Feed-back from growers and experts about Euphoros tools.

A combined report from experts meetings in three testing sites: Almería (Spain), Morahalom (Hungary) and Bleiswijk (The Netherlands).

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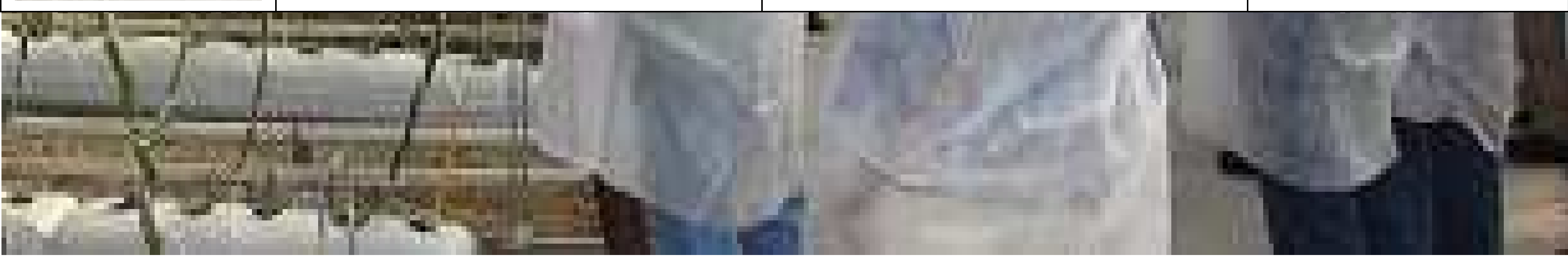

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Deliverable 4 (WP 6)

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Abstract

The overall objective of the four-years project EUPHOROS is the development of a sustainable greenhouse system that minimizes the use of inputs and emissions to the environment, yet with high productivity and resource use efficiency. Working Package 6 of this project deals with implementation of the in the other WP's developed tools in combinations relevant to three local markets. To ensure that the combinations of elements to be tested in the greenhouse conditions at each site are tuned with the expectations of the local growers, at each site a feed-back session has been conducted with a group of relevant stakeholders, potential users of the results from the WP's in practice. Each site has conducted this feed-back session in a way that fits the knowledge exchange structures of the area and the crop where the implementation trials are going to be performed..
The broadest meeting has been held in Almería, where the meeting was combined with a big seminar.
In all three meetings held in the three locations the following goals have been achieved:

- Growers are aware of the existence of the project
- Growers are involved in the choice of the tools developed within Euphoros
- Growers have given preliminary feed-back to the developers

Not all developments are equally appealing, either because they do not see application in their greenhouses, or because they can not get a good impression on how this developments work or how they can contribute to a beter greenhouse management and input reduction.
The preliminary discussions between the test locations together with the meetings have contributed to a plan of tool combinations to implement in trials.

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1 Introduction

The overall objective of the four-years project EUPHOROS is the development of a sustainable greenhouse system that minimizes the use of inputs and emissions to the environment, yet with high productivity and resource use efficiency. Three commodity-based work packages (WP) are developing a diversity of innovative tools and systems to reduce energy, water, fertilisers, pesticide consumption, and waste. Another WP optimizes the growing environment, developing innovative but robust monitoring tools for performance assessment, early detection and response management. The balance between environment and economy is addressed in a dedicated WP. Another Working Package, WP 6, deals with implementation of the developed tools.

The objective of this work package is to integrate the tools developed in the other WP's in combinations relevant to three local markets and to test the feasibility of each combination. This is achieved through two lines of actions: i) involvement of the end users (leading growers and/or growers' organization, extension services) during the development phase; ii) test and evaluation of the most promising combinations of elements at prominent applied research stations in Spain, The Netherlands and in a commercial growers' organisation in Hungary. In the first meeting of the project partners it was decided that the two working crops for most of the developments would be tomato and cut roses, and already a preliminary choice for location / crop combinations was made: tomato will be the working crop for the test and evaluation in Spain and Hungary; roses will be the working crop for the testing phase in The Netherlands.

The present report covers task 6.1 of this working package. The purpose of this task is to ensure that the combinations of elements to be tested in the greenhouse conditions at each site are tuned with the expectations of the local growers. To this purpose, at each site a feed-back session has been conducted with a group of relevant stakeholders, potential users of the results from the WP's in practice. Each site has conducted this feed-back session in a way that fits the knowledge exchange structures of the area and the crop where the implementation trials are going to be performed. The results of the meetings so far have lead to an outline of the tool combinations that are going to be tested in the three sites.

Per test site, the method used for the meeting, the number and affiliation of attendants, and the results of the discussion are summarized. Some general conclusions and the final testing plan for all three locations close this report.

2 Almería, Spain

2.1 EEFC and the Spanish horticulture

The main goal of the Euphoros project is to ensure that all the developments achieved at the end of the project are adopted by the final stakeholders, in this case, greenhouse growers across Europe, making them more efficient in the use of inputs in their business and therefore, more competitive and environmentally friendly.

However, it is clear that the greenhouse industry differs greatly from northern countries to the Mediterranean basin. Therefore, it is very important, that, at an early stage of development of the project, the potential stakeholders of each area are informed about the project, the research and development work in curse and expected technological developments. Their opinion is important in order to decide whether the work being done and scheduled is in tune with their expectations and also to decide which developments are interesting to be implemented in each one of the three testing sites.

The EEFC has a large experience of dissemination of greenhouse research carried, not only in the own Experimental Station, but also by other researchers in national and international public or private research centres. The EEFC organizes monthly seminars with great success of attendance and their doors are continuously open to any potentially interested agents of the greenhouse industry of Spain and the rest of the world, being a proof of this the number of annual visits which last year was above 3.000 visitors. However, a few words must be said about the peculiarities of the dissemination of greenhouse research results in the context of Almería, which differ greatly from that of colder climates like The Netherlands. In countries like The Netherlands, growers show a more direct implication in the first hand knowledge of what researchers are doing to improve their business, maybe due to higher education levels, maybe to tradition. The greenhouse industry in Almería is still nowadays a family business, with an average greenhouse surface per grower of less than 3 ha, and all the growers without exception are advised on a weekly basis by a technical adviser, normally hired by the cooperative and paid by the growers themselves. Their advice to the growers extends from nutrition, water use and plant protection to other technological decisions such as greenhouse cooling and heating technologies acquisition and management, greenhouse structures, etc. For the EEFC, for other research centres and even for companies like the Seed Companies or Plastic developers, these technical advisers are often a very good link to transmit the different advances to the growers since they share a common language with researchers on one side, and with growers in the other. Most of the growers are usually reticent to attend seminars unless they are related to the presentation of new cultivars or plant protection products.

