European Cooperation in Science and Technology
- COST -

Secretariat

Brussels, 9 June 2011

COST 4124/11

MEMORANDUM OF UNDERSTANDING

Subject :	Memorandum of Understanding for the implementation of a European Concerted Research Action designated as COST Action FA1101**:** Omics Technologies for Crop Improvement, Traceability, Determination of Authenticity, Adulteration and Origin in Saffron

Delegations will find attached the Memorandum of Understanding for COST Action FA1101 as approved by the COST Committee of Senior Officials (CSO) at its 182nd meeting on 17 May 2011.

MEMORANDUM OF UNDERSTANDING

For the implementation of a European Concerted Research Action designated as

COST Action FA1101

OMICS TECHNOLOGIES FOR CROP IMPROVEMENT, TRACEABILITY, DETERMINATION OF AUTHENTICITY, ADULTERATION AND ORIGIN IN SAFFRON.

The Parties to this Memorandum of Understanding, declaring their common intention to participate in the concerted Action referred to above and described in the technical Annex to the Memorandum, have reached the following understanding:

1. The Action will be carried out in accordance with the provisions of document COST 4154/11 Rules and Procedures for Implementing COST Actions, or in any new document amending or replacing it, the contents of which the Parties are fully aware of.

2. The main objective of the Action is to build up a network of collaborative research on the structural organization of Saffron genome, DNA fingerprinting, chemical fingerprinting, proteomics, transcriptomics, and metabolomics of this crop.

3. The economic dimension of the activities carried out under the Action has been estimated, on the basis of information available during the planning of the Action, at EUR 48 Million in 2011 prices.

4. The Memorandum of Understanding will take effect on being accepted by at least five Parties.

5. The Memorandum of Understanding will remain in force for a period of 4years, calculated from the date of the first meeting of the Management Committee, unless the duration of the Action is modified according to the provisions of Chapter IV of the document referred to in Point 1 above.

A. ABSTRACT AND KEYWORDS

Saffron is the highest priced agricultural product and a good example of profitability, sustainability, cultural and social values, and high labour demand. This COST Action addresses coordinated research on Saffron -OMICS for crop improvement, traceability, determination of authenticity, adulteration and origin to provide new insights that will lead a sound Saffron Bio-Economy. Research groups involved in this COST Action join experience in different plant sciences. They will combine and focus their efforts on a variety of scientific objectives toward main challenges found in the Saffron crop. Novel concepts on genomics such as genotyping will be exploited. New, parallel data acquisition technologies in metabolomics and large-scale phytochemistry have effectively changed bottlenecks in crop & food research, from data acquisition to data interpretation. To meet this challenge requires a concerted cross-project and multi-disciplinary approach from the different domains considered in this Action. Increased knowledge of genetics and physiology of traditional crops through the omics 'revolution' is a need. The aim of CAP is to guarantee long-term food security, quality, value and diversity of food produced sustainably, and creating local employment. The development of sustainable rural economies based on HVAP such as Saffron, in synergy with DG SANCO's policies, is pursued in the EU programmes.

Keywords: *Crocus sativus* L., Saffron, biodiversity, genetic resources, breeding, genomics, metabolomics, molecular markers, phytochemistry, traceability, adulteration, authenticity, fraud

B. BACKGROUND

B.1 General background

The main challenge in the scope of the Common Agricultural Policy (CAP) is the development of a sustainable economy based on High Value Agricultural Products (HVAPs). Saffron is the highest priced HVAP in the world. Its prize can reach 20,000 €/kg retail. The Saffron crocus (*C. sativus* Linn) is a perennial, triploid and genetically sterile plant that is only vegetatively propagated via its corms which undergo a period of dormancy. This plant has been traditionally cultivated for its red stigmatic three-branch styles which not only comprise a highly desirable "golden condiment" but also, its second chemical derivatives have been used in medicine for a number of health properties.

