CARBGROWTH

"Maximisation of greenhouse horticulture production with low quality irrigation waters"

Project summary

The overall objective of *CARBGROWTH* is to offer to the EU greenhouse horticulture producers a solution allowing to increase in at least 25% the greenhouse horticulture production (kg/m2) due to a cost-effective CO2 injection and irrigation water supply system. Consequently, farmers will increase the margin of benefit of their industrial activity, becoming less dependent to EU subsidies and more competitive face to non-European horticulture producers. European aquaculture producers will also have the opportunity to valorise the wastewater produced in their facilities and, consequently, to economise the treatment costs associated to this water which becomes a valuable by-product for the agriculture sector.

Agriculture in the European Union faces some serious challenges in the coming decades: competition for water resources, rising costs, competition for international markets, changes in climate and uncertainties in the effectiveness of current European policies as adaptation strategies. The EU is the main export destination with almost one-half of the world's imports. In the last years, fruit and vegetables imports have experimented a constantly growth (up to 39% for the period 2002-2008). Therefore, in order to ensure their competitiveness against producers from other Non-European countries with lower labour costs as Morocco, or Israel, European growers need to adopt new agricultural technologies to improve net production, ensure quality and reduce production costs. On the other hand, European aquaculture represents 20% of the total fish production. Major environmental impacts of aquaculture have been associated mainly with high-output of wastewater of intensive systems.

The main goal of *CARBGROWTH* is to reuse low quality water for irrigation purposes and increase in net production (kg/m2) through CO2 injection. By increasing CO2 and supplying more irrigation water, the plant could use the solar energy required to increase the final production. However, the main constrain to this strategy is the high cost associated to commercial CO2 supply, which has made this solution ineffective so far. Greenhouses crop producers request a final affordable solution, with a verifiable increase in growth production.

In order to satisfy the needs of these two different sectors, CARBGROWTH is developing a multi-strategy approach consisting on:
(1) Increase net production and tolerance to salinity through CO2 injection.
(2) Recover CO2 from exhaust gases from greenhouse heating systems by photocatalysis for its injection in the greenhouse facility.
(3) Reusing industrial wastewater for irrigation purposes and reducing the cost associated to water supply by photocatalysis.
(4) Reduce charge loses in irrigation systems.
(5) Develop process control to optimise irrigation, CO2 injection and greenhouse climate control.

Summary of the context and main objectives.

Horticulture represents 18% of the total value of agricultural production in the EU and uses only 3% of the EU's cultivated land. Fruit and vegetables (F&V) play an important role in today's society and form a major part of a healthy diet. The sector is very diverse and is perhaps the most complex and least understood part of EU agriculture.

Greenhouse horticulture faces many difficulties such as rise of material and fuel cost, increased public demand for reduction of environmental load and deterioration of profitability. The challenge is to develop innovative technologies for greenhouse environmental control and new cultivars suitable for production under a controlled greenhouse environment to establish energy-saving, low-carbon, labor-saving, and low-cost greenhouse horticultural production systems.

European efforts to increase greenhouse horticulture production have been well addressed in the last decade. Despite the technical advancements of the greenhouse horticulture, the key to increase the production stands in the study of the plant bio-chemical processes. The limiting factors of the photosynthetic process are availability of CO2 in greenhouse photosynthesis production (max. the atmospheric concentration: 380 ppm); and water.

Water supply depends on high quality water availability and irrigation systems have been greatly developed in order to optimize this supply. However, the scarce of irrigation water is a problem in some European countries, and therefore the Horticulture producers are promoting to develop solutions for reutilization of waste wasters (such as aquaculture waste-waters) and poor quality waters (high saline content).

The CO2 injection, to increase Greenhouses CO2 concentration level concentration, has been the center of the scientific community for several years. By increasing CO2 and supplying more irrigation water, the plant could use the solar energy required to increase the final production. However, the main constrain to this strategy is the high cost associated to commercial CO2 supply (46-62€/ton) 13, which has made this solution ineffective so far. Greenhouses crop producers request a final affordable solution for greenhouse fruit and vegetable producers with a verifiable increase in growth production.

