Executive Summary:

SUSTAVINO, funded under Research for the benefit of SME-AGs in the Seventh Framework Programme aimed to help European wine producers to meet environmental regulations by developing an Environmental Quality Strategy for Wine production (EQSW) and an EQSW label, encompassing integrated approaches not only for minimising and treating wastes and wastewater, but also for valorising them. In order to reach this goal, common and state-of-the-art technologies and techniques applied to the different waste and wastewater streams originated from the wine production have been examined in case studies at wine cellars in four European countries. The identified alternatives included treatment, disposal, reusing and valorising. Special attention has been paid on the implementation of simple and economic but efficient solutions in order to allow European wineries, and SME wineries in particular, to effectively compete against emerging markets.

To start with, an intensive screening of national and European legislation affecting wineries has been performed and all information available on quality labels and seals of approval at European, national and regional level has been compiled, accompanied by the development and distribution of a questionnaire to gather information on existing wine making processes and waste management practices in the European wine industry. This allowed for a comprehensive assessment of the situation small wineries in the EU are faced up with. Having all the collected and process information as basis, alternative solutions for treatment and valorisation of wastewater and waste were selected. For wastewater: aerated storage, membrane bioreactor (MBR), microalgae/fungi, aerobic SBR and anaerobic digestion. For waste: composting, anaerobic digestion, extraction of polyphenols, landspreading and co-firing. After initial technical and economical investigation of the different alternatives, case studies have been performed, including experiments at lab- and pilot scale in order to decide on the most suitable alternatives for each participating wine cellar.

The information gathered so far served as basis for the definition of requirements and criteria to be considered during the development of the EQSW. The criteria to be met with the EQSW consequently constituted the input for the development of the three main modules to be comprised in the EQSW – module 1: waste minimisation, module 2: wastewater treatment, module 3: solid waste treatment and valorisation alternatives. The modules concentrate on general technologies and practices, offering alternative measures, in order to be applied by any winery.

Then, a preliminary EQSW was implemented in the participating cellars following individual implementation plans for each of the cellars with regard to their specific requirements and demands, and the selected techniques and measures were assessed. At the end of the monitoring period, changes in water and waste pollution due to the implementation of the EQSW were assessed and evaluated and the final EQSW was defined.

Finally, a corresponding EQSW label was designed and protected as a trademark, to be granted by the SME-AGs to any winery interested. The label is intended for demonstrating that a wine has been produced according to a certain environmental standard which will be in the long term secured by annual audits at the wineries.

All these results have been transferred to the SMEs and SME-AGs participating in the project via several face-to-face training courses in different countries and will be further disseminated by e-learning modules which have been developed based on the information, feedback and conclusions from the face-to-face trainings and integrated on the SUSTAVINO website (www.sustavino.eu)

Project Context and Objectives:

About 65 % of the world's wine production is managed by European winegrowers. Wine production in Europe is traditionally performed by small and medium sized, family owned companies and co-operatives. Solid and liquid residues are not treated in an appropriate way with serious impact on the environment. The wine industry is known to produce high amounts of wastewater with sometimes extremely high organic loads (COD 2.500-67.000 mg/L). The discharge of these waters causes shock loads to municipal wastewater treatment plants or has significant impacts on rivers and lakes, in the cases when the vineyards are not connected to a sewer system at all. In addition, solid residues are also not handled properly. In many cases they are deposited in the vineyards to be used as fertilizer (sometimes composted, most often not). The degradation of the waste during storage leads to odour formation and ground water contamination. These handling practices have been shown to be ineffective in complying with the legislative environmental requirements, disposal regulations, and safety restrictions for solid re-use. Moreover, the tremendous potential of the high-value, biologically active substances contained in these wastes is not known to the winegrowers and remains untapped. Moreover, environmental legislations and quality regulations are becoming stricter and they force vineyards to take measures to improve the environmental situation in wine production. The winegrower associations are aware of this situation and want to initiate necessary R&D activities to offer technical assistance to their member SMEs. To cope with this challenge the wine producers need technical support.

Therefore SUSTAVINO intends to help the European wine producers, to meet environmental regulations by providing an Environmental Quality Strategy for Sustainable Wine production (EQSW), which will encompass integrated approaches for treating and valorising wastes and wastewaters in a cost-effective and ecological way, and by carrying out comprehensive training and capacity building to the SMEs and SME-AGs. In order to attain the general aim of the project the following specific objectives will be undertaken:

- Minimise the environmental impacts of wine production
- Improve, adapt and implement innovative and cost effective treatment technologies for winery wastewater and solid residues
- Foster compliance with the relevant regulatory framework
- Develop an EQSW label
- Implement an extensive capacity building and dissemination programme
- Establish permanent contacts between the participants
- Reinforce the commercial appeal of the European wine
- Safeguard the rural economic sector at a regional level

Below, the entire structure of the SUSTAVINO project is found, showing research focus areas and targets divided in its work packages:

WP1: Assessment of small wineries in the EU

WP 1 was led by project partner DUERO and was developed from month 3 to month 13 of the project. It was divided into five tasks that had the following main objectives:

- Benchmarking national and European legislation affecting wineries
- Definition of wine making process and existing waste management practices in the wine industry
- Requirements for existing quality labels and seals of approval
- Definition of performance parameters and quantitative characterisation of winery wastes
- Definition and preparation of SOPs for the qualitative characterisation of wastes and performance parameters

WP2: On-site evaluation of wine cellars and case studies

WP2 was scheduled to run from month 3 to 24 of the project, led by INRA. The main objective of the WP was to evaluate the participating wine cellars on-site. It was divided into four tasks with the following objectives:

- Definition of common criteria for the on-site evaluation and assessment of participating cellars
- Field work - On-site evaluation and assessment of participating cellars
- Case studies including lab- and pilot-scale tests
- Economic evaluation of treatment methods, waste minimisation techniques, and valorisation alternatives

WP3: Development and implementation of an Environmental Quality Strategy for Wine production (EQSW) and label

WP3 was led by project partner TTZ and was scheduled to be developed from month 22 to month 33 of the project. It was divided into 4 main tasks having the following aims:

- Definition of requirements and criteria to consider for the development of the EQSW
- Development of the 3 main modules comprising the EQSW: waste minimisation, wastewater treatment, solid waste treatment and valorisation alternatives
- Implementation of the EQSW in the participating cellars
- Design of the EQSW label and definition of procedures for the subsequent market introduction

WP4: Dissemination and training

WP4 was devoted to dissemination activities and ran continuously throughout the project, led by VIF. It was divided into four tasks with the following objectives:

- Design and development of general dissemination instruments
- Promotion and advertisement of the project results
- SUSTAVINO face-to-face training courses
- SUSTAVINO e-learning courses

WP5: Project management

The aim of WP5 was to ensure an effective project management and co-ordination over the entire project duration. The work package was scheduled to cover the period from month 1 to month 38 of the project and is led by TTZ. It is divided into 3 main tasks with the following objectives:

- General and administrative management
- Scientific management

- Dissemination and IPR management

Project Results:

Assessment of small wineries in the EU

First of all, the partners compiled all information available on the current and upcoming national and European legislation affecting wineries: production restrictions, wastewater and solid waste legislation, the reform of the Common Market Organisation for Wine (Wine CMO) etc. A comprehensive report including information from all the EU27 Member States was supposed to be produced. This proved impossible because there is no available translation of the pertinent legislation to English or other languages of international circulation, so it was impossible for the AGs to collect information from countries outside the consortium. Therefore, the partners prepared a comprehensive catalogue of all European and national legislation affecting wineries, the wine production process, wine marketing, waste and wastewater treatment and disposal and the utilisation of agricultural wastes as fertiliser for the EU countries represented in the consortium.

Furthermore, information on wine making practices, infrastructures and environments for a significant range of small wine cellars established in the European Union was collected. The information to be compiled encompassed the number and size of vineyards, variety of grapes, wine production rates, water consumption, waste management and treatment methods (if existing), etc. For this purpose a questionnaire was developed by the RTDs and AGs. The questionnaire was translated into the national languages of the participating AGs. The AGs distributed the questionnaires among their members via their websites, mailing lists and interviews. By the end of September 2009, the feedback on the questionnaires was quite poor, probably due to interferences with the vintage period and summer holidays. The only feedback until then came from wineries in France and Spain. Thus, a second step of data collection and evaluation has been done during 2010. A very condensed version of the original questionnaire was prepared for the second step and was translated to French, German, Spanish, Italian and Portuguese and then distributed. This time, the partners were supported by COPA-COGEGA who distributed the questionnaire among its members. The general conclusions from analysing the questionnaire are available in the respective report as annexed to this document.

