions of Castile-La Mancha (Spain), Western Macedonia (Greece) and Sardinia (Italy). It would be appropriate to identify the measures for promoting and supporting the production, at least in a transitory phase, in order to overcome the current production crisis of the Old Continent. These are the most important conclusions resulting from the White Book of saffron:

1. The cultivation of saffron is an opportunity to increase the economy, develop the agricultural sector and generally, to support all disadvantaged European production regions. In general, the introduction of the plant to the rotation cycle of cultivation, improves the obtained results.
2. The methods applied nowadays are outdated, while newer ones are not positively accepted and are rarely used, even though some of them have proven to be efficient in the field.
3. The lack of labor force leads unavoidably to the mechanization of cultivation.
4. It is necessary to perform systematic hazard analysis as well as to monitor weaknesses of the production systems in the sector, guaranteeing high quality and product safety.



Fresh stigmas (Corongiu)

5. Enterprises involved in the treatment and commercialization of saffron, should invest in creating etiquettes that would allow a better differentiation of the saffron quality.
6. All national and international quality control standards should be reinforced in order to limit spreading of adulterated saffron in the European market deriving from the third countries that affect considerably the competitiveness of European saffron.
7. All frauds regarding the origin of the product could be detected by imposing traceability norms.
8. Commercialization could be supported by developing new products or innovative presentations. The use of saffron should go far beyond the food sector and its application in pharmaceutical and parapharmaceutical products should become the next goal.
9. Additionally, it would be essential to multiply the engagements of all regional, national and European authorities regarding applied mechanized and sustainable production research, utilization of by-products and the production of high added value goods. A possible European Saffron Research Center would be in position of supporting, conducting and coordinating the various research programs. The center could also function as a foundation for promotion of the achieved research results. Knowledge propagation policies regarding cultivation methods, treatment, conservation and commercialization are necessary in order to maintain the high commercial value of saffron and increase the yield at cost-efficient levels for the producers.
10. In Europe, economical and social impacts are remarkable, since 4% of the global production derives from Europe while more than 90% of the products are distributed in European countries. In order to maintain first place, European production enterprises should develop various cooperative forms at a larger extent.
11. For facilitating a more efficient transfer of information, it would be possible to incorporate all factors involved in the production of saffron (producers, technicians, politicians, researchers, treatment and commercialization enterprises, consumers). Such exchange could be encouraged by the creation of an intersectoral association embodying the representatives of all involved parties.

**A1 REGIONAL SAFFRON CULTIVA-
TION AND HARVESTING TECHNIQUES
IN SPAIN, GREECE AND ITALY**



Harvesting of flowers (UCLM)

A1 REGIONAL SAFFRON CULTIVATION AND HARVESTING TECHNIQUES IN SPAIN, GREECE AND ITALY

This section presents the methods applied for saffron planting and harvesting in all three Mediterranean regions of Castile – La Mancha (Spain), Western Macedonia (Greece) and Sardinia (Italy).

A1.1 ECOLOGY OF SAFFRON CULTIVATION

A1.1.1 CLIMATOLOGIC CONDITIONS

Saffron *Crocus sativus* L. grows equally well in mild continental climate as in Mediterranean climate with cool winters and dry summers and under dry Mediterranean humidity conditions. The plant is resistant to extreme temperatures varying from 40°C during summer, to -15°C in winter. All three regions have a Mediterranean climate despite differences in temperature and rain frequency. In Castile – La Mancha the climate is continental Mediterranean with very warm summers and frosty winters with minimum rainfall amount (between 250 and 400 millimeter). The Mediterranean climate of Sardinia is even milder with frequent rains during fall and winter. Winter in Sardinia is generally milder, summer is dry and warm, while rainfall lies at approximately 560 millimeters of rain.



*Saffron cultivation in the field
(Corongiu)*

The climate of Castile – La Mancha resembles to the climate of Western Macedonia although rainfall is more frequent (700 millimeters).

A1.1.2 Edaphic conditions

The most favorable soil for saffron planting is the one with clayey texture and a calcareous level at 40 – 50 %. Generally, this plant can grow even in soil with less favorable features. A depth of 60 to 70 centimeters is recommended, with good drainage, less developed structure (cloddy or sub-angular) and average texture that enables root penetration while preventing from puddle forming. The areas of Castile – La Mancha where saffron is cultivated, are characterized by lightly calciferous soil, deep and friable, that demonstrate a developed structure and average texture. However, the soil of Sardinia where saffron is cultivated, is characterized largely by alluvial deposits with uniform sandy clay texture, water permeated, fertile, drained and allocated in protected zones around villages. During the last years, saffron cultivation has been performed also on less fertile soils of alluvial origin, with uniform sandy texture, with grid and a not so strong ability to hold moisture. On the other hand, in Western Macedonia the cultivation soil is mild, sandy, light calciferous and alkaline, dry and with a slight inclination of the ground.