Besides these urgencies, there is a lack of knowledge transfer from Academy and Research Centers to Agriculture Associations and SME producers that difficult the implementation of this type of technology in many greenhouse facilities. CARBGROWTH intends to fill this gap by targeting a solution that supplies cost-effectively CO2 and irrigation water to the greenhouse production system to increase by 25% the total greenhouse horticulture production (kg/m2).

The overall objective of the *Carbgrowth* project is to offer to the EU greenhouse horticulture producers a solution permitting to increase in at least 25% the greenhouse horticulture production (kg/m2) due to a cost-effective CO2 injection and irrigation water supply system. Consequently, farmers will increase the margin of benefit of their industrial activity, becoming less dependent to EU subsidies and more competitive face to non-European horticulture producers. European aquaculture producers will also have the opportunity to valorise the wastewater produced in their facilities and, consequently, to economise the treatment costs associated to this water which becomes a valuable by-product for the agriculture sector.

Aware of the challenges the consortium of the project proposed the improvement of the production by reusing and taking advantage of the latest technologies to take advantage of the most suitable use of the resources commonly used in greenhouses while optimizing production achievement of the following objectives:

1. Maximisation of total production up to 25%.
2. Identification of optimum C02 concentration for the optimisation of plant –growth (800-1000 ppm).
3. Increase plant tolerance to salinity up to 40%.
4. CO2 recovery from wastewater and exhaust gases to cover the greenhouse demand (≈4,5 kg/m2.d).
5. Modelling C02 behaviour inside the greenhouse facilities.
6. Water and horticulture products coupling with European legislation ratios for heavy metals, nitrates, nitrites, phosphorus, pathogens, ions and other hazardous compounds

By joining the efforts of 4 National SME Associations (AMOPA, AGRO, RATHO and CCIM), it has proposed a definitive solution for European SMEs in the Greenhouse Crop production sector. In this project we present a multi-strategy approach to meet the objectives:

By achieving the targeted objectives Carbgrowth offers to the European agriculture producers the possibility increase the total horticulture production. Consequently, farmers will increase the margin of benefit of their industrial activity, becoming less dependent to EU subsidies and more competitive face to non-European horticulture producers. European aquaculture producers will also have the opportunity to valorise the wastewater produced in their facilities and, consequently, to economise the treatment costs associated to this water which becomes a valuable by-product for the agriculture sector.

Description of the work performed and main results

The increase of CO2 concentration in **sweet pepper plants** had direct and significant effects in the response of these plants to both saline and drought stress, being the intensity of the response modulated by the type of the substrate. Regarding saline stress, when salted water (NaCl) was applied, sweet pepper plants that grew at high CO2 concentration showed similar growth (plant fresh weight) than those irrigated with no salted water at standard CO2 concentration cultivated in coconut coir, peat & perlite, and perlite. Regarding drought stress, CO2 significantly increased plant fresh weight in control (non-stress plants) and in the drought-stressed plants cultivated in coconut coir, peat & perlite, and perlite but not in rockwool. Our study indicates the feasibility of using low quality water when high CO2 concentration is applied, however higher stress conditions do not mitigate growth or photosynthesis reductions effectively. The coconut coir fiber substrate is a bio-degradable and eco-friendly product that had one of the best responses to saline or drought stress when high CO2 is applied. When exposed to increased CO2 concentration, the **tomato plants** (cv. Daniela) showed an important increase in plant fresh weight but this response was affected by the type of stress and the type of the substrate. Our study shows the benefits for tomato plants under non-stress conditions when CO2 is increased, but severe stress could reduce this potential benefits in this cultivar (Daniela), however, when using coconut coir fiber or peat & perlite substrate this response under saline stress is higher than in perlite or rockwool.

A numerical modelling procedure has been developed to **model the transport of CO2 in a greenhouse** for a given set of boundary conditions. A transport equation is solved for the concentration of CO2. The model therefore includes the effects of convection, diffusion and buoyancy. The tool will be used to give an accurate estimate of the distribution of CO2 in the greenhouse taking account of the effects of temperature, pressure and moisture content and that different diffusion and transport models have been studied and tested to reproduce the real CO2 pattern within the greenhouse.