Moreover, all the relevant regional, national and European information on quality labels and seals of approval was compiled. The information was taken into consideration later on during the project when developing the EQSW. The EQSW will facilitate the implementation of existing standards throughout Europe, especially in the New Member States and Candidate countries.

An European Quality Label did not exist at the beginning of the project. There are some Regulations on European level that lay down the requirements to be met by the existing

quality labels in the EU. The most important is the Common Market Organization for Wine (CMO) issued in Regulation (EC) 479/2008 of the Council of 29 April 2008. Though all European countries adopt European Community Regulations and their guidelines regarding quality labels and seals of approval for wine commercialisation, there is also a great variety of national standards on this subject. In every European country there are different regulations depending on specific geographical areas, different Denominations of Origin and Indications of Origin. In France alone there are 295 designations of origin (AOC, "Appelation d´Origine Contrôlée") and 150 wines with a geographical indication (GI). In Italy, local factors lead to a deviation from the usual labelling system. Many of the finest Italian wines may be labelled as IGT (Indicazione Geografica Tipica) to avoid Denomination of Origin (DOGC and DOC) regulations. Furthermore, some quality wines carry the Vino da Tavola (Table wine) appellation. Finally, countries like Hungary that produce national wine sorts, have additional wine quality classes for these sorts.

This turns out in the existence of a great diversity of quality labels and seals within the European Community which makes it difficult for the consumer to understand what they are really purchasing. Establishing a European quality label or seal which, complying with all current regulations, will thus facilitate consumer information and wine commercialisation.

A literature research on the winemaking process and the waste streams resulting from the different winemaking steps, as well as quantitative data on the characteristics of winery wastes was done. This research revealed the importance of the effect of the winemaking process on wine characteristics. It is well known that phenolic compounds are very important for the overall wine quality, and are therefore intensely studied. A brief review of the factors affecting the total content and relative concentrations of different phenolic compounds in wine was presented in the deliverable. The review also showed that it is difficult to generalise about winery waste and wastewaters characteristics. Wastewaters result mainly from cleaning operations during the different steps of wine production. The different winemaking processes and wine types determine the necessary cleaning operations, resulting in large variations in wastewater volume and load among cellars. The main common characteristic found was the large seasonal variability of both wastewater volume and load, due to the seasonal character of the winemaking process. In this sense, between 40 to 80% of the water consumption and wastewater generation takes place between the pressing and the first rackings.

In summary, the characterisation for the wastewater made by different authors is shown in Tab. 1. Effluents are characterised by a high and variable organic load, a large part being biodegradable. Most of the organic load, around 87%, is dissolved. Generally the pH is acid but periodically it may be alkaline after cleaning operations with large usage of caustic products. Winery wastewater contains low amounts of nitrogen and phosphorous relative to total carbon. It also contains large amounts of phenolic compounds.

On the other hand, wastes and by-products represent a 20% in weight of the produced wine (Arvanitoyannis et al., 2006). The main organic wastes are grape pomace, lees and stems. Solid wastes are characterised by low pH and high content of phytotoxic and antibacterial phenolic substances, with low biological degradability.

The bibliography review showed that there is no universal treatment option for winery wastewater because the water consumption and wastewater volume and load depend on the conditions in the winery. A pollution assessment needs to be carried out in each cellar to find the best treatment option. The review showed also that there is still pollution minimisation potential by applying waste minimisation practices such as the segregation of wastewaters networks (separating cooling waters from washing waters).

Actual wastewater treatment takes place in two phases: pre-treatment and organic load removal. For the pre-treatment, taking into account the seasonal nature of the wastewater a storage phase is often required. The latter may be followed by a primary treatment such as screening or grit removal to prevent abrasion of the mechanical equipment. Organic load removal can be achieved through physical processes such as evaporation, evapo-concentration with fractioned distillation or ultrafiltration or biological technologies (aerobic and anaerobic processes). Land-spreading of winery wastes is also classified as a treatment option. The main conclusion of the literature research was that taking into account physical and chemical characteristics of winery wastewater, most available treatment options could be used for these wastewaters, but that in practice, the variable volume and load of the discharge pose serious treatment efficiency, sizing and cost problems.

Finally, a review of the main winery waste valorisation alternatives was made. The most widespread valorisation technique is composting, through which organic waste is converted into soil amendments. It is also important to consider the high polyphenols content of solid by-products from wine industry (higher than in any other type of agro-industrial wastes) especially that of grape seeds, which could be turned into a marketable product. Polyphenols have been tested in the cosmetic industry and in pharmaceutical products with very good results. The wastes have potential as energy source: grape pomace can be used to produce fuel in pellet form while the wastewaters can be fermented to produce biogas.

After this literature research, the most important parameters and indicators to be measured for the characterisation of winery wastes were established (Tab. 2) which were used during the field experiments for the project later on.

It was suggested also that the following parameters: metals, polyphenols and total and faecal coliforms should be analysed at least once, and if they proved relevant should be continuously monitored. Even if no literature on the pesticides present in the wastewater was found, it was suggested that an analysis of the pesticide content of winery wastewaters might be of interest.

In order to define standardised procedures for the laboratory analysis of the parameters which have been identified being crucial, a set Standard Operating Procedures (SOPs) for the field work which was carried out subsequently in work package 2 was developed. The SOPs served later during the project as standards for the SUSTAVINO project partners, in order to have comparable results in the subsequent qualitative waste and wastewater characterisation analyses. Thus, a standard method for the analysis of each parameter has been established. It was decided that the sampling procedure is at least as important as the chosen measurement methods to have comparable results.

The measurement protocols followed for the different analyses are summed up in Tab. 3. The main source of SOPs used was the Standard Methods for the examination of water and wastewater, 18th Edition 1992, edited by Arnold E. Greenberg, Lenore S. Clesceri, Andrew D. Eaton. For some of the available methods more procedures are available, depending on the available sample size, concentration and some characteristics that can bias instruments (like sample colour in the photometric determination of concentrations).

On site evaluation and case studies

In order to assess the specific current situation of the four participating wine cellars and to collect all the necessary information, on-site visits and qualitative waste characterisation were performed (case studies) which served as the basis for the development of the Environmental Quality System for Wine production at a later stage of the project. For this, a clear concept was designed of what had to be assessed and which processes and wine making periods had to be covered by asking all the participating wine cellars to provide detailed information to the RTDs with regard to following issues:

1. The wine making process description
2. Infrastructures and surroundings

Regarding the wine making process description the following aspects were of main interest: crush size and volume produced, amount and variety of grapes processed, process charts, water consumption quantity and treatment/disposal methods of produced wastes, internal measures for pollution control, management of cleaning processes, by-products and residues, cellar sewerage systems (industrial wastewater, rainwater and domestic water network), yearly production patterns (seasonal variation, peaks, etc.).

In contrast, in terms of the infrastructures and surroundings each winery was asked to provide information regarding the geographical location and existing nearby connections (main roads, sewerage network, municipal wastewater treatment plants, distance to urban/rural settlements, access to fresh water, closest industries active in the valorisation business, etc.). It was as well important to consider the availability and proximity of fields around the cellar for spreading and waste storage options. This information was meant to be supported by maps graphics, etc. This intended information was asked from the winemakers with support of a detailed questionnaire (Fig. 1).

The participating wineries encompassed red and white wine cellars, which was as well reflected in production processes, type, and amount of waste produced. Since there are four RTDs and four wine cellars, each RTD was in charge of visiting one cellar, in order to optimise resources. Therefore finally all the RTDs and wine cellars will actively participate in this task. These questionnaires were filled together with the RTDs during a visit at the wineries and finally a report was prepared by each RTD summarising all aspects about the wine making process at the respective winery. All the collected information was evaluated and the existing gaps and future needs assessed during the on-site visits for each of the consortium wine cellars.

Finally, the information was used for the preparation of an action plan. This action plan, which was the final output of this task, was used during the on site evaluation of the wine cellars, that were carried out later on during the following vintage, the peak production time as winemaking is a highly seasonal activity.

The on-site assessment was done at the wine cellars participating in SUSTAVINO, i.e. Cramela Prahova, Alana Tokay, Weingut Holstein and Solar de Muñosanto located in Romania, Hungary, Germany and Spain, respectively. The assessments were done through visits of the RTDs to the cellars and detailed interviews with the staff. Additionally, in three of the four cellars (except Cramele Hallewood) waste and wastewater samples were taken and analysed to facilitate the case studies. Information was gathered about production processes, water consumption, quantitative and qualitative waste characteristics and waste management practices.