2.2 Informative Seminar

We decided therefore, that it was good idea to invite both growers and technical advisers to a seminar in which the Euphoros project and its activities would be presented in order to ensure, at least, the presence of the technical advisers, which in any case always attend our seminars in the EEFC on a normal basis. The meeting was organized the past 12th of May, with good attendance of around 80 people, mostly as we expected, technical advisers from the two most important growing areas of the province. The meeting was attended also by different journalists and articles about the seminars are being written right now in specialized national magazines (i.e. Plantflor, next issue). The program of the seminar can be found on appendix 1.

The seminar counted with the presence of two other participants of the project: Dr. Cecilia Stanghellini (Wageningen University, coordinator of the project) and Dr. Alberto Pardossi (University of Pisa, responsibles of WP3). A summary of the lectures follows.

2.2.1 Opening

During the last twenty years, growers in Almería have seen their net incomes compromised due to the progressive increase in the costs of the different inputs used in their greenhouses. The development of new tools which help in improving the efficiency in the use of these inputs, without affecting the quantity and quality of their yields, must improve the profitability of the growers.

2.2.2 Euphoros project

The coordinator of the project, Dr Cecilia Stanghellini, from the Protected Horticulture Unit of the Wageningen University (The Netherlands), exposed the generalities of the project and the repercussion on the achievement of the proposed objectives. She explained these objectives which range from the decrease in the use of inputs so important as energy, water and fertilizers, substrate recycling, decrease in the use of phytochemicals, etc.

During her intervention, she highlighted that the Project will end up with competitive proposals for the market, reason why companies as Hortimax, Ciba, Groglass, Perlite, Terra Humana and Morakert participate in the project, ensuring their presence to keep an eye on the final economic benefit and that the most promising developments will be commercially available at the end of the project.

A brief summary of the different work packages was introduced to the attendants, especially of WP1, WP4 and WP5, leaving a broader presentation of WP2 and WP3 for the other two speakers.

2.2.3 Soiless cultivation management

Dr Alberto Pardossi, from the University of Pisa (Italy), explained the relation between water management and nutrition in soiless cultivation. His presentation dealt with the limitations of closed soiless systems. "When the water quality is not good, part of the nutrient solution must be flushed away every several days, becoming the system semi-closed. Besides, this flush usually has high concentrations of nitrates, so, depending on the legislation of each country, this could be limiting for the application of such systems".

Dr. Pardossi proposed different strategies to avoid flushing the nutrient solution so often which are based on monitoring the recirculation solution, not only based on the sodium or chloride content, but also on nitrate content. These experiments are conducted with the aim of achieving one of the main objectives of the Euphoros project, which is to decrease as much as possible water and nutrient use in soiless growing systems. Besides, Dr. Pardossi presented the advances in the development of methods economically and technically feasible to recycle perlite and rock-wool.

2.2.4 Energy

Dr. Esteban Baeza, resercher of the Experimental Station responsable for the Euphoros project, explained the Energy work package, for which the Experimental Station is responsible. The main objectives can be summarized as: development of optimal greenhouse covering materials (optically and thermally), obtaining maximum benefit from thermal storage, developing criteria for sufficient natural ventilation and CO_2 fertilization, use of renewable energy sources, minimization of the use of fossil fuels achieving high yields in different climate areas.

The first factor affecting the amount of solar energy which enters the greenhouse is the greenhouse cover, and depending on its optical and thermal properties we will have different amount and quality of radiation, so new coverings are to be developed that optimize the capture of energy for different areas. The company Groglass, mainly for cold areas is developing glass coatings which decrease reflection and also add NIR filtering properties to the glass. In the case of Mediterranean greenhouses, the most common material used as greenhouse cover is polyethylene. The company Ciba will develop a new PE film prototype that will be tested in the EEFC.

This new film will have maximum transmissivity to PAR radiation and photoselectivity to NIR radiation (reflection), decreasing the amount of sensible and latent heat accumulated inside the greenhouse, decreasing the ventilation requirements and therefore, increasing the chances for CO_2 enrichment.

Nowadays there is no such material in the market with total selectivity to NIR radiation without an effect also in the PAR radiation transmission. That is the main goal in this task.

Other properties which will also be interesting to incorporate to this new cover are self cleaning (anti-dust) and anti-fog, with good durability.

2.2.4.1 Thermal storage: triple advantage

A second part of the project will focus in the practical possibilities of thermal storage, extracting, exchanging and storing the excess energy accumulated inside the greenhouse during the daytime to use it later as a source of heating or just to be released/cooled at night to the atmosphere in times when night temperatures are not low (heating is not required). This thermal storage could be a short term storage (day/night) or seasonal (storing during the summer to use it during autumn/winter/spring).

If thermal storage is associated with total or partial closure of the greenhouse, its efficiency is improved, increasing the time and the concentration of CO_2 enrichment, which should increase the yield and the tightness of the greenhouse should help to protect the crop against the entrance of pests and diseases. The use of fine wire heat exchangers allows also for the collection of the water condensated as the air is cooled, increasing water use efficiency, a must in areas like Almería, where water is a scarce resource.

2.3 Feed-back questionnaire

After the seminar, a questionnaire was given to the attendants in order to know first hand their opinion about the developments of the Euphoros project and have a clearer idea of which technological set is more interesting for Almería during the testing stage of the project. The questionnaire is included as appendix 2.
The attendants were asked to punctuate from 1 to 5, being 1 minimum punctuation and 5 maximum punctuation, the level of interest they had for each of the developments, and their comments and suggestions.
The returned questionnaires were processed afterwards; the average punctuation to each development and the comments are summarized and explained below per development.