Adulteration and fraud constitute a main problem of HVAPs, including Saffron, and they must be fought with the development of technological tools based on fine chemistry, molecular biology and applied physics. Saffron is adulterated with a variety of chemical and biological substances. Mislabelling of the country of origin confuses and/or misleads Saffron consumers. Fraud is an enormous problem for the Saffron industry and could comprise its long-term viability. The loss of land surface dedicated to Saffron crop in many areas of Europe has resulted in a corresponding genetic erosion. The sterility in Saffron limits the application of conventional breeding approaches for its further improvement. These facts support the interest of biotech breeding approaches to be useful to increase the genetic variability of the crop. Hence, the creation of a germplasm bank for this species, including wild relatives to broaden the available gene pool useful for genetic improvement of the crop has been a great achievement. Since 2007, the European Commission **AGRI GEN RES** 018 action has permitted the creation of the World Saffron and Crocus Collection (WSCC), which contains a good representation of Saffron biodiversity.. There is an urgent need for collaborative research on Saffron OMICS at EU level, since Saffron is a European crop for its cultural and historical background, food-safe tendencies, and commercial quality, prestige of the European Protected Designations of Origin (PDOs) and leadership of the EU research teams.

B.2 Current state of knowledge

This COST Action aims to the sound "Omics Technologies For Crop Improvement, Traceability, Determination Of Authenticity, Adulteration And Origin In Saffron" taking advantage of the germplasm collection (WSCC) created through the EU AGRI GEN RES 018 action "Genetic Resources of Saffron and Allies (*Crocus* spp): CROCUSBANK. Since 2007, the "CROCUSBANK" 018 action has permitted the creation of the alleged World Saffron and *Crocus* Collection (WSCC), a unique collection which contains a representation of the genetic variability present in saffron crop and wild relatives at global scale. At present the germplasm collection consists of 454 accessions representing 50 different *Crocus* species (including Saffron *Crocus*) and is expected to increase up to more than 600 accessions by the end of CROCUSBANK action (end of 2011). The CROCUSBANK project has initiated the development of –omic techniques for characterisation of Saffron germplasm. Likewise, the international consortium that supports the

current COST Action has come up to the development of techniques to detect new-generation biological adulterants in saffron, based on DNA fingerprinting (genomics). Additionally, fraud involving the origin of saffron is widely detected. Several PDOs are established in Europe. To differentiate Saffron of different origins (areas of cultivation and/or manufacturing), based on their physical-chemical or organoleptic features, is not easy. Unfortunately mixtures of expensive European Saffron with cheap Saffron are very common. Newly, some of the COST Action participants are developing –omics technologies for genomic typing of Saffron in PDOs.

B.3 Reasons for the Action

There is little background on genetics/genomics and the other "omics" in *C. sativus* due to the low number of research teams working on these topics. Based on this challenge, an intense coordination is required in order to approach the major fields on Saffron RTD, to achieve synergy amongst experts, to avoid repetition or competition between groups working on the same area, and to contribute to the development of a RTD structure on this field. It should be noted that Saffron is a minor crop that accounts for about 55,000 hectares worldwide, with a production of 60 to 250 t per year, with little or null impact in the agricultural policies of producing countries (with the only exception of Iran), but with tremendous significance in the European agriculture tradition and competitiveness as a HVAP. The scientific human power involved in Saffron breeding is little, with a few dozens of researchers distributed in India, Iran and Europe. In such scenario this "*boutique*" crop requires global actions. In conclusion, although the COST Action and other EU initiatives start and are developed in Europe, they go beyond European borders and have a worldwide prospect. The final objective is to preserve *Crocus biodiversity*, to carry out *genetic improvement* and to protect *quality*, *sustainability*, and *safety* of production of PDO Saffron in the EU, setting example for other producing countries (Iran, India, Morocco, etc).