The assessment revealed that the Weingut Holstein winery had the lowest water consumption per liter of wine produced (0.25 l water/l wine), which is low in comparison to values reported in the literature. The Solar de Muñosancho cellar had a water consumption of 1 l water/l wine, a value coherent with the literature, while the water consumption at the Alana Tokay winery was quite high, 5 l water/l wine. This is also due to the fact that at the Alana Tokay winery is undergoing renovation and water is used also for construction works. All wineries use fresh water from the municipal system.

The wineries are generally situated in rural areas with mainly small villages in the vicinity, and where several other wineries and, in the case of the Spanish cellar, other agro-industrial producers are situated, putting pressure on the wastewater and waste treatment facilities during the peak season. All of them send part (in the case of Cramele Hallewood) or all of their wastewater to the municipal plants for treatment. Except for Cramele which owns a composting facility and also sends part of its solid waste off-site for composting, none of the other wineries treats their solid waste. They generally store it and spread it on the land belonging to the cellar. The Spanish cellar sends part of the pomace and wine lees to the alcohol distillery.

The characteristics of the wastewaters from the cellars fit the general trends described in the literature. The largest volumes of wastewater are discharged during the vintage and the rackings. There are large daily variations in the volume and load of the wastewater, which could not be correlated to the amount of harvested grapes or the activity carried out in the winery. This fact shows that a proper instruction of the employees in water management techniques could lead to significant savings.

The average COD loads were high and most of the organic matter was present in dissolved form. The BOD5/COD ratios were high, suggesting good biological degradability. The amount of suspended solids varied from case to case, being high only in the wastewater from the Alana Tokay winery. Most of the suspended matter found in the wastewater from Alana was of inorganic nature, suggesting the need of a physical pre-treatment of the water.

The ratio of carbon to inorganic nutrients (nitrogen and phosphorus) was high, as reported by the literature. This shows that the wastewaters do not contain the sufficient amount of minerals needed by aerobic bacteria. External nutrients can be dosed during aerobic treatment, or an anaerobic treatment can be used to remove most of the organic load.

The wastewaters were tested for toxic compounds. Polyphenol loads varied among the wineries, being lower than literature values at the SOLAR cellar. Slightly higher heavy metal concentrations (Cu, Zn, Cr, Ni and Fe) were found only at the Weingut Holstein cellar. The common tendency for those higher values to occur at later stages of the wine making process indicated that the heavy metals were very likely to stem from the processing procedure or used materials and instruments. No significant concentration of pesticides was found in any of the samples. E. coli was detected only at Weingut Holstein, mostly in wastewater from white wine production.

The most important values obtained through direct measurements on site are summarised in the table below. The measured and estimated values (obtained from interviews with the staff) do not coincide because estimations are based on water bills which cover the entire year and not only the peak activity period in which the measurements were done, and because they

cover all water and wastewater used respectively produced, not only from winemaking but also from other activities.

During the technical meeting from Narbonne on the 25th of February 2010, the RTDs decided to test at lab-scale the largest possible number of solutions and to have then a more restricted choice for pilot-scale tests, based on the preliminary results from the lab-scale tests. The main solutions available to treat winery effluents, which were considered by RTDs during the technical meeting, are listed in Fig. 2.

As far as winery solid waste treatments are concerned, physical and biological technologies are available, of which the main examples have been discussed during the technical meeting: land spreading, incineration or co-firing, distillation, composting and anaerobic digestion. Just like polyphenols extraction, tartaric acid recovery, etc., some of the solid waste treatments could be considered as valorisation methods. Fig. 3 presents some value added conversion of bio-products from wine-making process.

Unless for fungi, composting and land spreading that were the subject of literature research, the following treatment and valorisation alternatives were tested at lab-scale in the facilities of RTDs indicated in brackets (Fig. 4). IPVE had furthermore investigated on waste and wastewater minimisation strategies.

ITACYL experimented with aerated storage and evaluated the temporal characteristics of the chemical oxygen demand (COD) of the winery wastewater in the bioreactors. As synthetic winery wastewater diluted lees and diluted white wine were used with varying initial COD concentrations (mostly around 10 g/l). As main results, it could be stated that the COD removal efficiency increased with increasing aeration time, whereas the presence of an inoculum did not affect the removal efficiency at all. As long as permanent aeration was provided a removal efficiency higher than 95 % could be reached. So, for small wineries, long term aerated storage can be performed (with relatively low investment and operation costs e.g. in ponds, old cement vats, etc). For these tests, the constant temperature of nearly 37°C was maintained. But, in many European wineries, temperatures are far below this value during the vintage period, therefore operation at different temperatures, with different stirring velocities and different aeration periods has been tested as well.

INRA performed experiments on the mesophilic anaerobic digestion of a synthetic winery wastewater. The aim of the test was to reach the maximum loading rate (OLR) while maintaining good removal efficiency. From an economical point of view, an 80 % soluble COD removal efficiency seems to be a good compromise and it was considered as the threshold to be maintained. The experiments showed that under the given experimental conditions, an OLR of 24 g/l*d could be achieved, indicating that this treatment method is

suited for wastewaters with high organic loads. However, in order to achieve discharge limits, anaerobic treatment needs to be followed by an aerobic treatment step.

INRA also tested the treatment of winery wastewaters using a Sequencing Batch Reactor (SBR). Diluted red wine was used as substrate for the trials. The initial COD concentration in the storage tank was adjusted to approximately 10g/l. The chosen rhythm of cycling was 1 cycle per day, which means that after filling the reactor the wastewater was aerated for 21 h and 3 hours were used for settling and withdrawing of the treated water and excess sludge. After 90 days of operation, the experimental setup started experiencing problems with the removal efficiency and sludge settling, the concentration of suspended solids in the effluent reaching 2,000 mg/l. INRA repeated the experiments with an initial concentration reduced to 5,000 mg/l but with the same organic loading rate. The result was the same with problem of high suspended solid concentration in the effluent and the reactor was stopped after 37 days of running.

INRA repeated the experiments with a different inoculum under the same conditions as in the previous experimental run (i.e. wastewater concentration of 5 g/l and OLR of 0.7 g COD/l*d). At the same time, in order to avoid or reduce the suspended solids problem encountered in the first experiments, coagulation agents, NALCO polymers (coagulant 7132 and 8103 Plus), have been applied.

TTZ did experiments dealing with winery wastewater treatment with heterotrophic algae. Due to the high COD content, low nitrogen and phosphorus contents and to its color, winery wastewater is a bad substrate for autotrophic algae cultivation, but might prove adequate for heterotrophic degradation by Chlorella protothecoides, an algae strain known for its capacity to accumulate large amounts of oil in the cell while consuming large amounts of carbon. This selected algae strain came from the SAG Göttingen collection. TTZ carried out batch experiments with Chlorella protothecoides in Erlenmeyer flasks, which were filled with 100 ml of samples of 3 synthetic wastewaters: diluted wine with a COD concentration of nearly 10 g/l and 20 g/l, and a mixture of diluted wine + grape juice (ratio 2:3) with a final COD concentration of around 20 g/l. The experiments were carried out under sterile conditions. Algae grew within all cultures with the highest rate obtained in the wine: juice mixture. The removal efficiencies of COD after 6 days of incubation ranged from 68.3 % (wine and juice mixture) over 74.3 % (diluted wine 20 g/l) to 83.5 % in the trials with diluted wine (10 g/l COD). The residual COD would need an additional treatment step to be removed.

Biomass productivity on the synthetic wastewaters was lower than on a standard glucose media. A different cultivation strategy, like fed-batch would improve biomass productivity. Lipid content could not be determined due to the small amount of samples available. Due to the need of aseptic conditions for this type of treatment, this valorisation technology is not applicable on-site in the wineries. If applied, this technology would have to be performed by further companies that are specialised in algal oil production.

TTZ collected information regarding an application of the MBR technology for the treatment of winery wastewaters. The information was mainly based on a literature research. The result obtained by Artiga et al. (2007) for MBR treatment using diluted white wine as substrate was high COD removals (above 97%), already after few days of operation. Besides, the organic matter removal was not affected by variation of OLR or COD concentration in the influent. The MBR technology might be even more cost intensive than the methods presented before, as permanent supervision is needed as well and the membrane modules impose clear additional investment costs. In contrast, no problems due to poor sludge settling properties have to be expected. Clear advantages of the MBR technology are that it could ensure a very good effluent water quality.