2.3.1 PE plastic film cover with optimized optical-thermal properties

The average punctuation given by the attendants to question 1.2 was 3.7, meaning that there is a certain interest in having a commercial plastic film with NIR reflection. However, the main concern, according to the suggestions and comments of the attendants, were that such materials should not be very expensive, when compared with the usual technique used in the Mediterranean area to shade and be able to transplant during the summer, that is, the whitening. Also some people claimed that such materials should be better used as a movable screen instead of as a fixed covering material, since we do not know yet whether they would have a negative effect during the winter, when NIR radiation is necessary inside the greenhouse to increase temperature.

On the other hand, question 1.3 received a punctuation of 4.1, so the attendants showed more interest in incorporating self-cleaning and anti-fog properties to the plastic films used as greenhouse covers. Attendants suggested that such properties should not affect the useful life of the material (three campaigns is the usual life of the PE plastic films used in the area). Almería, as many other Mediterranean growing areas, is very dry and the average rainfall is low, so dust easily accumulates in the plastic drastically reducing light transmission, reducing the yield potential especially in winter. People also suggested that both properties should have the same duration as the plastic, because nowadays you can find anti-fog plastic films in the market, based on the chemical additives, which provide a good effect on the first months but later the anti-fog effects disappear due to the migration of the chemicals which provide the effect. The lotus-effect observed in nature and based on micro-structures in the surface of the plastic should be the way to follow.

2.3.2 Thermal storage techniques

The average punctuation for questions 2.1 and 2.2 and 2.3 were 3.1, 4.1 and 4.1 respectively According to the attendants suggestions, people in Almería think our greenhouse structures are not prepared to do thermal storage closing the greenhouse since the majority of the greenhouses (99.9 %) are of the parral type, a very low cost greenhouse structure, with very little tightness. However, people saw as very attractive the idea of closing the greenhouse during the winter to store the excess sensible and latent heat accumulated during the daytime even in these colder months in our latitude and use it at night at least to maintain temperature slightly above the minimum biological temperatures that are usually achieved at night in the Mediterranean. The use of energy saving techniques such as double plastic or energy saving screens would allow for even better performance of such systems. In Almería, cucumber growers use commonly a plastic screen to increase temperature and humidity levels in the crop area. An extra heating at night would be very welcome by these growers. Attendants were sceptic about the decrease in the entrance of pests and diseases in the greenhouse by closing the greenhouse vents, since the lack of tightness of the greenhouses of Almería is responsible for most of the entrance of insects, etc. That is why people punctuated an average 3.2 for question 2.4. Question 2.5 was punctuated with an average 3.3. Almería greenhouses suffer many problems from excess humidity during the winter, and since the collection of this condensation is not possible (lack of enough slope, present of a wire grid in contact with the inner layer of the plastic film, etc.), natural ventilation is the only tool to eliminate the condensation for the growers, and since ventilation area is usually very low, the greenhouse vent remain open most of the day, so improving the greenhouse structures is a must before thinking on managing natural ventilation to enhance CO_2 enrichment at certain periods.
Question 2.6 was punctuated with an average of 4.0. People believe that the large amount of sunlight hours in Almería as well as good wind conditions, make very attractive the idea of making use of these renewable sources of energy to cover some of the energy consumptions of the greenhouses. However, in the case of photovoltaic electricity, an intelligent use should be made by placing the photovoltaic modules in unused areas such as covering water reservoirs (there are already flexible photovoltaic modules in the market). In the future, if economic semitransparent photovoltaic materials are developed and commercialized, part of the greenhouse cover could be implemented with such materials. However, average punctuation for this question (2.7) was 3.7, as people believe the investment in renewable energy equipment is expensive and quite dependent on government economic support for their acquisition.
Finally, the attendants evaluated as very interesting (4.5 points for question 2.8) the possibility of re-using the residual biomass of the plants as a fuel source for heating the greenhouse in winter. A group of growers could

invest in not expensive machinery to pre-treat the residual waste at the end of each growing cycle and produce pellets that could be burned to heat the greenhouses and to produce CO_2 to be used during the day after its sequestration. Different studies show that the average residual biomass produced in one ha of greenhouse in Almería during a whole growing season could cover 40 to 50% of the heating demand if a set temperature at night of 10 ºC is to be maintained. This idea seems more attractive to growers than composting the biomass.

2.3.3 Recirculation of water and nutrients

People gave an average punctuation of 4.0 to question 3.1. In Almería, around 20% of the growing greenhouse area is managed under soilless systems (around 5400 ha). The majority use open systems and considering the scarcity of water of Almería and the rising price of nutrients, closed systems should be more widespread. However, in many areas the water has low quality (high salinity) making these systems very difficult to manage without a frequent flush of nutrient solution. Therefore, growers and technicians would find it really interesting to have a tool that would asses them on how to manage such systems depending on the quality of the water (average punctuation of 4.1 to question 3.3).

In Spain, unlike in The Netherlands, recirculation of the nutrient solution is not compulsory by law, but in near future laws could change. That is why people find these systems so interesting, but also from an environmental point of view (people punctuated question 3.2 with 4.0 average), since it seems clear that the aquifers of Almería, from which the majority of the water used in the greenhouses for irrigation comes from, are being polluted with the lixiviates coming from the greenhouses. Closing the soilless systems would help to alleviate this problem, together with a more rational fertigation in the rest of soil growing systems greenhouses.

Growers and technicians are also aware of the importance of the environmental problem created by perlite and rockwool when they finish their commercial life, especially considering that at the moment there is no technically and economically feasible solution for their recycling. That is the reason why attendants gave a high average punctuation to questions 3.4 and 3.5 (4.3 and 4.2 respectively).