B.4 Complementarity with other research programmes

(1) Genetic Resources of Saffron and Allies (*Crocus* spp): **CROCUSBANK**, EU AGRI GEN RES 018 action 2007-2011 (www.crocusbank.org; http://ec.europa.eu/agriculture/genetic-resources/actions/f-018/index_en.htm; http://ec.europa.eu/agriculture/genetic-resources/publications/leaflet-2010_en.pdf). (2) Saffron adulteration by colour additives: developing and antifraud methodology (**SAFFRON**) CRAFT 2002-2004. (3) SAFFRON - *Amélioration de la compétitivité du secteur européen du safran en favorisant la qualité et l'innovation*. INTERREG IIIC 2005-2007 (www.europeansaffron.eu/). (4) Methodologies for implementing international standards for saffron purity and quality (**SAFFIC**), COLL-CT-2006 (www.saffic.eu/html/index.php?m1=5). -AGRI GEN RES is a Community programme on the conservation, characterisation, collection and utilisation of genetic resources in agriculture (http://ec.europa.eu/agriculture/genetic-resources/index_en.htm), and the CROCUSBANK project is the only action at world-scale level carried out on Saffron biodiversity. The other mentioned three projects are focused on Saffron spice chemistry and food science, with no relationship with *-omics* technologies, although some SAFFRON and SAFFIC partners are also participant in the current Action, taking advantage of its wisdom on fine chemistry, Saffron business and adulteration tricks. Therefore, there is not duplication amongst these projects and the COST Action, just the adequate coordination between experts.

C. OBJECTIVES AND BENEFITS

C.1 Main/primary objectives

The main objective of this COST Action is to build up a network of collaborative research in order to increase our knowledge of the structural organization of Saffron genome DNA fingerprinting, chemical fingerprinting, proteomics, transcriptomics, and metabolomics. This integrated knowledge will be the basis for the development of Saffron genetic improvement, and the maturity of reliable techniques to combat bio-adulteration and fraud. The network pursues an adulteration-free condition for Saffron industry. Such objective is absolutely relevant on the basis of the CAP and the EU Policy on Food Safety and Consumer Protection.

C.2 Secondary objectives

The information generated by coordination amongst the COST network will be used in: (1) *Genetic characterization*, estimation of *biodiversity* and development of *molecular* and *chemical descriptors* for Saffron and *Crocus* spp. at the WSCC (CROCUSBANK; www.crocusbank.org). (2) Novel *genomic tools* and modern *genetic* and *breeding* approaches for crop improvement in saffron and ornamental crocuses. (3) Development of *omics* techniques to detect new-generation biological adulterants in saffron, based on DNA and chemical fingerprinting. (4) Genomic typing of Saffron in PDOs and recognized areas, as tools for traceability applications, determination of authenticity, and for fighting against fraud of origin, labelling and marketing in this HVAP, the highest-priced European food product.

More specific objectives are: (i) Analysis of the Saffron genome by mapping (physical, large fragments) and sequencing (genome, ESTs, SNP polymorphisms, AFLPs, 454 cDNA sequencing). (ii) Analysis of the Saffron metabolome by two strategies: metabolic profile (precise quantification of specific metabolites of interest in Saffron) and metabolic fingerprinting (semi quantitative data acquired by LC-MS or 1H-NMR and (bio)markers revealed by multivariate statistical tools). (iii) Development of robust techniques to be used in traceability, determination of authenticity and origin, and adulteration detection, based on DNA fingerprinting and chemical fingerprinting. (iv) Dissemination of these knowledge and know-how (students, researchers, Saffron growers and industry), dialogue with society.

Targeted problems and expected goals will be directed to the generation of new knowledge about:

1. Saffron *biodiversity assessment, conservation*, and *breeding*, specifically through the following subjects: DNA-markers; structural and functional genomics, and metabolomics; biotechnology-based breeding methods.
2. Saffron chemical and biochemical characterisation and development of methods of analysis for control of *adulteration* by genomic and phytochemical fingerprinting.
3. Genomic typing for traceability, determination of authenticity, and to detect fraud of origin, mislabelling and marketing doubtful strategies. Configuration of Saffron DNA-markers profiles associated to distinct PDOs, and recognized areas.

C.3 How will the objectives be achieved?

To achieve the objective of the COST Action, international coordination, cooperative research, and a multidisciplinary approach, is required. This Action joints together geneticists, molecular biologists, biochemists, biotechnologists, analytical chemists, food technologists, plant breeders, but also manufacturers and experts in Saffron business. Some participants are recognised experts in plant genomics, having generated the database *SaffronGenes EST* (www.saffrongenes.org), and they amass great experience in molecular cytogenetics, structural and functional genomics, transcriptomics, metabolomics and last generation sequencing. Other participants are leader experts in chemical analysis and food technologies. The biggest experts in Saffron genetic resources and breeding are also included, as well as Saffron manufacturers and producers with more than two centuries of business tradition and expertise. Those participants come from the most important EU countries in terms of saffron production and uses (Spain, Greece, Italy, France) but also from other leading RTD countries (UK, Netherlands). Non-EU groups and experts are also included, reflecting the global dimension of this COST Action.