In order to clarify the conditions under which the application of the MBR technology would be favourable for the treatment of winery wastewater, ITACYL performed lab-scale experiments. Their experimental system consisted of an aeration tank with 5 hollow fibre micro-filtration modules (MICRONET N-POROUS FIBER) directly submerged into it. TTZ as well performed the pilot scale experiments within a 50 l reactor (nominal surface of membrane 3.5 m2) using diluted red wine as synthetic wastewater (final concentration of 10 g/l) and sludge from WWTP (recycle sludge from activated sludge tank).

Polyphenol extraction is a possible valorisation technology for winery solid wastes. ITACYL examined marc from white and red wine production in terms of their phenolic composition in order to see if the extracts obtained could be used in pharmaceutical, cosmetic or food industry. Polyphenol concentration varied greatly with the applied extraction method, the grape variety (the marc from white grapes contained more than from red grapes) and the winery, that is to say the wine-making process (probably mainly the applied pressing procedures).

TTZ summarised information regarding the potential use of winery wastewater for the production of fungal proteins. The overview was mainly based on the publication of Zhang et al. (2008). It was agreed that this waste water valorisation technology would be as well a complex treatment option that would have to be performed off-site by other companies. As the market for oil and derived products as biofuel might be more important than the one for proteins, it was decided that detailed experiments regarding this possible valorisation technology are not necessarily required.

TTZ did a literature review regarding the land spreading of solid winery waste that was presented in the technical meeting from Paris. As a conclusion to this literature research, it was stated that the amendment of soils with winery waste might have some beneficial effects. Nevertheless, the mostly low pH values, high electrical conductivity, the presence of phytotoxic compounds (like polyphenols) as well as the fact that the wastes are nutritionally

imbalanced do not make winery waste an ideal soil fertiliser. Composting could improve the fertilising properties of winery wastes.

The potential for co-firing was as well evaluated by TTZ and presented during the technical meeting in Paris. Winery wastes have a water content of approximately 55 %, which reduces their gross calorific value of 21 MJ to a net calorific value of approximately 7.5 MJ. So, the co-combustion of winery wastes could be economically viable only if the thermal pre-treatment costs to remove water are low. It was discussed during the technical meeting from Paris that considering the available results, the co-firing of winery waste has to be assessed ineffective.

The following points concerning the choice of technologies to test at pilot-scale were discussed during the technical meeting from Narbonne:

- Small and medium-size wineries do not produce large amounts of wastewater and solid waste to apply an individual continuous treatment. Moreover, the seasonal nature of the activity, and so the high variations in pollutant flows and organic matter concentration, often involves the need of storing the waste/wastewater for a certain period of time before treatment. The storage of the wastewater helps optimise the size of the treatment system and avoids high variations in the flow to be treated. Due to the usual high concentration of total suspended solid, a screening or a sieving is generally recommended as pre-treatment step.

- Due to the high biodegradability of the winery effluent (BOD5/COD around 40-50 %), biological processes are particularly well suited to treat this type of waste/wastewater. Anaerobic systems are used for highly loaded wastewater. However, these systems generally need to be followed by an aerobic treatment step in order to achieve the legal discharge limits. Aerobic systems have high pollution removal capacity, but the main drawbacks are the high energy consumption and the larger excess sludge production.

- Considering the low concentrations of inorganic nutrients, no specific treatment as biological nitrification-denitrification or physico-chemical P removal are necessary. This winery effluent characteristic could be a drawback if the effluents are treated aerobically as an addition of nitrogen and phosphorus might be then necessary to balance the BOD5/N/P ratio.

- Natural and forced evaporation will not be taken into consideration as these technologies need specific climatic conditions to be effective.

- Reed bed or other constructed wetland cannot be used as main treatment for winery effluent because the surface needed to achieve a sufficient removal efficiency and comply with the discharge standards would be too high due to the high COD concentration.

- One of the most important criteria to take into account is that small wineries have generally a restricted budget. Additionally wineries with production capacities up to 200 hl normally do not pay special taxes on waste and water treatment, therefore the municipal

wastewater treatment is usually a cheap alternative. So the foremost priority for the technical solution has been to select the cheapest alternative.

Based on these first results, it was decided that land-spreading, aerated storage, municipal treatment plants, SBR and MBR technology are the most important and feasible technologies for winery solid waste and wastewater. Regarding valorisation technologies, it was decided that the focus should be laid on the following possibilities, as they were assessed to be the most promising: Polyphenol extraction and algae production, with subsequent oil extraction.

The main conclusions on aerated storage tested at lab- and pilot-scale are that, on one hand, the aeration period showed a high effect on the biological degradation. So, depending on the discharge aeration periods can be applied. At pilot scale, the organic matter removal efficiencies achieved were lower, due to the insufficient capacity of the aeration system. On the other hand, the study revealed that the inoculation of the aerobic bioreactors did not have a significant influence in the COD degradation. Concerning the temperature parameter, it was found that bioreactors working at 37 ºC produced worse odours and achieved only 2 % higher organic removal than experiments carried out at 15 ºC, while increasing the running cost. So, for small wineries, long term aerated storage can be performed (e.g. ponds, old cement vats, etc.) with relatively low investment and operation costs.

The results of lab- and pilot-scale experiments for sequencing batch reactor showed, that this technology has a good removal efficiency for soluble COD (i.e. more than 96 % for all reactors), but the unwanted effect of free bacteria development, which increased the TSS concentration and total COD in the treated effluent, was found in all tests. However, the addition of a coagulant or a simple and cheap filtration system such as a sand-filter could be solution to reach a good effluent quality as far as total COD is concerned. So, sequencing batch reactor is well adapted for small and medium sized wineries, due to its low investment costs and low staff skills needed.

The MBR showed a stable response in both experiments over the time. The treated effluent quality was determined to be high (total COD removal efficiencies higher than 99% for OLR in the reactor of 0.5 g COD L-1d-1), so that it could permit the re-use of the water. The increases of OLR did not affect the operation of the MBR or the quality of the effluent. However, the permeability of the membrane module decreased over a longer investigation period, creating the need of an occasional cleaning of the membrane module. The accumulation of solids in terms of VSS was very low in the first experiment and with a slow tendency to increase in the second experiment but this increase did not affect COD in permeate or microbial viability.

During the first tests, microalgae have shown a potential for pre-treating winery wastewater. Using wastewater as substrate for biodiesel production from algae would reduce the

cultivation costs of the algae and would bring this technology a step closer to being economically viable. Nevertheless, still a lot of work needs to be done with regard to the cultivation of algae on winery wastewaters and biodiesel productivity needs to be determined, in order to assess the economic value of this treatment method. Different cultivation strategies and more algal strains need to be tested to improve biomass and oil productivity.

A literature review on land spreading and composting, as well as tests on polyphenols extraction and anaerobic digestion was done for solid waste treatment. It was determined that the use of solid winery wastes as soil amendments has some potential benefits such as the increase of the organic matter content of the soil. But some studies show negative that it can also affect plant germination and growth. Composting of winery wastes could correct the nutritional imbalance and reduce the concentration of phytotoxic components. It is possible to carry out the co-composting of winery wastes (sludge mixed with grape stalks) satisfactorily, while recovering organic matter. The additional cost of composting (inversion and operation costs) are low. Concerning polyphenols extraction, the results obtained in the study allow asserting that grape by-products have an important content of polyphenols. For that reason, these by-products can be used in pharmaceutical, cosmetic and food industry.

The anaerobic digestion of winery residues is another valorisation technology that was determined to be possible considering the biochemical methane potential. A comparison with the methane potentials of other organic material showed that winery residues are in the medium range, with values nearly equivalent to brewery waste. Nevertheless, the individual anaerobic digestion of winery solid wastes is not appropriate for small and medium sized wineries due to the small quantities produced. But on the other hand, the methane potentials suggest that the co-digestion of winery residues in an existing anaerobic co-digester can be a good solution. Concerning anaerobic digestion of winery wastewater, it can be stated that this technology is efficient for the treatment of highly concentrated winery wastewater. Indeed, experiments in an anaerobic fixed bed reactor showed that very high organic loading rates (24 g COD/l*d) could be applied while maintaining at least 80 % of organic matter removal. However, this process is quite sophisticated and is always combined with a post aerobic treatment to meet an effluent quality which can allow a direct discharge into surface water. So, it might not be very appropriate for small and medium sized wineries.