2.3.4 Minimizing the use of chemicals

For growers in most areas, and Almería is one of them, pests and diseases are always a “number one” problem. Therefore, whatever technology is developed to overcome the yield and quality losses caused by them, is usually adopted by growers at a much higher celerity than any other technological development (proved that it works, of course). An example in Almería, has been the quick change experienced in the past two years in which most of the pepper growers have switched from exclusive chemical control of pests and diseases to integrated pest management. That is the reason why growers and technicians attending the meeting punctuated so high (great interest) questions 4.1 and 4.2 (4.3 and 4.5 respectively). Regarding question 4.1, it is always attractive for the growers that plastic materials incorporate some kind of additive that decreases the activity of pests and diseases since it provides a means of controlling that is more or less constant in time, does not involve more labour use, it is not toxic, etc. However, the main concern exposed by attendants was that such photoselective materials should not affect the activity of pollinators and that the property should be stable during the whole life of the film and that the price should not be very high in relation to a standard material. In relation to question 4.2, the reason for such interest is that there is very little information on how the environmental conditions inside the greenhouses may affect the activity of biological control agents, therefore, the existence of models that may predict their activity, reproduction, etc. in relation to the climate conditions inside the greenhouse would be very welcome by growers and technicians.

2.3.5 Monitoring and greenhouse management support tools

The attendants gave, in general, lower punctuations (lower interest) to this group. Question 5.1 was punctuated 3.6, meaning, according to the comments, that growers think that having the possibility of knowing parameters such as ventilation rate, photosynthesis is obviously interesting, but it is probably one step ahead for the growers in Almería and probably, in most of the Mediterranean growing areas. We must keep in mind, that more than 99% of the greenhouse in Almería, for instance, does not have any kind of climate controller, not even motors to open and close the greenhouse vents, which are managed manually. Only nurseries and some more top growers have such systems, which are so common in cold climate greenhouses. The same applies for questions 5.2, punctuated 3.5 by the attendants. It is a fact that in large greenhouses, the climate is far from being homogeneous, and therefore, the development of cheap and reliable mini wireless sensors would be a great development to know better the heterogeneity of the climate and a first step for distributed control, allowing also for more homogenous growth and development of the crop. Question 5.3 was punctuated 3.5, because growers are more familiar with alert systems that detect, for instance, failures in the fertigation systems, which is the most generalized sophisticated device installed in the greenhouses of Almería. Questions 5.4 and 5.5 were punctuated with higher score (4.1 and 4.0 respectively), because growers and technicians are quite aware that when stress is visually detected (as it is normally done nowadays), the stress has already caused its damage, and because growers love the possibility of having a system to forecast anything from yield to quality, etc. However, they must know, that once again, in order to be able to forecast with models, models need input, and this input information needs sensors which normally do no exist in our greenhouses, just as it is mentioned in question 5.6, and since such sensors are usually identified as expensive and since in our greenhouses, growers assume that the plants are under stress very often due to poor climate control, that is why attendants punctuated only 3.4 to this question. In few words, firs step is to improve the greenhouses structures and implement climate control systems, and then, think about further developments. This applies also to questions 5.7, 5.8 and 5.9 (punctuated 3.9, 3.6 and 3.4). Growers see these early detection systems as a very interesting development, but still trust more visual monitoring of pest and diseases as the main tool to know when to use chemicals and/or to release natural enemies. Many pests appear in very specific spots (such as aphids) inside the greenhouse, and according to growers, such sensors should cover the whole greenhouse surface, something difficult for economic reasons.

3 Bleiswijk, The Netherlands

3.1 Knowlegde exchange in Dutch Horticulture

Nearly every Dutch grower is a member of the Dutch organization LTO Groeiservice. The member growers, organized by crop groups, are represented by a few volunteers that gather together a few times a year to discuss about many different subjects relevant for their horticultural practice, like research, promotion, environmental issues, legal regulations and lobbying. This groups of growers are known as the "Landelijke Gewas Commissies", in English something like the "Dutch Crop Comitees". There is a Dutch Crop Comitee for many economically and in numbers of members important crop. Obviously, Rose is one of such crops.
The members of the Rose Dutch Crop Comitee usually have an important influence in the decisions which research projects should be funded by the Dutch Horticultural Product Board, and also during the duration of the research project these members follow intensively the course of the experiments providing the researchers with advices and their own expertise.
But the rose growers group is quite a big one with a relatively big budget for research. Therefore, too many projects are being carried out to be followed by this small group of volunteers. That is why the Dutch Crop Comitee has delegated this tasks to several smaller groups of growers with a specific interest, called "BCO" (Begeleidings Commissie Onderzoek, Research Guiding Commitees).

3.1.1 Relevant Research Guiding Commitees for Euphoros

At the moment, there are three of these rose growers groups susceptible to form an accessible board for discussing the chances of the tools developed in the different WP. One committee is advising a project in which several methods for purification of drainage water in order to maximize recirculation are being tested, and as such linked to the Euphoros objectives in WP3. The group consists of growers, researchers, commercial laboratories, rose growing consultants and members of the Dutch water boards.
A second group is advising since a few years the crop health projects aiming a broader use of integrated pest management, and therefore linked to WP4 and parts of WP5. Group integrants are researchers, growers, rose cultivation consultants and representatives of both the chemical pesticide industry and the suppliers of beneficials.
The third group has advised a project on the use of NIR screens and sensors to reduce heat development in the greenhouse, linked among others to WP2 and WP5. Although this group is not active anymore at this moment, they are likely to be gathered again for a new project planned to start in short to test different greenhouse cooling methods. It was decided to gather the groups only after having decided in a previous discussion exercise with specialist researchers, which tools make a chance to be implemented successfully in rose cultivation in the Dutch situation.

3.2 Preliminary tool selection by specialist researchers

In this exercise, a group of colleagues discussed the tools being developed in the different working packages in order to present to the busy (and economically very concerned) rose growers, only those tools that make a chance to be implemented successfully, and that are applicable to the rose crop in Dutch conditions. For the decision, the crop requirements, the environmental impact and economic aspects (evaluation made in WP1), of the reduction of inputs were taken in consideration.

Roses in The Netherlands are grown under glas, therefore, plastic cover coatings are not applicable.
AR glass is an applicable tool, that allows 8% more light to get into the greenhouse. If this, together with some other climate measures, can achive that lamps can be switched off during 10% of the actual time (from 5700 h to 5130 h.) then 4,13 €/m^2 are to be saved, which delivers 23,6 € investment capacity.