A complete sweet pepper production cycle has been monitored and studied and the results showed that, in controlled irrigation and atmospheric conditions, the plant productivity increased by 52.7% in plants grown with 400ppm of CO2 and by 38.17% in those plants with 800ppm of CO2. In the case of plants cultured in saline irrigation the differences were more marked given that the production was increased by 61.7% in plants cultured in 400ppm of CO2 and by 59.2% in plants grown in 800ppm of CO2. Beyond the productivity, there are other important factors that influence sweet peppers growing and trade and that is the case of fruit precocity. After analysing the first three harvests in plants irrigated with control solution, markedly differences were found between plants grown under high CO2 and those cultured in control conditions as the production season can be anticipated.

These results shows the increased CO2 to 400ppm inside the greenhouse and a proper salinity conditions could definitely increase the production in the horticulture industry. The external appearance of fruits, particularly their colour, is of prime importance when considering the various attributes that define quality but they were not considerable differences in colour and the same level of product quality was achieved, only in much less time as the production was made in 4 months.

Different technological devices have been developed, tested and integrated for complete the Carbgrowth Solution: Solar Water Photo-reactor, the Gas Treatment Unit and the RAS (Recirculation Aquaculture System).

- Water catalyst photo-reactor: A solar water photo-catalyst reactor has been developed. It is based on two concentric glass tubes coated with TiO_2 catalyst and a solar collector based on Fresnel lenses able to increase the photo-catalyst capabilities of the system. It has been designed for the water to flow through the coated glass tubes in order to maximize the active catalyst contact surface area. The main experimental test shows conclusive results of the photo-catalyst activity as it was able to degrade the organic matter content of waste water coming from surplus or the RAS system.

- Gas Treatment Unit: This treatment unit comprises the PAHs photo-catalysis reactor and an advanced functionalized compound to sequestrate the CO_2 of the cleaned coming from the flue gases of the heating system of the greenhouse. This kind of treatment is a novelty as, according to the research in literature, it hasn't been reported before as a complete system before. The tests made in real conditions concluded that it was able to degrade 80% of the PAHs of the input gases. The sequestration is done by means of a novel functionalized silica powder that is able to capture the CO_2 from the incoming gases and that is able to free the CO_2 on demand if the silica heated more than 50ºC.

- RAS: The greenhouse was provided with a RAS with tilapia fishes and integrated with the Water photo-catalyst system. The complete study of the growth and the production of nutrients of the crops have helped the integration of the RAS with the irrigation system of the greenhouse. Also a complete fish production cycle was studied where the fish reached a commercial. In the RAS, the biological process of nitrification is used to oxidize toxic ammonia excreted by fishes, into nitrite and finally into a less toxic compound nitrate that can be used in the plant production process.

Taking this into account and the respectively performance tests of the different technologies developed during the project and integrated as the complete Carbgrowth Solution (Water Photo-catalyst reactor, Gas Treatment Unit and RAS) the CO_2 and nutrients needed or an horticulture production in a greenhouse could be reused and delivered from the different resources in a common greenhouse (wastewater from the irrigation system and the flue gases from the heating system) and the use of a sub-product like the fishes from a RAS.

These conclusions defines the Carbgrowth technology as a TRL6 (Technology Readiness Level) which means that the basic research has been done and the conceptual prototypes have been tested with the expected results and that the Carbgrowth technology is ready to be on an industrialization phase.

An automated Carbgrowth process using self-adaptive neural networks based control systems. A key feature of neural networks is an iterative learning process. The network processes the records in the training data one at a time, using the weights and functions and then compares the resulting outputs against the desired outputs. Errors are then propagated back through the system, causing the system to auto-adjust the application to the next processed record. This process occurs over and over as the auto-adjustment is continually refined so the next time around the output values will be closer to the observed output values.