All these investigations and experiments underlined, that a large number of possible solutions for the treatment of winery waste exist. Nevertheless, even if the site-specific technical criteria are significant in the choice of a treatment solution, for all small and medium wineries the economic criteria will be the most important. Each RTD contributed to the economic assessment according to the following responsibilities:

- Land spreading (ITACYL, with support of the other three RTDs)

- Aerated storage (ITACYL)

- Municipal treatment plants (IPVE)

- Sequencing batch reactor (SBR) (INRA)

- Membrane bioreactor (MBR) (TTZ)

IPVE was moreover meant to investigate waste and wastewater minimisation strategies. The aim was to develop guidelines to reduce the quantity of pollution to be treated. It was found that simple methods are available to optimise the management of effluents from a winery with more or less high investments with the aim to reduce the water volume and the quantity of pollution to be treated. They are summarised in the following tables, divided into measure, which can be applied without any specific investment (Tab. 5) and measures, which do require investments (Tab. 6).

In order to simplify the comparison of the economic evaluation of the different studied technologies, cost calculation was focused on three cases, as shown in Tab. 7.

Regarding the calculation of treatment costs, both the operation of existing facilities as well as the erection of treatment plants was considered, whenever possible. The economic evaluation considered investment costs, running and maintenance costs as well as the degree of skills in terms of manpower. In order to calculate costs for newly constructed plants quotations from companies were taken into account, especially for on-site treatment. For those technologies that are not on-site-technologies, as e.g. the treatment in municipal wastewater treatment plants, quotations from companies, offering these services were taken as basis for cost calculations.

The task was completed with an Microsoft Excel tool in order to calculate and compare costs of wastewater treatment options at different wineries. The economic feasibility of different treatment technologies can be estimated by this tool, where one sheet provides a general overview whereas the other sheet deals with the different treatment options in detail.

Development and Implementation of an Environmental Quality Strategy for Wine production (EQSW) and label

The EQSW (Environmental Quality Strategy for Sustainable Wine production) label was meant to be developed in accordance with existing standards related to wastewater, wastewater reuse, wastes and solids disposal throughout Europe. In order to make it easier to know whether this label complies with these standards, all relevant European standards on waste minimisation, wastewater treatment, solid waste treatment and valorisation alternatives were identified and presented.

The investigation of the market demands resulted in a comprising summary about different sources, all stating, that sustainability is becoming a more and more important aspect in commercial wine affairs. Besides, it is assumed, that a certification of this sustainable production would result as well in an improved reputation, an increased product quality and finally higher selling prices. As the most important factors regarding the location of the winery, the following were considered as relevant for the EQSW:

- property size/available land onsite for disposal,
- proximity to nearby surface waters and natural surface drainage,
- the depth of groundwater,
- soil type and permeability.
- winery wastewater loads,
- waste constituent levels,
- seasonal load variation,
- future plans for expansion,
- economic considerations,
- adjacent land uses,
- proximity to residents.

Moreover, all seals of approval and respective labelling have to follow the “international organisation of vine and wine (www.oiv.int) international standard for the labelling of wines and spirits of viticultural origin”.

In terms of the winemaking process, it was summarised that several types of processes exist due to the fact that different types of wines are produced. Those different types lead to the production of waste and wastewater that are not only different quantitatively but also qualitatively. The mix of those variables that is characteristic of each winery gives a qualitative conditioning to the optimisation of the sustainability of each winery. For the description of the waste and wastewater management systems comprehensive check-lists have been developed, helping to display a detailed picture of the established systems on the investigated wineries. In order to evaluate the environmental performance of the cellars regarding the adopted valorisation alternatives for the waste and by-products the following factors had been identified:

- Cellar size
- Annual quantity of waste or by-product fractions produced in the cellar
- The application of any valorisation alternatives for all different winery wastes (on-site or off-site treatment)
- Future management plan for the reusing or recycling of the winery wastes
- Possibility to subscribe (or create) to a cooperative responsible for the waste and by-products valorisation management?

Based on this, the three main modules for EQSW were developed:

a. Module 1: waste minimisation (IPVE)

b. Module 2: wastewater treatment (TTZ)

c. Module 3: solid waste and valorisation alternatives (ITACYL)

Before dealing with the technical criteria to consider for the development of the environmental strategy, the administrative structuring of the EQSW label (registration admission commitments, the accreditation, the commitments control and the communication to the public) was set out. The possible general implementation procedure of the EQSW was defined, as it is shown in Fig. 5.

In Module 1, the main waste minimisation alternatives applied to any winery were defined. Wastewater minimisation alternatives involve segregation of water network, minimisation of used water, cleaning process improvement and recycling of the cooling water. The reduction of pollution load of effluents could be achieved throughout the separation of pollutants from water and wastewater, the separation of high and low-strength waste streams and by-product recovery. The alternatives for packing and energy minimisation were also included.

In Module 2, the main existing wastewater treatment technologies that might be suitable for small wineries were summarised. This information was obtained from the case studies and bibliography research carried out by the consortium with regard to wastewater treatment alternatives. These wastewater treatment technologies are: land spreading, constructed wetlands, long term aerated lagoons/aerated storage, sequential batch reactor, submerge membrane bioreactor, anaerobic fixed-bed reactor, municipal wastewater treatment, algae and fungi.

Finally, in Module 3, some alternative technologies for solid waste valorisation are proposed. Among those, the following practices are recommended: composting, incineration and co-firing of the stalks, polyphenol extraction from the pomace, extraction of grape seed oil, distillation of lees, agronomic use of waste perlite and recovery of tartaric acid. Additionally, the European network of contacts active in the valorisation business developed in task 2.4 was included in this module, thus if a wine producer is interested in a specific valorisation option, they can communicate with the appropriate company.

The preliminary EQSW were subsequently implemented in the participating cellars and the implemented techniques/measures were assessed and evaluated. Indeed, the main objective was to check the compatibility of the preliminary EQSW with the field reality by the implementation of it in the participating cellars and the evaluation of the changes as a result of the implemented EQSW.

Each RTD implemented the EQSW in its affiliated cellar that is to say: ALANA Tokaj winery in Hungary for INRA, SOLAR winery in Spain for ITACYL, Weingut Holstein winery in Germany for TTZ and Cramele Halewood wineries in Romania for IPVE. The results and comments of the four case studies of implementation of the preliminary EQSW in cellars are presented hereafter after pointing the general methodology for the implementation of the EQSW.

General methodology for the implementation of the preliminary EQSW:

Though the implementation of the preliminary EQSW is quite site-specific as the needs and expected results of each participating cellar are different, a general methodology was designed as basis for the subsequent work of each RTD with its affiliated cellar.

This implementation was done in 3 steps:

- Determination of the winery needs,
- Planning of the alternative implementation,
- Assessment of the changes due to the implementation of the EQSW.

Determination of the winery needs

On the basis of the assessment results, the needs of the participating cellars were identified and are a mix of compulsory objectives according to the different legislation (see tasks 1.1 and 1.3) and of voluntary objectives based on the expectations of each cellar.

Planning of the alternative implementation

The implementation of the EQSW, and the linked minimisation and treatment or valorisation alternatives, was planned in order to avoid any major disruptions of the smooth production in the wineries. A proposed procedure to plan the alternatives' implementation was designed including the following steps:

- Screening and selection of the alternatives: Among the alternatives presented in the three modules of the preliminary EQSW, the RTDs and cellars chose the most suitable solutions, taking into account the winery constraints, in order to fulfil the decided environmental objectives.

- Responsibilities for the implementation of the selected options: The responsibilities for the implementation of the selected options and the time to do it were determined.

- Scheduling of the planning and of the implementation: As task 3.3 began in April 2011, the implementation of the alternatives was planned at the beginning of the task so that the alternatives were put in place before the beginning of the 2011 vintage period which is the most polluting period. Of course, depending on the winery needs, the selection and implementation of minimisation, treatment or valorisation alternatives could be performed over a longer period.

Assessment of changes due to the implementation of the EQSW

The aim was to assess the changes resulting from the implementation of the EQSW in the wine cellars. A monitoring protocol was developed by the RTDs at the beginning of task 3.3 to indicate the performance indicators and the sampling schedule. Then, this protocol was applied through a monitoring period which covered the vintage period.

The implementation of the preliminary EQSW in the ALANA Tokaj winery (INRA)

Determination of the ALANA Tokaj winery needs

The ALANA Tokaj winery is not affected by the legislation due to its small-size (150 to 250 hl of produced wine per year). The main objective of the implementation of the EQSW at ALANA Tokaj winery was to better organise the winery wastewater and solid waste management with the consultation of the local water company and authorities. Another objective was to implement minimisation alternatives as much affordable as possible in order to reduce the volume of produced wastewater.

For solid waste management, ALANA Winery respects all the legal expectations as there is an authorisation to spread solid waste on the vineyard. Nevertheless, the owner was interested by alternative affordable solutions.