A1.2 GENETIC IMPROVEMENT

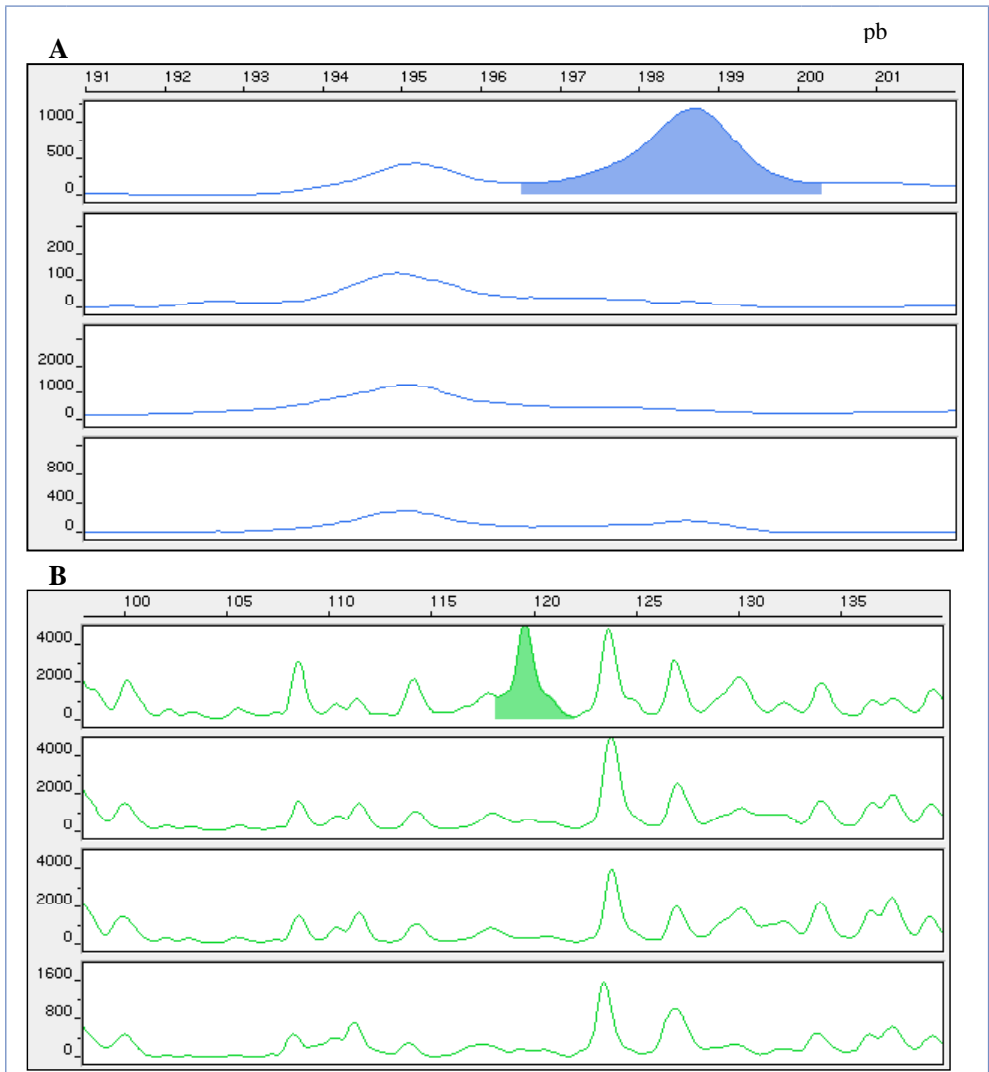
Saffron is a triploid sterile plant and the only method that leads to conventional genetic improvement is clone trimming.

Neither Sardinia, nor Western Macedonia has conducted scientific research regarding genetic improvement of saffron.

Since 1995, in Castile – La Mancha, a group of researchers from the Provincial Institute of Agricultural Technology (ITAP) and the University of Castile-La Mancha (UCLM), are developing a program for saffron improvement by clone trimming, which demonstrates encouraging results. The initial material (with the objective to estimate maximum variability) consists of bulbs harvested from the most important regions of traditional saffron cultivation in Spain.

A great number of morphological parameters have been studied and the productivity was measured. Upon analysis of the principal components and a cluster analysis, the bulbs with best features have been selected.

During this research, standardization has been studied through the use of molecular indexes. (AFLPs: Amplification Fragment Length Polymorphism). AFLPS profiles of four different regions have been analyzed: Mancha, Iran and Greece. The 4325 amplified peaks (molecular indexes) demonstrated distinctively a great similarity between the four areas (Fig. 1). Keeping in mind the germinal reproduction of saffron, the revealed similarities between those different locations seem to be logical.



Marking of two different areas (A) 199 and (B) 120 of the primary pairs responding solemnly to saffron from the region of La Mancha. (Z1:Saffron from La Mancha, Z2: Iran 1, Z3: Iran 2 and Z4: Greece)



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