It was discussed that the methods for monitoring drainage water being developed within WP3 by UNIPI, are not applicable to The Netherlands for two reasons:

1- Recirculation of nutritive solutions in The Netherlands is already a common practice, though not reaching 100% of the total used water. Estimations indicate that about 30% of the total used water with fertilizers is wasted. Provided the monitoring tools ensured a 100% closure of the system, they would provide a saving of only 0,3 €/m^2 year.

2- Full recirculation of solutions is not possible due to reasons different than the ones the monitoring tools in Pisa are being developed for: water quality in The Netherlands is good; accumulation of Sodium and Boron are not likely to happen quickly.

Thermal storage methods are neither applicable to the rose crop cultivation as it is cultivated now. Roses are heated for a great deal by the photosyntethic lights. Extra heat is supplied by heating pipes below the crop, filled with residual heat from the electricity generation from natural gas. In roses, there is normally no heat shortage but a heat excess. When possible, rose growers cluster with growers of other crops to which they transfer the excess heat.

Monitoring tools like the PRI (Plant Reflective Index) have proved in preliminary trials with a rose crop not suitable. Others, like the ventilation monitor, can help reduce the heat loss by ventilation and save energy, but as said, roses do not have a warmth shortage, and therefore, the ventilation monitor is not an instrument that would help save energy. The transpiration model, on the contrary, has proved to work satisfactorily in trials, and it can help to beter adjust irrigation to the crop needs.

Spider mites as pest are quite well controlled at the moment in The Netherlands. Therefore, the modeling activities within WP4 would not be relevant for the current problems with rose, or not contribute to a substantial reduction of the pesticides used as compared to the reference situation, since most of them control this pest in an integrated way (combination of beneficial predators of the pest and chemical corrective pesticides to fight hot spots).

A tool that due to early detection of pest contributes to achieve a 10% reduction of pesticide use in the Dutch situation will deliver an investment capacity of 1,5 €/m^2 . If the tool contributes to save precious scouting time, a reduction of 0,25 hour labour per m^2 per year would increase the investment capacity to approximately 5 €/m^2. Based on this economic potential and on the information supplied at the annual Euphoros partners meeting in March 2009, it was decided to present the “electronic nose” to the “integrated comitee”. At that time, the developers could announce having reached a high level of accuracy in the detection, being able to measure “infection” before it was clearly visible on the plants.

3.3 Stakeholders meetings

It was decided to present the AR Glas and the transpiration model to the NIR-screen and sensors group. However, this group has not held recent meetings, so to the moment of writing this report, this tool has not been presented yet.
The previous plan of presenting Euphoros to the “water management” guidance committee was cancelled due to the lack of interest of this tool for growers in the Dutch situation.

To our opinion, the “integrated guidance committee” is the most relevant Dutch stakeholders board to discuss the possibilities of the tools from Euphoros WP4, aiming to reduce the input of “Plant Protective Chemicals”, more precisely, the electronic nose. This meeting was held in April 2009, and in the subchapters below, more information is given about the board and the meeting itself.

3.3.1 The choice of the Board

The “BCO Rose Geïntegreerd” is one of these specialized growers study subgroup selected because of their specific interest in Integrated Pest Management and that gathered together for the first time in 2002, with the occasion of the start of a new research project (the search of new beneficials against the main rose pests). The composition of the group has varied since then, but it is composed of growers, researchers and representatives of the pest control industry (see the list of names and companies represented below).

3.3.2 Composition of the Board

Present members:
Tom van der Gouw (Advisor crop health at Syngenta)
Tom Konijn (Advisor Horticoop)
Ronald Scholte (grower in Kwintsheul)
Chris Bot (manager at Van der Arend and former rose grower)
Marco van der Lans (Bayer)
Muriel Klein Beekman. (Koppert)
Jan Hulst (Horticoop, making the move to Bayer)

Dirk van Rijn (rose grower in Kudelstaart)
Kees Kouwenhoven (Brinkman)
Wesley (Nic Sosef)
Juliette Pijnakker (Researcher integrated pest management rose and other ornamental crops)
Mattijs Beelen (crop manager LTO Groeiservice)
Nieves Garcia (Researcher rose and other ornamental crops)

Absent members:
Martin Zuiderwijk (Syngenta),
Frans van Heiningen (rose grower in Roelofarendsveen)
Pierre Ramakers (senior crop health researcher)

3.3.3 Purpose of the meeting

To increase the chance of presence by all members, coming from different points of the country and with busy schedules, it was decided not to invite growers only for the presentation of the WP 4 tools, but to combine the presentation of the tools with their most inminent regular meeting, in which several other research projects as well as the new developments and the actual situation in the farms were discussed.
For the input reducing tools being developed within the Euphoros project, the meeting is meant to start informing the end users at an early stage and increase in this way the chance of acceptance of the tools as well as giving feed-back.

3.3.4 The board's opinion about the presented tool

Growers and advisors as well as the representatives of the industry do welcome this development as they believe in automatized pest detection techniques in a nearby future. They will also welcome a chance to be involved as an advisory board during the development phase of tools that can help improve their scouting practice.
The board have also many questions and also place a set of conditions such a device should meet in order to be useful in their growing system.

1- What would be the minimal distance to the plants to allow smell measurement?
2- How pest-specific could it become? Ideally, it not only says that there is an infection, but it also says which kind of pest or disease is causing the infection.
3- Detection limit should be low enough. According to them, a trained scouter is able to smell severe infections of the most common pests and diseases; an electronic nose should be able to smell spots with a much lower infection level than those registered by a human nose.
4- The nose should not be hindered for the detection of spots by the presence of beneficials used to control the pests.
5- The same applies to evaporated sulphure, often used to control mildew and with a very strong smell.
6- The sensor should be able to precisely indicate the position of the spot where the smell is originating (indicating there is an infection but not telling where is useless).
7- The sensor should be "movable"; ideally, connectable to a harvest trolley, or hanging on one's back and giving a 'beep' noise when infection is measured, as some metal-detector idea.
8- A grower suggested that it would be useful to combine the electronic nose with other stress detection systems like the MIPS
9- More information, supplied by the developing engineers, would be appreciated

All this opinions were collected, and an attempt was made to summarize the most important features for such a device from the point of view of the users; these are:
Accuracy (low detection limit), pest and spot specificity, selectivity and transportability.