Implementation of the alternatives at ALANA Tokaj winery

Wastewater

The selected treatment solution in ALANA Tokaj winery is the co-treatment of winery wastewater with domestic effluent at a municipal wastewater treatment plant (WWTP) located in Szerencs.

An on-site visit in Màd, Hungary, was done by INRA on the 9th and 10th of August 2011, in order to determine the relevance of this solution through a visit of the Szerencs WWTP and a discussion with a member of the management staff of the plant, but also to discuss about the practical implementation of the solution in the ALANA Tokaj winery (i.e. piping). The treatment plant in Szerencs is working quite satisfactorily and there are only very few wineries connected to this plant and thus the effluents from the ALANA Tokaj winery can be accepted without generating any problem and no agreement is required from the water company.

However, it was decided to reorganise piping at ALANA Tokaj winery in order to create a separate rainwater collection system to avoid the introduction of rain water in the collection pipes during rainfalls.

Some other minimisation alternatives were also implemented:

- Rise of the environmental awareness of the seasonal staff and use of better practices for cleaning during vintage,

- Regular checking of pipe connections and taps for leaks,
- Recovery of rainwater for cleaning of agricultural machine,
- Recovery of wine lees.

By-products and solid waste

There were two solutions for grape marc management:

- Aszú botrytised grape marc is accepted by a local small distillery due to their high sugar content.
- The rest of grape marc is spread in the estate vineyard some kilometres away from ALANA Tokaj winery.

The alternative solution proposed is the off-site composting of the grape marc at Miskolc plant (30 km away from the winery) that already treats the sewage sludge from Szerencs wastewater treatment plant.

Assessment of changes due to the implementation of the EQSW at ALANA Tokaj winery

Reduction of water consumption

Water consumption for the harvest 2011 was 29 m3 and the volume of must produced was 207 hl. For 2009, the total quantity of water consumed was 43.6 m3 and the volume of must produced was 150 hl. The ratio of water used per litre of must produced was then respectively 2.9 and 1.4 litre of water per litre of must produced in 2009 and 2011.

However, both measures of 2009 and 2011 are over-estimated as they include other water uses that may occur at the winery (concrete making for building for instance). Furthermore, even if the water consumption appears to be better in 2011 than in 2009, it is hard to correlate this improvement to a rise of the environmental awareness of the seasonal staff. Indeed, 2009 was a rainy period during the harvest, which required the use of much higher amounts of water to clean the boxes that got dirtier with mud. More data acquisition in the following vintage periods would be necessary to assess the impact of minimisation alternatives on water consumption.

Solid waste treatment

The solid waste management changed significantly after the implementation of the EQSW. Indeed, the total amount of pomace produced in 2011 (i.e. 9.78 tons) has been delivered to the composting plant in Miskolc and was not applied in the vineyard anymore.

Aszú botrytised grape marc and lees were sold to Boldogkő Fruit Kft distillery that accepted to receive both kinds of by-products. Thanks to this income, the winery should reach a well balanced budget for the treatment of its by-products.

The implementation of the preliminary EQSW in the SOLAR winery (ITACYL)

Determination of the SOLAR winery needs

Due to the small size of the SOLAR winery, European and national legislation related to wastewater and waste management does not affect its activity.

The expectations of the SOLAR winery were mainly:

- To reduce water consumption in cleaning operations during the vinification process.
- To remove solids content in winery wastewater.

Implementation of the alternatives at the SOLAR winery

Wastewater:

In order to reduce water consumption, the following minimisation alternatives were implemented in the SOLAR winery cellar:

- Set-up of a specific flow meter to measure the water consumption that only comes from the cleaning operations during the vinification process
- Check periodically pipe connections and taps for leaks
- Register periodically water consumption
- Increase seasonal staff awareness
- Check pressure of water in the taps

By-products and solid waste

In order to remove the solids content, three mesh screens were installed in the cellar:

- One inside the cellar (mesh size = 0.2 mm), in the manhole where wastewater generated during cleaning operations of fermentation tanks is collected.
- Two outside (mesh size = 3 mm), installed in two different manholes where wastewater coming from the cleaning operations of the pressing machine and the destemmer is collected.

Another minimisation alternative was adopted: to make dry cleaning operations before cleaning with water, in order to remove solid wastes.

Assessment of changes due to the implementation of the EQSW at the SOLAR winery

Reduction of water consumption

During vintage period in 2011, the water consumption was 59.6 m3. The quantity of processed grapes was 65 Tones and, therefore, the wine produced will be 488 hl. The ratio wastewater/wine produced was calculated to be 1.22 l/l.

During vintage 2009, the water consumption was assessed through the water bill of the cellar. Thus, the calculated ratio was 1.15 l wastewater/l wine produced.

During vintage 2010, water consumption was assessed through the reading of the general flow meter of the cellar. Based on this measurement, the ratio was calculated to be 0.85 L wastewater/l wine produced.

Therefore, a slight increase in water consumption has been observed after the installation of the flow meter. Factors such as the routine use of high pressure water for cleaning, lacking environmental awareness of the cellar staff and leaks in pipe connections and taps could make it difficult to substantially reduce water consumption.

Solid waste treatment

Total COD and solids removal efficiency varied between 60 to 80 % in destemming, pressing and must clarification. However, the removal efficiency drastically decreased during tank cleaning operations after fermentation, achieving values lower than 10 %. This tendency could be explained by the decreasing in the size of the solids present in the wastewater as the vinification process is carried out. Thus, wastewater coming from destemming contained solids of bigger size (mainly rest of leafs, stalks, grapes, etc.) than those contained in wastewater coming from cleaning operation after fermentation. In that case, the solids were fine (rest of yeast, for example). With respect to the operating capacity of the mesh screens, no problem was detected in the performance of the outside mesh screens, where destemming and pressing were carried out. However, the mesh screen located inside the cellar presented fouling and clogging, causing serious interruptions in usual staff activity. As a result of the assessment, it could be concluded that mesh screens resulted to be useful as simple tools for removal of solids content in winery wastewater coming from destemming and pressing (the first steps of vinification). However, the proposed environmental objectives were not achieved in the further steps of wine production, where the mesh screens were not able to remove the pollution load of the wastewater and, in addition, they caused interruption in the cellar activity.

The implementation of the preliminary EQSW in the Weingut Holstein (HOLST) winery (TTZ)

Determination of the Weingut Holstein winery needs

German legislation forces German wineries to pay a special tax for the pollution produced during wine production, mainly linked to wastewater, so that Weingut Holstein winery has to pay each year a tax of about 1,500 €. As a consequence, the main aim of the implementation of EQSW was to reduce the pollution generated by the winery to such levels that the winery taxes will be cancelled. In order to do so, and based on the lab experiments and previous

experiences, a Membrane BioReactor system (MBR) has been chosen to be implemented and tested onsite.

Implementation of the alternatives at Weingut Holstein winery

The EQSW focuses on 3 main points: minimisation of produced waste, pollution reduction by applying waste treatment technologies and valorisation technologies.

Waste minimisation alternatives were studied in this winery but no measure was applicable or needed.

Pollution reduction by treating the wastewaterThe total volume of wastewater produced by Weingut Holstein winery is around 146 m3 per year. For wastewater treatment, the best alternative to be applied, according to the needs and waste characteristics of Weingut Holstein winery, is a wastewater treatment technology, specifically a Submerged Membrane BioReactor (MBR). From the results obtained at lab scale and the characteristics of the wastewater produced by Weingut Holstein winery, a bioreactor of 760 l was set-up at the winery in 2011 and operated for validation.

The MBR system was made-up of the following components:

i- Three tanks (a feed chamber of 1,060 l, a MBR chamber of 760 l and a sludge chamber of 460 l),

ii- An aeration system,

iii- A membrane submerged module with a total membrane area of 7 m2, a maximum flux of 50 l/m2*h and pore size of 0.04 μm,

iv- A permeate system,

v- A sludge recirculation system,

vi- A level control system,

vii- A control panel.

By-products and solid waste

Regarding valorisation alternatives, TTZ could not find any company nearby which is willing to use the solid waste or the wastewater produced for added value products production.

Assessment of changes due to the implementation of the EQSW at Weingut Holstein winery

Reduction of water pollution

TTZ has implemented an on-site treatment at Weingut Holstein winery with the setting up of a Membrane BioReactor (MBR) with the aim of reducing the quantity of pollution discharged into the environment by the winery. After the installation and start-up of the MBR, the system has been controlled and checked by TTZ, thanks to the collaboration of the winery staff. The MBR was operated from October 2011 to December 2011.