Urgently needed is the reinforcement of coordination activities, through meetings, exchange and/or transference of OMICS technologies, research stages for young scientists, and dissemination activities. The exchange of information in the form of reports, publications, and experimental procedures and hence the development and evaluation of novel DNA and chemical fingerprinting tools will be achieved through state-of-the-art conferences, workshops, and seminars. These means will bring the researchers from both academia and industry together and thus broaden the views of the researchers and fortify their problem solving capabilities. Furthermore, the exchange of experts, scientists, and graduate students for training, especially through Short-Term Scientific Missions (STSMs), will facilitate the Action to achieve its objectives. Additionally, at least three Training Schools concerning state-of-the-art techniques will be arranged in conjunction with European or national courses and graduate schools.

C.4 Benefits of the Action

Benefits from the proposed networking and capacity-building activities are foreseen as best mechanisms for COST support: The Action will initiate knowledge building on important molecular and phytochemical characters to be used in breeding programmes, traceability applications, determination of authenticity, and detection of adulteration which allows the development of:

(1) Molecular markers for characterisation of local varieties, land races, or cultivars. These Saffron lines would achieve higher yield and quality, and would be adapted to the different socio-economic circumstances, climatic and edaphic conditions, and new production systems (organic, greenhouse, etc.).

(2) Robust techniques to detect adulteration in the Saffron industry provoked by the addition of parts of other plants, animal matters, artificial products, organic colorants, and extracts from *Gardenia jasminoides* and *Buddleia officinalis* that contain crocetins, just the same kind of apocarotenoids present in Saffron. The last category represents the new generation of Saffron bio-adulterants, difficult to detect, that currently are invading the market.

(3) Molecular markers for the enhancement of local germplasm for Protected Designations of Origin, Geographical Indications and recognized areas in Europe and abroad.

The proposed COST Action will provide an open and flexible framework including the invitation to join other participants, especially young researchers, looking forward to extend the network at a larger stage of counties signing the MoU.

C.5 Target groups/end users

(1) Saffron breeders and farmers, especially by using the germplasm conserved and characterized at the World Saffron and Crocus Collection (WSCC), a milestone achieved by the AGRI GEN RES 018 ‘CROCUSBANK’ Project (www.crocusbank.org) and gathered in the Bank of Germplasm of Cuenca (Spain).

(2) Food Standards Agencies and Consumers Defence Associations fighting against adulteration and fake food products.

(3) Saffron Protected Designation of Origin (PDO) Councils, created to protect the integrity of European Saffron by carefully legislating the labelling. They must ensure that only products genuinely originating in that region are allowed in commerce as such. Currently these PDOs are: (i) *Krokos Kozanis* (Kozani, Greece) www.kozani.gr/krokos/index.htm ; (ii) *Azafrán de La-Mancha* (La-Mancha, Spain) www.doazafrandelamancha.com/ ; (iii) *Zafferano dell´Aquila* (L´Aquila, Italy) www.zafferanodellaquila.it/pagine/index.asp ; (iv) *Zafferano di Sardegna* (Sardegna, Italy) www.zafferanozaf.it/dop.htm ; (v) *Zafferano di San Gimignano* (Tuscany, Italy) www.agriturist.it/documenti/zafferano_di_san_gimignano_dop.pdf ; (vi) *Zafferano delle Colline Fiorentine* (Firenze, Italy) www.zafferanodifirenze.it/; & (vi) *Munder Safran* (Mund, Switzerland) www.mund.ch/mund/mundersafran.