These questions and requirements have been discussed with the developers. In the next meeting by the stakeholders, the answers will be communicated.

3.3.5 The Board's attitude towards tests with this development

The growers will welcome trials to test the prototypes, either in trials at the research centre of Wageningen UR or at their own greenhouses, where they would be prepared to receive the equipment and the researchers.

4 Morahalom, Hungary

4.1 Morakert and the Hungarian horticulture

Morakert is itself a "stakeholders board": a cooperative of more than 750 growers, with an active "inner group". In winter every week the experts of the cooperative organize advising programs for growers where consultants, input material producer representatives, plant researchers, laboratory experts are usually invited to present new technologies, cultivation methods and giving watering, plant protection, technological advises. After the programs free conversations and discussions are allowed to answer the questions of the growers and listen to their opinion about the subjects. One of these weekly meetings has been used to inform the stakeholders about the developments in Euphoros.
Presently, in Hungary it is hard time for growers, and for cooperatives as well. The financial crisis impresses the turnover very much, the inputs have to be payed for with delays. Many growers are having serious financial difficulties, which has an impact on their williness to attend meetings and be positive to new developments that involve some investments.

For these reasons, we chose not to present all the tools that are being developed within the EUPHOROS project to our stakeholders. Instead, we decided to present only those tools already selected in the Warwick meeting of EUPHOROS partners in September 2009 for implementing in the test site in Hungary.

4.2 Stakeholders meeting

The meeting held on the 24th of November 2009 at Morakert is summarized below. The attendants were a small group of local growers (three growers, who are members of the cooperative and have greenhouse technology) and consultants (Zoltán Görög, Mórakert Cooperative's consultant, Viktor Dencs, greenhouse leader and consultant).

4.2.1 Presented tools

In Euphoros project three kinds of tools have been preselected to implement in Hungary. The tools have been considered by the project members to be environmentally and economically relevant and feasible for the Hungarian situation. These new technologies and methods are:

1. Drain water recirculation system
2. Soft sensor for ventilation and or transpiration
3. Early warning model for powdery mildew

These tools were presented to the mentioned board, and an abstract of the board's opinions is per presented tool summarized below.

4.2.2 Grower's opinions per tool

4.2.2.1 Drain water recirculation system

According to hungarian growers and experts, drain water recirculation is an excellent, acknowledged technology in Hungary as well. Unfortunately it was not the part of the previous, older investments, and new projects do not start recently (because of lack of financial sources), therefore it is not so prevailing in Hungary. Till 2008 the world market price of fertilizers did not give reasons for a more considerable investment with a direction like this.
The interest revived as soon as the economic situation required the more economical use of input materials, but as it is very difficult and costly to fit this to the existent technology, no implementations had started yet. Furthermore, hungarian laws of environment do not deal with drain treatment and drain recirculation issues.

At new greenhouse investments canalicular systems are applied, which reduces the physical and chemistry pollution of the collected drain water significantly. Canalicular system is the drainage collection system (little canals) between rows, usually in Hungary drain water flows on the plastic surface (layer), that is why the collected drain is more polluted with plant materials, sand, soil, chemicals etc. The collection, mixing into the fresh nutriment solution is more difficult with obsolete drain collection system and fertilization unit. An additional problem is the fast and accurate checking of the nutrient content. At more developed greenhouses they usually have pH and EC meter. The development of cheap measurement methods by the Euphoros partner UNIPI will help, but boron is not a great problem, neither is sodium. Growers are open to get to know simple and cheap analytical techniques, but they feel they will have to analyse more elements than only Boron and Sodium if they would have a drain recirculation system.

A new fertilization and UV disinfecting unit just in itself is around 40.000 € (Priva) and it can supply appr. 2 hectares, if the surface is under this that means higher costs/m^2 . Hungarian growers and experts have calculated that the minimum economical surface of installing this system at new investments is 1 hectare, but they also think that these systems are able to supply a 2-3 hectare greenhouse fertirrigation as well (which is much more cost-efficient), but this size of greenhouses is extraordinary in Hungary, where the average surface must be under 1 hectare, furthermore single layer or dual layer greenhouses with simple irrigation, without heating etc. are much more ordinary than glasshouses with high technology.

The foresaid viewpoints limit this acknowledged, very important technology in the aspect of economy and environment protection, which are also accepted by growers and consultants. Growers have seen these systems from exhibitions in foreign countries; they would be open to use these, but they can not afford them. If Euphoros implementation trials show solutions that can be feasible with lower costs, that could be helpful for them.

4.2.2.2 Soft sensors

Climate computers, like Priva Integro computer in the hungarian trial greenhouse, have very serious and developed softwares, which include more sensors and monitor applications too. There is an opportunity to install some sensors which could interrupt several applications, give error codes or alarm by judging determined parameters, datas.

These functions could serve not for self-defence only, but onto the demands of the given horticultural culture is mouldable. There is an opportunity of a continous and momentary data purchase, and averaging. Capable to watch the watering chemistry and quantity datas, furthermore the related datas of water flow. From the ventilators and heating system attached or calculated datas are available for the producers. The measuring instruments (or sensors) can be calibrated and their maintenance is continuous.

New developments can be achieved from greenhouse technology producers usually anually, and the new versions have more accurate monitoring system.

So the researches with a direction like this are progressive, but the system administrator spends suitable attention on this, according to growers' opinion. Some of them already have the technology or check these things themselves, but they are open to develop their greenhouse system with new sensors, if they help to improve the efficieny and prevention of the production.

Anyway additional soft sensors (ventilation and transpiration monitor) are mostly welcome by growers with modern greenhouse technology, they are open to get to know new sensors and methods of monitoring that could fit to their existent climate system.

4.2.2.3 Early warning model for powdery mildew

Powdery mildew infection is a whole year problem in hungarian greenhouses. It's first appearance can be expected in the middle of March when the load is considerable on the plants. In this period can be occured, that windows do not open because of humidity only, but the weather develops so advantageously, that the temperature will be the main factor. The changing humidity and the load together come as a predisposing factor, so the infection appears sooner or later. Preventionally sulphur powder is scattered onto the heating pipes in 10-15 kg/hectare dose. The well-timed prevention sould be exceptionally efficient if the ventilation strategy is correctly set. Tming is very very important, and a well time prevention can save a lot of chemicals and further treatment. If this is not enough, penkonazol, sulphur or azoxistrobin agent products are applied with the respect of the catering case, waiting time and other viewpoints. Defences are started promptly at the time of the cognition of the symptoms. Traditional application schemes ("calendar spraying") is not used anymore; the decision to spray is done by careful crop scouting methods (by eye, nose) to recognize the infection. Depending on the level of the infection, patch treatment or a full surface treatment is applied.