The MBR was operated at Weingut Holstein winery in order to study the effect of temperature and organic load rate changes. Samples have been sent to TTZ laboratories every two weeks from the winery and TTZ has visited the system whenever necessary.

During the system operation, different Organic Load Rates (OLR) have been applied in order to check the stability of the system with regard to COD concentration in the permeate as it was observed previously in the pilot plant experiments. The applied OLR was around 0,8 g COD. Total COD removal efficiency has been stable during the system operation with values in the range 95-98 %.

The results gathered by TTZ are promising but still need some optimisation regarding electrical consumption, and the behaviour of the system during the peak period of wastewater production should also be checked on site. Nevertheless, MBR technology could be a future suitable technology for winery wastewater treatment to be used in irrigation (it will depend on the legislation applicable to the specific country) or as a pre-treatment before the local wastewater treatment plant.

The implementation of the preliminary EQSW in the CRAMELE Halewood Group (IPVE)

The CRAMELE Halewood Group is located in Romania and has 4 wineries:

- Ploiesti, that is responsible for packaging and storage of wine and laboratories,

- Azuga, that is responsible for processing the sparkling wine, rural tourism, wine tasting and tourism in general,

- Tohani, that is responsible for the grape harvest, wine storage and packaging,

- Urleateanu, which is responsible for ageing in barrels and tourism in general.

Determination of the CRAMELE Halewood Group needs

The expectation of the CRAMELE Halewood Group with regard to the SUSTAVINO project is mainly an improvement of the management of wastewater and solid residues with minimal cost. In a first step, they want to focus on the concept of wastewater and solid waste minimisation, adopting changes in their wine production system in order to decrease the quantity of wastewater and solid residues.

Implementation of the alternatives at CRAMELE Halewood Group

The work with CRAMELE Halewood Group focused on the first part of the EQSW that is to say the minimisation of the production of wastewater and solid waste.

Wastewater: Both the winery and the competent authorities, examine the wastewater regularly.

Solid Waste: The winery does not examine the solid waste.

Assessment of changes due to the implementation of the EQSW at CRAMELE Halewood Group

The main results of the implementation of minimisation strategies in the CRAMELE Halewood wineries (2011 versus 2010) are:

• The total load increased in 2011 in relation to 2010 because the wine produced increased by 24.27 %,

• The winemaking efficiency (l of wine produced per kg of grapes harvested) was within the range of industry standards (72.1% in 2011), being that value a slight decrease (1.9 %) when compared with 2010,

- Moreover, in 2011 the total amount of wastewater decreased (13.5 %),
- Therefore, the ratio of volumes of wastewater per wine produced also decreased (18.5 %), meaning that the calculated average concentration of the wastewater increased in 2011 (31.8 %).

In the finishing and bottling winery (Ploiesti):

- The ratio of volume of water consumed per wine produced decreased by 14.9 %
- The ratio of volume of wastewater produced per wine produced also decreased by 30.0 %.

In the production winery (Tohani):

- The ratio of volume of water consumed per wine produced decreased by 29.8 %
- The ratio of volume of wastewater produced per wine produced also decreased by 28.8 %.

After finalising the EQSW assessment and evaluation, the SUSTAVINO label was designed.

This label, together with the related EQSW-strategy was registered in the "Office for Harmonization in the Internal Market" with the number 010089274. The mark has to be used in its entirety, with all the words and elements that compose it, in the same order and with the typography that is agreed by the mark owners. The size of this is free, but in any case the word “SUSTAVINO” must be perfectly legible. The mark owners are equally the participating SUSTAVINO associations. In order to set all necessary rules about the use conditions and about how this mark will be granted and used, a regulation contract between the SME-AGs was designed and finally signed until the end of the project in March 2012. This Regulation is meant to be a very important step to achieve the successful EQSW label introduction into the market. With regard to the plan for the market introduction, it is considered that it will be possible to offer the EQSW label for commercial purposes. A possible marketing plan was developed.

The most important objective of the EQSW is to offer technical assistance and support to wine producers to meet environmental regulations. The final goal is to improve their sales rates and their image. Besides, the valorisation of wine wastes and the improvement of

wastewater treatment may create new employment possibilities. Moreover it might be a way to diversify business. With this implementation it is intended to:

- provide the required knowledge to the viniculture workforce to perform their job in an eco-efficient way, prevent water quality deterioration and protect ecosystems' health.
- propose new solutions not only for the re-use of the wine waste in agriculture, but also for the production of common and novel products for other sectors, such as tannins, oils, pigments…
- help the European wine producers, not only to meet environmental regulations by providing the required knowledge to treat their wastes in a cost-effective and ecological way, but also to strengthen the wine sector and the rural areas in general.
- help to retain rural populations and promote a significant business in traditional regions of Europe, seeking the integration of women in the process of rural development, agriculture and tourism in the area.

Potential Impact:

The potential impact and the main dissemination activities and exploitation of results

The European wine sector is the global market leader with more than 45% (EU25) of vines and 60% of global production. With 1.6 million vineyards, vines occupy roughly 3.4 million hectares in the EU 25. In total, wine-growing farms employ more than 1.500.000 people full time. With the latest accessions to the EU, i.e. Bulgaria and Romania, the European wine-making sector has strengthened its position in the sector and it accounts for almost 60% of the global distribution of wine areas. However, European winemakers are facing serious economic problems, with falling domestic consumption, excess production and increased popularity of the New World wines.

The European wine production structure is highly different to that of other producing countries, i.e. the New World wine producing countries, where the winemaking is generally carried out by companies and grape growing by labourers working for those companies. In Australia, for example, the average surface area of a wine holding is 50 hectares. The European wine production is traditionally bound to small and medium sized family owned cellars and co-operatives. About 71% of holdings growing grapes for wine have less than five hectares of land. This structure ensures high quality and diversity of wines in different European regions.

The activities and results of the SUSTAVINO project aim to an integrated and sustainable wine production in Europe. The focus was on the sustainability of vineyards and their comprehensive improvement, including waste reduction, decrease of water consumption, waste water treatment and re-use, as well as waste treatment and valorisation. SUSTAVINO intends to help large communities of European small wine producers to meet environmental regulations by implementing an Environmental Quality Strategy for Wine production (EQSW), including EQSW label, for minimising, treating and valorising wastes. Such a quality label will be furthermore used as an image tool for market benefits and increased competitiveness due to the consumer demand patterns on environmentally conscious products. The overall strategic impact of the project results is therefore to reinforce the strong reputation of European wines not only as traditional and high quality wine but also as sustainable product, to recover former markets and to acquire new ones in both the EU and worldwide. The project is expected to positively affect thousands of small wine producers.

SUSTAVINO’s socio-economic impact

One important aspect of wine production and its complementary products is the associated generation of large quantities of waste streams. The SME-AGs have identified the need to solve this important problem affecting many of their members as wineries' employees and owners are far from being aware of the environmental implications and new regulations affecting them. The SME-AGs participating in SUSTAVINO are situated in some of the main wine producing countries in Europe, a total of six. By disseminating all the information about the results gathered in SUSTAVINO via face-to-face and e-training courses, the project will directly improve the skills of the employees from the wineries on this specific subject. In addition, SUSTAVINO supports the SME-AGs to apply integration policies to the viniculture sector of the newest Member States like Romania, and others relatively new like Hungary and Czech Republic, having a strong ancient tradition in the wine-making art and being important players in the global market.

Hence, it is expected that the results of the SUSTAVINO project will arouse the SMEs' awareness of the importance of a profound knowledge on sustainable waste and waste water management from the viticulture and wine sectors through training and education. They will be provided with the tools to improve their production practices and waste management and treatment methods. This includes in particular the minimisation of solid and liquid winery residues as far as possible, having not only an environmental but as well an economic impact as costs for fresh water and for treatment and/or disposal will be reduced.

The New World wines are putting pressure on the European wine sector, which weakens their sales position. Between 1996 and 2000, Italian and Spanish wine exports increased only 9,1% and 3,5%, respectively, while the French ones even slightly decreased by 0,9%, on the contrary Australian, North American and Chilean wine markets increased by 124%, 127%, and 60%, respectively (Newspaper El Mundo: 2003). This leads to huge difficulties to withstand competition from new bigger wine producers and also cope with environmental legislations at the same time. Unless the necessary measures are put into place, this situation can make wineries drive out of their business.