(4) Associations of Saffron producers in EU emerging areas with trademarks such as: (i) *Safran du Gâtinais* (France) *www.safrandugatinais.fr/;* (ii) *Safran du Quercy* (France) www.safran-du-quercy.com/; (iii) *Safran dela Font Saint Blaise en Limousin* (France) www.safrandelafontsaintblaiseenlimousin.fr/ , (iv) *Safran de Provence* (France) www.safran-du-ventoux-en-provence.com/, (v) *Safran du Tarn et du Lauragais* (France) www.safrandutarn.com/; (vi) *Azafranes del Jiloca* (Spain) http://azafranesjiloca.com/home.asp ; *Azafranes de Campo Bello* (Spain) http://azafrandebello.galeon.com/; *Zafferano di Cascia* (Italy) www.zafferanodicascia.com/; & *Wachauer Safran* (Austria) www.crocus-austriacus.at/.

(5) Politicians, Managers and Foundations for Rural Sustainable Development, since Saffron is a social crop that fixes rural population.

(6) the European Scientific Community will find excellent opportunity to strengthen key -omics technologies within the course of the Action.

D. SCIENTIFIC PROGRAMME

D.1 Scientific focus

The Action will be in compliance with the general rules of the COST Framework and will include:

(i) -State-of-the-art conferences, workshops and seminars. (ii) Exchange of experts, scientists, and graduate students for training, especially in the form of short-term scientific missions, and (iii) Exchange of reports, publications, and experimental procedures.

The scientific/technological areas will be those focusing on development of OMICS technologies for the following:

- Characterisation of Saffron genetic resources and crop breeding.

This includes genomics, transcriptomics, epigenomics, proteomics, metabolomics, interactomics, cytomics and bioinformatics. The following issues are being approached initially (i) high resolution mass spectrometry for the characterisation of metabolites found in Saffron stigmas; (ii) massively parallel sequencing of the transcriptome of Saffron stigmas, for the identification of transcripts responsible for the synthesis of key metabolites, (iii) alignment of transcriptome sequences from *C. sativus*, and from its putative ancestors to verify the auto-, vs. alloploid and the mono- vs polyphyletic origin of this species, and (iv) SNP mining of the transcriptome sequences of different ecotypes of *C. sativus*, with the aim of uncovering intraspecific variability; development of SNP assays useful for the non-ambiguous identification of local ecotypes.

- Development of techniques to detect new-generation biological adulterants.

Briefly, pure Saffron is composed exclusively of dried stigmas of *Crocus sativus* L. flower, a perennial bulbous. The high price of saffron makes it frequent subject of adulteration of various types, including the mix of colorants and authentic Saffron stigmas with flowers and other parts of different plants artificially coloured with organic dyes (tartrazine, Sudan red, etc.), that can be detected by suitable analytical techniques (ISO 3632) . Recently, however, massive adulteration of

Saffron with natural dyes has been detected. The chemical composition is almost identical to that of Saffron, rich in crocin and crocetin, typical carotenoids of *C. sativus* stigmas. This chemical similarity means that quality control standard techniques fail to detect such adulteration. The commonly called 'Gardenia Yellow' and 'Buddleja Yellow' are extracts from the fruits of two plants, *Gardenia jasminoides* Ellis and *Buddleja officinalis* Maxim, respectively, which are sold as natural dyes from China at low price, and even through the Internet. With such colorants and staining various filamentous materials, it is possible to create cheap "pseudo-Saffron", with good colorant strength and chemical composition similar to Saffron, but without the organoleptic characteristics of the real spice. Alone or used to "cut" the real Saffron spice we face a new refined form of adulteration that, of course, must be prosecuted, because it endangers the honourable Saffron production and the product's reputation. To date, detection of this last-generation biological adulteration requires the use of sophisticated chemical analysis techniques (HPLC, LC-MS-MS and LC-DAD). Despite their obvious usefulness they have the disadvantage of high cost in equipment, personnel and time, as well requiring large amounts of sample (in the order of milligrams) and, sometimes, previous extractions. Modern genetic fingerprinting techniques (genomics), imported from forensic science, is an alternative technology. Among its main advantages are that are highly specific, require very small amount of sample for analysis (micrograms) and require no preparative extractions. Therefore, the genetic fingerprint is considered an ideal technology to control the purity of food products. There is only one scientific paper that establishes a molecular method for detection of foreign plant material in the samples of saffron spice [Ma XQ, Zhu DY, Li SP, Dong TT, Tsim KW (2001) Authentic identification of stigma Croci (stigma of *Crocus sativus)* from its adulterants by molecular genetic analysis. Planta Med. 2001 67:183-6]. These authors sequenced the ribosomal RNA spacer regions of *C. sativus*, and three species that are frequently used in the adulteration of saffron in the Far East, *Carthamus tinctorius* L., *Hemerocallis fulva* L. and *Hemerocallis citrina* Baroni, finding multiple polymorphisms among these sequences that could be used for the design of molecular markers of adulteration. However, no records of work designed to detect massive adulteration with *Gardenia* and *Buddleja*.