Growers and experts also think, that a plant monitoring device must be an important direction in prevention of infections, furthermore it is agreed that schemes and regulations must be worked out, which can help processing the datas collected by existent technologies easily.

5 Conclusions

The broadest meeting has been held in Almería, where the meeting was combined with a big seminar. The organization meetings in The Netherlands and in Hungary have suffered from the economic crisis, growers are less open than normal to new developments.

In all three meetings held in the three locations the following goals have been achieved:

- Growers are aware of the existence of the project
- Growers are involved in the choice of the tools developed within Euphoros
- Growers have given preliminary feed-back to the developers

Not all developments are equally appealing to the growers, either because they do not see application in their greenhouses, or because they can not get a good impression on how this developments work or how they can contribute to a beter greenhouse management and input reduction.

The preliminary discussions between the test locations together with the meetings have contributed to a plan of tool combinations to implement in trials. This plan is shown for each location in appendix 3, as it was discussed and approved by all project partners in Warwick in September 2009.

Appendix I.
Program of seminar EEFC

OTRI COEXPHAL

FAECA FEDERACIÓN ANDALUZA DE EMPRESAS COOPERATIVAS AGRARIAS

FUNDACIÓN cajamar

VIII Seminario Técnico Agronómico Campaña 2008/2009

MEJORA DE LA EFICIENCIA EN EL USO DE INPUTS EN LA HORTICULTURA

Lugar: Salón de actos de la Estación Experimental de la Fundación Cajamar
Paraje Las Palmerillas, nº 25 - 04710 Sta. Mª del Águila (El Ejido)
Fecha: Martes 12 de mayo de 2009 **Hora:** 16:30 –19:00

Programa:

16:30 -**Desarrollo de sistemas de invernadero sostenibles en Europa (Proyecto Euphoros)**
Dr. Cecilia Stanghellini
Plant Research International, Universidad de Wageningen, Holanda

16:45 -**Estrategias para el manejo de la fertilización carbónica en invernaderos Mediterráneos**
Dr. Cecilia Stanghellini
Plant Research International, Universidad de Wageningen, Holanda

17:15 -**Efecto del enriquecimiento carbónico sobre la producción y la eficiencia en el uso del agua**
Dr. Pilar Lorenzo
IFAPA La Mojonera

17:45 -**Café**

18:00 -**Gestión de sistemas de cultivo sin suelo recirculantes y nuevas técnicas para el reciclado de perlita y lana de roca**
Dr. Alberto Pardossi
Universidad de Estudios de Pisa, Departamento de "Biología de las plantas", Pisa, Italia

18:30 -**Optimización del uso de energía en invernaderos: el almacenamiento térmico**
Dr. Esteban Baeza Romero
Estación Experimental Fundación Cajamar

Appendix II.
Feed-back questionnaire EEFC

OPINION QUESTIONNAIRE FOR FINAL USERS OF THE PROJECT DEVELOPMENTS

For EUPHOROS project it is of great interest to know at an early stage of development, the opinion of the potential final users of the project's developments.
Therefore, after having listened and seen today's presentations, we kindly ask you to evaluate with an interest scale from 1 to 5 (being 1 null interest and 5 maximum interest) and also to write your suggestions and personal opinions which will be for the project of great use for the final success, which after all, aims at increasing the competitiveness of our growers in the European and world markets.

1. **Development of a PE plastic film prototype with optimized optical-thermal properties for Mediterranean greenhouses.**

1.1.-¿Which improvements in the optical and thermal properties of the greenhouse plastic films do you think that should be incorporated in the new materials?	
Please, punctuate from 1 to 5, being 1 minimum punctuation and 5 maximum punctuation, the level of interest that for you has:	
1.2.-That a new plastic film for greenhouse covering is developed that incorporates photoselectivity (reflection) to NIR radiation ("cooling" films).	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
1.3.-That the new plastic film incorporates self-cleaning and anti-fog properties.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
SUGGESTIONS AND COMMENTS:	

2. **Interest on the use of thermal storage techniques in warm climate greenhouse areas.**

Please, punctuate from 1 to 5, being 1 minimum interest and 5 maximum interest:	
2.1.-Developing technically and economically feasible techniques for thermal storage in warm climates.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
2.2.-Close the greenhouse in winter and use heat exchangers to extract and store the accumulated thermal energy as a heating source for the night.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
2.3.-Heating at night using energy saving techniques.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐

2.4.-¿What do you think of having less incidence of pests and diseases in winter due to long time closing of the greenhouse?	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
2.5.-To limit natural ventilation during certain periods to favour carbon dioxide enrichment.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
2.6.- The use of renewable energies to cover some of the energy consumptions of the greenhouse.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
2.7.-Development of photovoltaic semi-transparent materials to be used as partial greenhouse cover.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
2.8.-The use of residual biomass as a source of fuel for greenhouse heating and CO_2 enrichment.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
SUGGESTIONS AND COMMENTS:	

3. **Development of a diagnosis tool to optimize the recirculation of water and nutrients in closed soilless growing systems under sub-optimal water quality conditions.**

Please, punctuate from 1 to 5, being 1 minimum interest and 5 maximum interest:	
3.1.-Recirculation of the nutrient solution in soilless systems as a mean to save water and nutrients.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
3.2.-Recirculation of the nutrient solution in soilless growing systems as a mean to reduce pollution due to nutrient lixiviation.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
3.3.-Considering the great variability in the quality of the water of the different growing areas and assuming that in a near future the re-circulation of the nutrient solution will be compulsory by law ¿What interest do you see in the development of a computer tool which assess in the optimal management of the re-circulation process depending on the water quality of each area?.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
3.4.-Evaluate the importance of the problem of substrate waste in Almería.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
3.5.-Evaluate the importance of developing technology to recycle perlite and rockwool waste.	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
SUGGESTIONS AND COMMENTS:	