Hence, SUSTAVINO will give solutions to a sector suffering from the competition of the New World wines. It will help to retain rural populations and promote a significant business in traditional regions of Europe, seeking for rural development, agriculture and tourism in the respective areas. SUSTAVINO aims at helping the European wine producers, not only to meet environmental regulations by providing the required knowledge to treat their wastes in a cost-effective and ecological way, but also to strengthen the wine sector and the rural areas in general, by means of the compliance of the Environmental Quality Strategy, which will be also used as a marketing tool (EQSW label). A survey carried out by the German Federal Environment Agency regarding the German eco-label "Blue Angel" showed that 76 % of companies believed that the eco-label had increased competition for environmental innovation in their branch, and that 63 % thought that it had increased the marketability of their products "clearly" or "to some extent". This makes specially sense in the case of wineries, due to the fact that wine is well known as part of the Mediterranean diet and one

major concern of the consumers is the quality of the product. Thus, the image of an environmentally friendly produced wine will even lead to an enhancement of the positive product social image.

The implementation of the developed EQSW and the use of the EQSW label will prove compliance with the Environmental Quality Strategy and will positively affect the general environmental-related awareness of the society. Establishing the EQSW label will consequently be a marketing argument for wineries as it will provide a quality standard to consumers throughout Europe, being a seal of quality which indicates that the manufacturer is being regularly audited by the certification organisation. This is expected to raise awareness of national and European authorities and might in longer term lead to an improved regulatory framework for this sector.

Special attention throughout the whole project duration has been paid on the implementation of simple and economic but efficient solutions for the SME wineries. It is expected that the implementation of the SUSTAVINO EQSW techniques/measures will have in the short term an impact on the final product costs not higher than 10 %. In the medium and long-term, this disparity would be paid off by the following additional benefits generated by its implementation – in a short mid-term period it is expected to increase wineries' benefits by 5 %. The implemented techniques and measures respectively are expected to allow European wineries to compete against emerging markets on a sustained basis.

The by-product valorisation from the solid wastes, such as the extraction of polyphenols, provides yet another potential to generate income besides mere wine production ('portfolio diversification') as well as might create new employment possibilities for this particular sector and areas.

The implementation of the developed EQSW to the sector will in the wider sense, allow the establishment of benchmarks for future improvement in environmental performance and the prevention of environmental accidents as a result of being aware of the environmental impact that winemaking processes induce.

SUSTAVINO's wider social implications

SUSTAVINO is in line with the community societal objectives to promote throughout the Community a high level of employment and social protection, equality between women and men, the raising of standard of living and quality of life, and economic and social cohesion and solidarity among Member States as described below:

Environmental, quality of life and health

SUSTAVINO will provide environmental benefits in particular to the Mediterranean winemaking countries, in which production is subject to frequent periodic droughts and only limited water resources are available.

Winery effluents lead to serious eutrophication and bacterial pollution in ground water and downstream rivers, thus causing a significant environmental and health risk in those areas associated with non-urban ecosystems. Sustainable viniculture will improve the protection of the surface and groundwater resources. SUSTAVINO will not only prevent contamination of water resources, but will lead also to fresh water savings by promoting safe internal water cycles re-use, re-cycling, and waste valorisation. SUSTAVINO provides the required knowledge to the viniculture workforce to perform their job in an eco-efficient way, prevent water quality deterioration and protect ecosystem (plants, wildlife and fish) health.

In addition, an enhancement of the environmental quality is directly linked to a better quality of life for the citizens, particularly those who have to stand odours, emissions, polluted water and destroyed vegetation. Furthermore working under environmental friendly conditions, it will improve the health of the inhabitants of the area due to a better quality of the water discharged to the rivers and seas and even in waterways in case of storms (contaminated effluents to the ground water generate cancerous by-products when mixed with chlorinated drinking water).

Vineyards are normally located in mountainous areas where other agricultural practices are difficult. By means of a sustainable viniculture, soil erosion and desertification, already affecting 16 % of the European land (115 million ha) – especially in the Mediterranean region – will be prevented, since it contributes to the conservation of very diverse ecosystems.

Rural development, employment and gender dimension

Agriculture is on the centre of rural development and rural women are on the centre of agriculture, and viniculture in particular. Moreover, women are not only the source of labour force for agricultural activity but also take most of the responsibility at home (domestic task, childcare). In winemaking areas women contribute to 60-80 % of the total work but they do not profit from social and economic benefits in proportion to the responsibilities they undertake. Furthermore, the continuous trend of decrease in rural population due to economic pressures results in increasing impoverishment of rural society. Most affected are women and children. Overcoming these problems is possible by sustainable planning and management of rural areas according to their resource potential.

SUSTAVINO will give solutions to a sector suffering from the competition of the New World wines. It will help to retain rural populations and promote a significant business in traditional regions of Europe, seeking the integration of women in the process of rural development, agriculture and tourism in the area. Wine tourism encompasses the tasting, consumption, or purchase of wines at or near the source. Wine tourism can consist of visit to wineries, vineyards, and restaurants known to offer unique vintages, as well as organised wine tours, wine-festivals, etc. It is an alternative that combines the winemaking process with service and thus, an important instrument in terms of retaining rural populations, creating jobs and social interaction opportunities for rural women. In addition, the industry active in the valorisation sector will be promoted and supported.

Considering all the socio-economic and wider impacts explained above, the results gathered within the scope of SUSTAVINO are expected to lead to the following internal and external benefits as foreseen in the DoW:

Internal benefits:

☐ Organisational benefits, basically derived from improvements in the quality of management, improved environmental performance, and compliance with existing environmental regulations.

☐ Financial benefits, such as cost savings from material, energy and waste reductions and efficiencies and product re-valorisation, which result in improved economic performance.

☐ Capacity building of wineries' workforce leading to increased employee motivation and improved job performance.

External benefits:

☐ Commercial benefits, such as new customers/business opportunities, preferred supplier status, clear environmental profile contributing to competitive/marketing advantage or satisfaction of existing customers.

☐ Environmental benefits, basically derived from improved environmental performance, increased energy/ material / water efficiencies, recycling and reduced pollution.

Thanks to the dissemination activities carried out during the whole project, SUSTAVINO will positively affect the general environment-related awareness of the consumer and thus of the society and will furthermore improve the skills of the employees from the wineries who have

participated in the face to face and e-learning courses. Moreover, in a wider sense, a comprehensive, European-wide emission reduction and thus an enhancement of the environmental quality is directly linked to a better quality of life for the citizens in viticulture regions.

Main dissemination activities and exploitation of results

In order to reach the target groups and achieve the objectives for dissemination and exploitation, general dissemination instruments have been designed and implemented. A project website has been designed (www.sustavino.eu), providing large information about the project, and was updated continuously with actual events, press releases about the project, etc.. Besides the public part of the website there is a private password protected area that can be used by the project participants to discuss or share information. Since then, several changes have been made in the format and text of the website following the guidelines given by the EC (EU Project Websites – Best Practice Guidelines, March 2010) in May 2010. The actual main page of the website is shown in Fig. 7.

TTZ has designed and sent to the rest of the partners a standardised electronic presentation of the project in power point to be used in different dissemination events. This The first and last slides of this presentation are shown in Fig. 8.

TTZ has furthermore designed the master file of SUSTAVINO flyer (Fig. 9) following the design of the website and the presentation. All translations into the official languages of the SME-AGs participating in the project have been done.

Paying special attention to the consumers in order to increase their awareness of ecological wine, all the partners are responsible for spreading the project itself and its results, by distributing press releases among consumer groups so as to keep them informed of every stage of the project, presenting it in different events, meetings, forums, encouraging the publication of articles on SUSTAVINO in magazines, websites, bulletins… and trying to make the best combination of channels to deliver the information generated to the different recipients.

TTZ has designed the master file of SUSTAVINO poster (Fig. 10) following the design of the website and the presentation. ‘All translations into the official languages of the SME-AGs participating in the project have been done.

All these results have been transferred to the SMEs and SME-AGs participating in the project via several face-to-face training courses in different countries, provided by the RTDs. The ultimate goal of the training courses was to serve as a vehicle for the assimilation of the EQSW guidelines by the SME-AGs and SMEs, so they can fully exploit and use them. They were designed in such a way that the SME-AGs and SMEs acquire all background information and specific technical knowledge gathered along the project RTD activities and they can act later on as multipliers.

The SUSTAVINO project results will be further disseminated by e-learning modules which have been developed based on the information, feedback and conclusions from the face-to-face trainings and integrated on the SUSTAVINO website.

Beyond the completion of SUSTAVINO it is foreseen to actively keep the contacts established in the project between the partners and the networking contacts with third parties, which will provide new opportunities to continue with new projects and further collaboration in different investigations. The European network of contacts for companies active in the valorisation business will be up-dated continuously, even after the project completion.

List of Websites:

www.sustavino.eu