- Implementation of traceability tools.

Fraud involving the origin of saffron is widely detected. Several Protected Denominations of Origin (PDOs) are established in Europe (see C5). The purpose of these protected labels is to preserve cultivation, manufacturing and merchandising of Saffron in their specific areas. Excellence and gourmet quality of Saffron has always been associated to European productions. Although major production comes from third countries: Iran (Khorasan), Morocco (Taliouine –Montagnes du Sirwa- & Vallée de L'Ourika), and India (Kashmir), as Saffron in bulk, the spice is manufactured, packaged and commercialised in European brands. To differentiate Saffron of different origins (areas of cultivation and/or manufacturing) based on their physical-chemical or organoleptic features is not easy. Unfortunately mixtures (as blends or *coupages*) of expensive European Saffron with cheap Saffron mainly from Iran are very common nowadays. These mixtures are marketed with ambiguous labels, such as *Natural Saffron*, *Selecto Saffron*, *Saffron Artisan*, *Superior Saffron*, *Product of ... (a certain EU country)*, etc. It is very likely that the use of stable isotopes as biomarkers of traceability is the technological solution in the future, to prevent fraud of origin of saffron and many other related products of PDOs and PGIs. The international consortium that support this COST action do not perform isotopes techniques, but -omics applied research aims to develop new insights into the DNA of saffron and other plant dyes, which will be useful for the detection of adulterants and strengthening the fight against fraud in Saffron industry.

D.2 Scientific work plan – methods and means

Based on these challenges, an intense coordination is required in order to approach the major fields on Saffron OMICS, to achieve synergy amongst experts, to avoid repetition or competition between groups working on the same area, and to contribute to the development of a RTD structure on this field. The Action will focus on main objectives, all involving advanced research tools and concepts:

- Genetics & Genomics.

To investigate the degree of genetic diversity that exists within Saffron local varieties, those have undergone solely clonal reproduction. Then, genetic variation between Saffron clones will be analysed and the polymorphisms found further characterized to understand the nature and frequency of this genetic change that occurred during long-term vegetative propagation. We aim to clarify the genetic relationships among geographic or genetic groups both cultivated and wild (heterozygosity of varieties; identification of genetic bottlenecks, origin of *C. sativus*).

- **Molecular markers assisting breeding, traceability and adulteration control**.

The goal is to provide molecular markers for the characterisation of *Crocus* germplasm, their application in selection of improved cultivars, and the development of analytical techniques as tools to support traceability in the different PDOs (La Mancha, Kozani, L'Aquila, Sardinia, San Gimignano, Firenze, & Mund), as well as specific markers to detect the presence of *Gardenia* and *Buddleia* adulterants.

- Transcriptomics & Metabolomics.

The characterisation of the transcriptome of Saffron stigmas is the most vital to shed light on the molecular basis of flavour, colour biogenesis, genomic organization and biology of gynoecium of Saffron. The information derived can be utilized for constructing biological pathways involved in the biosynthesis of principal components of Saffron i.e., crocin, crocetin, picrocrocin and safranal.

- Phytochemistry.

The development of chromatographic techniques (HPLC, LC-MS-MS, LC-DAD & GC), tristimolous colourimetry, infrared spectroscopy (FT IR, FT-NIRS), amongst others, and their introduction in the ISO/TS 3632-1 (2003) norm that regulates the purity and quality of Saffron, will improve the certification of authenticity of the spice, and the detection of adulterants.
Four work areas are proposed, differentiated on the basis on the use of different techniques and scientific approaches:

1. Nucleic acids work (genetics, genomics and transcriptomics).
2. Chemical work (phytochemistry, biochemistry and instrumental analysis)
3. Integration work (molecular and phytochemical markers for fingerprinting useful in breeding, traceability and authenticity).
4. Office work (dissemination, management, administration, coordination, etc.)