4. **Minimizing the use of chemicals (pesticides and fungicides).**

Please, punctuate from 1 to 5, being 1 minimum interest and 5 maximum interest:

4.1.-Development of additives (filters) for the greenhouse covering materials to prevent/interrupt the sporulation of phyto-pathogenic fungus and bacteria and/or alter the behaviour of insect pests, using tomato mildew and spider mite as target examples.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
4.2.-Development of models which evaluate the environmental conditions under which the biological control agents act more efficiently and how and when releases must be scheduled.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
SUGGESTIONS AND COMMENTS:	

5. Development of monitoring systems and greenhouse management support tools.

Please, punctuate from 1 to 5, being 1 minimum interest and 5 maximum interest:	
5.1.-Development of sensors which allow for the prediction and real time monitoring of parameters such as ventilation rate, total crop evapotranspiration and photosynthesis inside the greenhouse.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
5.2.-Development on mini-wireless sensors which allow for the real time monitoring of temperature and humidity in different spots of the greenhouse.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
5.3.-Development of a diagnosis module to identify fails such as infiltration through the greenhouse vents (incomplete closing), valves deterioration, etc.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
5.4.-Development of a module to identify stress phenomena at an early stage (ej. Measuring an increase in leave temperature).	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
5.5.-Development of monitoring systems based on sensors and intelligent crop models to forecast yield, quality and inputs requirement.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
5.6.-Use of plant monitoring sensors (photosynthesis, sap flow, leaf area, fresh weight gain, drainage volume, water uptake, plant stress, etc.) as a source of data for the yield and quality monitoring systems, etc.?	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
5.7.-Development of sensors for the early detection of pests and diseases infections using tomato mildew and the two spotted spider mite as examples.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐
5.8.-The implementation of sensors and analysis software for early detection of possible pest and disease infestations.	1 2 3 4 5 N/A ☐ ☐ ☐ ☐ ☐ ☐

5.9.-What feasibility do you see in establishing realistic thresholds which allow for early detection and alert of real interest for the grower?	1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ N/A ☐
SUGGESTIONS AND COMMENTS:	

Appendix III.

Trial plan all locations

Location	crop	Tool	Specification	Potential input reduction	Required for implementation / *Questions for developers*
Bleiswijk	roses	Glass cover	AR glass with NIR-coating / *Difuse glas with NIR coating ???*	If lamps can be switched off during 10% of the actual time (5700 h to 5130 h.) then 4,13 €/m^2 are to be saved => 23,6 € investment capacity	Changing glass cover in one compartment (Groglass) Grow crop for one year in 2 comps. (PPO) Monitor growth, light and climate effects (PPO / PRI)
		Electronic nose		If pesticide use can be reduced by 10% saves 30 € cent/m^2 => 1,5 € investment capacity	Nose (Warwick) Monitor in rose compartments (PPO / Warwick)
		Soft sensor	transpiration model	Not quantified. Assumption: 5% water saving by reduced mismanagement; no savings in fertilizers due to “100% closed sytems”	Sensor installation (PRI). Monitor (PPO/ PRI) Make calculations (PPO / IRTA)

Location	crop	Tool	Specification	Potential input reduction	Required for implementation / ***Questions for developers***
Morahalom	Tomato	Irrigation model	Recirculation of drainage water (*Morakert does not agree yet, serious objections need to be solved first; what can be the contribution by the partners). Aron looks also for an alternative location*	If recirculation can save somewhere between 10 and 50% on fertilizers, 0.69 to 3.45 €/m^2 can be saved => 3.4 to 17.2 €/m^2 investment capacity.	Separate one / two row from general irrigation (Morakert) Place 2 separate fertirrigation tanks / one drainage collection tank, separate pumps *(who can supply this?)* Install a small water disinfection device (*who can supply this?)* Advise on fertirrigation adjustments and water quality monitoring (UNIPI) Grow crop for one season and monitor growth (Morakert) Make calculations (PPO / IRTA)
		Pest/ disease model	Powdery mildew or spider mites/ both	If pesticide use can be reduced by 10% saves 0.12 € cent/m^2 => 0.6 € investment capacity	*Is the model applicable already in normal growing conditions (huge surface)?* (Morakert / Warwick) Good instructions about the operation of the model (Warwick) Specify conditions and needed informatic equipment (Warwick) *Can the model only test but not determine the pest control strategy* (Warwick)?(crop health is leading)
		Soft sensor	Fault diagnose	Not quantified. Assumption: 10% energy saving by reduced mismanagement, saves 0.38 € /m^2 => 2.2 € investment capacity	Sensor installation (PRI). Organize possibility of reading Morakert climate computers by PRI at a distance. Monitor growth and climate (Morakert/ PRI)

Location	crop	Tool	Specification	Potential input reduction	Required for implementation / ***Questions for developers***
Almería	tomato	Plastic coating	With NIR and antidirt *(CIBA is asked to develop one material with both)*	Not quantified. Assumption: if light can be increased and heat can be reduced, windows will keep longer closed and [CO_2] will increase => production will increase accordingly, so more production with same input.	Changing plastic cover in one compartment (Ciba) Grow crop for one season (EEFC) Monitor growth, climate and light transmission (EEFC / Ciba)
		Pest / disease model	powdery mildew	If pesticide use can be reduced by 10% saves 0.04 € cent/m^2 => 0.19 € investment capacity	Test model in experimental growing conditions (EEFC / Warwick) Good instructions about the operation of the model (Warwick) Specify conditions and needed informatics equipment (Warwick)
		Thermal day storage system	We have a water tank system that we are going to evaluate	If 50% energy can be saved, then 0.13 €/m^2 are to be saved => 0.75 € investment capacity	Crop growth for one season (EEFC) Evaluation of the system: climate, crop physiology, water and energy consumptions (EEFC)
		Sensor	Smart-dust *(very interesting to install them in our small closed compartment to obtain temperature fields generated by heat exchangers located over the crop)*	Not quantified.	Install sensors (Hortimax) Monitor crop and climate (Hortimax / EEFC)