This strategy have been followed in order to be able to install the system in any type plantation and optimize the production results without the intervention of an operator and according to the measurements of the conditions in the greenhouse. But with only one growth campaign the

Finally, comprehensive full cost benefits analysis was made according to the results of the integration phase. The integration capabilities and options for the systems that gathers the Carbgrowth solution was considered. New optimization solutions have been also taken into account like that fact that the heating capabilities of the solar concentrator can be used, not only to degrade the organic content of water but also, to increase the temperature of the water of the RAS that in the case of tilapia, could increase the production of fish up to 50% if the temperature of water could reach 25ºC.

Nevertheless each of the items (RAS, Gas Treatment Unit, Water photo-catalyst reactor and the automatic control system) has been evaluated separately and then as a whole. In this way it can be convenient for a farmer to analyse the options of its particular production process and if it is necessary to introduce the whole system or only part of it. As a conclusion the system is feasible in various scenarios but it would be better to integrate the system in different ways according to the location of each particular greenhouse.

Potential impact and use

CO2 production for injection in greenhouses is the main area of interest for the *CarbGrowth* partners, in particular IAGs which area of activity is focused in agriculture. However, we will keep in mind the secondary applications (e.g. algae production, waste water treatment plants and aquaponics market) to explore potential opportunities during the dissemination activities. We have performed an updated search for the potential market of the *CarbGrowth* main application: the number of greenhouses. According to a latest report (January 2012), the total area of world production of greenhouse vegetables is 405,841 Has. This figure is more conservative than the initial estimates and restricts the greenhouse market to only vegetables, as opposed to all greenhouse cultivated crops such as flowers or fruits. The *CarbGrowth* system responds greatly to the need of tomato and pepper crops, due to its role in the European agricultural competitiveness and its cultivated importance (86% of the total crops under greenhouse cultivation in Europe). Therefore this figure, although restrictive, is a good approximation of the real potential market for the *CarbGrowth* system greenhouse application. Based on the new potential market, we have redefined our target penetration to a 5% of that market in ten years.

If we consider an average size in greenhouse facilities we could estimate a market size of the same magnitude. We have preferred to be conservative in the calculation of *CarbGrowth* market potential, taking into account different investment capacities, variety of greenhouse structures (glass, plastic) or diverse climate conditions. Some structures, especially the ones that are not well insulated, are not suitable for CO2 injection and may need to invest in their greenhouses before injecting CO2. Therefore, we have considered that just 20% of the total greenhouse number in Europe will implement the *CarbGrowth* technology (405,841 ha *20%/0.6 ≈ 135,280 end users) and a market penetration of 5% in the 10th years (average greenhouse size 0.6 has). Based on our estimates of target penetration, we anticipate that the production of Greenhouse Horticulture Products grown with *CarbGrowth* technology will grow steadily over the five-year period to our initial target of 4% growth rate of EU Greenhouse Horticulture sector. This Consortium estimates a lifespan for the *CarbGrowth* technology of 10 years.

According to the developments achieved during the project it has been made a definition of the Carbgrowth technologies as a product. The deliverables made among this tasks includes the expected IPR results and the conditions for the access to the background.

In the final plan for use & dissemination of foreground, we established the basis to determine how partners of CarbGrowth project can use background, foreground but also the share of IPR (including licensing) resulting on CarbGrowth project.

A comprehensive description presents the CarbGrowth product, including the background of the need for the developed technology, expected results and distribution among partners. A competitor's analysis is performed in order to compare our solution with existing market solutions.
In the exploitation plan, the potential markets for the technology being developed has been identified, segmented, and the initial market forecasts have been revised based on latest market figures, in order to limit the field of commercialization to the most interesting markets.

Also it has been performed perform a competitor's analysis following with the exploitation plan. Finally the dissemination activities aiming to ensure the dissemination of the knowledge and results generated during the project among the main stakeholders have been described.

The study showed the Carbgrowth acceptance in the market and have identified the potential end users of the technology and their main buying drivers.

- **Greenhouse grower**. This is the main end user and beneficiary of the CarbGrowth technology. Given the industrial sector of the consortium IAGs, mainly in the field of agriculture, access to this end user is greatly facilitated and the dissemination actions has been directed to this end user.