E. ORGANISATION

E.1 Coordination and organisation

Transversal collaborations, Short Term Scientific Missions (STSMs), and meetings between the Working Groups will make it possible to reach the objectives. The large consortium possibility and the financial support for meetings and STSMs as provided in the framework of COST are crucial to achieve the objectives.

The Management Committee (MC) will manage the Action in compliance with the existing COST regulations. The MC will organise bi-annual meetings to monitor the progress of the Action. Seminars and workshops with all WGs will be organized in conjunction with these meetings. Working Group leaders, a Steering Group (SG), and an STSM Manager may be elected by the MC to assist with the management. Preferentially, the Steering Group could consist of the Chairperson, the Vice Chairperson, the Working Group leaders, and the STSM Manager. The STSM Manager would also manage the organisation of the Training Schools, so that existing national (or international) graduate courses could be integrated with the Training Schools. One of the tasks of the SG would be to coordinate the publication of reports and proceedings from the Action, as well as to manage the publication of reports through the public Action website.

The establishment and publicity of the STSM system during the first year of operation will be an important milestone. The current Action should be able to manage at least ten STSMs per year. Another important milestone is the establishment of the system for Training Schools and thus the integration or upgrading of state-of-the-art national graduate courses to serve the participants of the Action. The establishment of a working public Action website with up-to-date information of the Action is another important milestone, which should be achieved during the first year of operation. The arrangement of seminars, workshops, and WG meetings, according to the timetable depicted in the F section, is the fourth important milestone that the MC will be responsible of.

E.2 Working Groups

The Action will be organized in 4 Working Groups (WG) related to the main objectives and technical areas (see D2):

WG1. Genetics, Genomics & Transcriptomics (coordinated research on these fields).

WG2. Phytochemistry & Metabolomics (coordinated research on these fields).

WG3. Molecular and Phytochemical fingerprinting for breeding, traceability, and authenticity (development of technological tools).

WG4. Dissemination, Project Management & Coordination.

The Action will encourage the exchange of scientists between the participating partners through STSMs. The outcome of the STSMs will be presented at the annual seminars. The Action will be carried out in cooperation with existing national and international research programs related to OMICS technologies or/and Saffron. Scientists from related fields are promoted to take part in the Action to provide input of new ideas and an exchange of information. A website for the Action will be created and maintained to enhance the communication within the Action and to inform the external scientific community and disseminate the results.

E.3 Liaison and interaction with other research programmes

The European projects focused on Saffron research are mentioned in Section B4. Amongst them, the EU **AGRI GEN RES** 018 action "Genetic Resources of Saffron and Allies (*Crocus* spp): CROCUSBANK", 2007-2011, deals with the creation, characterisation, and exploitation of a germplasm collection (bank) in *Crocus* species, including saffron crocus (*C. sativus* Linn.). This useful collection is an urgent need for saffron breeders and farmers. The collection has two main goals: First, to collect and reproduce saffron bulbs, coming from all the countries that cultivate saffron, for direct use of this plant material in selection programmes all over the world; and second,

to create a collection of saffron allies for conservation, since they are endangered and threatened taxa and populations in *Crocus*, and for research in taxonomy and evolution, genetics, physiology, ecology and agronomy. These *Crocus* species are exploitable sources of resistances and other agronomical interesting traits to be transferred to saffron, through appropriate breeding programmes and technological tools.

The current COST Action addresses coordinated research on Saffron -OMICS which are very useful in germplasm characterisation. Consequently, data about Genetic characterisation, estimation of biodiversity and development of molecular and chemical descriptors will be shared with the CROCUSBANK project WP05 (www.crocusbank.org). If there is overlap of dates between projects (CROCUSBANK extends to December 2011), there will be a coordination meeting amongst the CROCUSBANK Descriptors Group (WP03: List of Descriptors) plus the Chemical and Molecular Characterisation Group (WP05: Characterisation and Evaluation), and the COST participants. This meeting could take place in coincidence with the CROCUSBANK Final Assessment Meeting.

Although the other projects have finished, whenever possible, joint meetings and workshops will be arranged with groups involved in these projects, some of them also participants in the present Action, to further allow the exchange of research experiences and methods and to deepen the contact between researchers from related areas. Furthermore, representatives from the SAFFRON and SAFFIC projects will be encouraged to participate in the Action seminars and workshops.

E.4 Gender balance and involvement of early-stage researchers

This COST Action will respect an appropriate gender balance in all its activities and the Management Committee will place this as a standard item on all its MC agendas. The Action will also be committed to considerably involve Early-Stage Researchers. This item will also be placed as a standard item on all MC agendas.

F. TIMETABLE

The total duration of the Action will be four years, calculated from the date of the first meeting of the Management Committee. Meetings and seminars in the Working Groups will be held according to the plan below. The seminars will be common for the four Working Groups. The MC meetings and the seminars will be held at the same time. The MC may also decide to arrange the WG meetings as joint meetings/seminars and in conjunction with the bi-annual MC meetings. Additionally, at least three Training Schools concerning state-of-the-art techniques will be arranged in conjunction with European or national courses and graduate schools.

Year 1	Year 2	Year 3	Year 4
Start			
Plan	Seminar	Seminar	Workshop
WG1/2/3/4	WG1/2/3/4	WG1/2/3/4	Training School
	Training School	Training School	Final Report
			End

G. ECONOMIC DIMENSION

The following 12 COST countries have actively participated in the preparation of the Action or otherwise indicated their interest: CH, DK, EL, ES, FR, HU, IL, IT, MK, NL, TR, UK. On the basis of national estimates, the economic dimension of the activities to be carried out under the Action has been estimated at 48 Million € for the total duration of the Action. This estimate is valid under the assumption that all the countries mentioned above but no other countries will participate in the Action. Any departure from this will change the total cost accordingly.

H. DISSEMINATION PLAN

H.1 Who?

The most important results from this Action will be new knowledge on OMICS technologies for crop improvement, traceability, determination of authenticity, adulteration and origin in Saffron. Main target groups for dissemination of information of such results are the Saffron farmers, plant breeders, food standards agencies, consumers' defence associations, protected designations of origin (PDOs), associations of saffron producers, and entities involved in rural sustainable development. All of them are important target groups for the Action.

The MC will also maintain an active contact to the COST Products and Services (FPS) Domain.

H.2 What?

The participating partners (mainly national research institutes and universities) will distribute interim and state-of-the-art reports, as well as proceedings and presentations from the COST Action to the national stakeholders. These papers will also be available through the public Action website. Saffron industry people will be invited to participate in the seminars and workshop of the Action.

The general scientific community will be informed through participation in national and international conferences and symposia, and through scientific publications. The Action will also aim at setting up an e-mail network for new information that includes related national research institutes and universities, in conjunction to those participating in the Action.

The Action will encourage researchers to publish their findings and the most outstanding results from the final report in peer-reviewed scientific and technical Journals. Furthermore, efforts will be put to also publish selected results in non-technical, popular science, publications to reach outside the scientific community.

The MC contact to the Domain FPS will be maintained by:

- Establishing close contact with the appointed liaison officer of the Domain Committee.
- *Via* the appointed *Rapporteur*, by inviting him/her to the events organised by the Action and providing him/her all relevant reports and memorandums.
- *Via* attendance of the Chairperson or his/her representative at the meetings of the FPS DC when appropriate.
- *Via* Annual Progress Reports.

In addition, the MC will inform Domain FA about its activities related to that Domain. The most feasible procedure for this communication will be decided together with the FPS liaison officer.

H.3 How?

The dissemination methods listed in part H.2 aims at reaching as wide an audience as possible concerning the European Scientific Community and the Saffron related industries. The Action also aims at raising the awareness of the general European Community, as well as the industry, towards the development of OMICS technologies to improve quantity, quality, and honesty in Saffron production.

Especially young researchers will benefit from strengthening their future networks as well as their scientific capabilities.

The Short Term Scientific Missions and Training Schools offered within the Action will certainly contribute to this.

The dissemination plans will be evaluated by the MC on a yearly basis and revised at the end of the penultimate year of operations. The MC will also take into account any novel sufficient means of dissemination that may occur during the course of the Action.