- **Aquaculture farmer**. This type of end user was initially identified in *CarbGrowth* as a potential user of the technology for cleaning the waste water coming from their activity. A more in depth validation of this end user has been performed at this stage taking into account the *CarbGrowth* system performance up to date in terms of load of organic matter that the system can take.
- **Waste water treatment plants.** This type of end user, although not considered initially as a beneficiary and therefore potential user of the *CarbGrowth* technology, has been identified due to the interest of photocatalysis in breaking down the pesticides particles contained in the water. Currently water treatment plants don´t destroy pesticides but transfer them from one place to the other, therefore, *CarbGrowth* photocatalytic system would offer a solution for the pesticides treatment in waste water.

Finally the dissemination activities aiming to ensure the dissemination of the knowledge and results generated during the project among the main stakeholders are described, in terms of supply chain & end users. This allows to direct the presentation of the different results (water or gas photocatalytic systems) to the main interested stakeholders.

In this section we will identify the results from the *CarbGrowth* project, functionalities of the resulting system and results distribution among the consortium partners.

<u>RESULTS:</u> The results of *CarbGrowth* initially identified to be exploited by this Consortium were the following:

- R1: CO_2 recovery from greenhouse heating exhaust gases by photocatalysis
- R2: CO_2 recovery from low quality water treatment by photocatalysis
- R3: CO_2 injection system for greenhouse facilities in order to increase horticulture production.
- R4: Control of CO_2-humidity-temperature balance inside the greenhouse.
- R5: *CarbGrowth* quality protocol
- R6: A cost effective CO_2 and water supply that will permit to implement the *CarbGrowth* system at industrial scale.

<u>DISTRIBUTION OF RESULTS</u>: The results distribution among the consortium partners has been defined as follows:

AMOPA shall be co-owner of all the rights relating to the *CarbGrowth* project results and to the <u>*CarbGrowth* system</u> IPR;

AGROSTAR shall be co-owner of all the rights relating to the *CarbGrowth* project results and to the <u>*CarbGrowth* system</u> IPR;

RATHO shall be co-owner of all the rights relating to the *CarbGrowth* project results and to the <u>*CarbGrowth* system</u> IPR;

CCIM shall be co-owner of all the rights relating to the *CarbGrowth* project results and to the <u>*CarbGrowth* system</u> IPR;

RITEC will have royalty free with non-exclusive rights for results related with the water and CO2 distribution systems and the process control of the CARBGROWTH system.

DAMCO will have royalty free access to results of photocatalyst solar concentrators and photocatalyst system for exhaust gas treatment applications.

ANDR (Beneficiary 7) will have royalty free access to results of photocatalyst for water treatment

The IPR distribution is reflected in the table below.

Foreground	***AMOPA***	***CCIM***	***RATHO***	***RITEC***	***DAMCO***	***ANDR***
CO2 recovery from greenhouse heating exhaust gases by photocatalysis	Ownership	Ownership	Ownership	Other	Licensing	Other
CO2 recovery from low quality water treatment by photocatalysis	Ownership	Ownership	Ownership	Licensing	Licensing	Other
CO2 injection system for greenhouse facilities in order to increase horticulture production	Ownership	Ownership	Ownership	Licensing	Licensing	Other
Control of CO2-humidy-temperature balance inside the greenhouse	Ownership	Ownership	Ownership	Licensing	Other	Other
Carbgrowth quality protocol	Ownership	Ownership	Ownership	Licensing	Licensing	Other
A cost effective CO2 and water supply system.	Ownership	Ownership	Ownership	Other	Other	Other

Table 1: Results distribution among partners

Following the project development and a further research into the market and end user needs, **the main patentable results identified** within the *CarbGrowth* system are R1 and R2. They are two sub-systems of the general system R6, which will have application in technological different types of greenhouse, generally associated to different geographical regions in Europe.

1) Photocatalyst system for exhaust gas treatment (gas photoreactor). This system is applicable in high technology greenhouses with heating system and cogeneration systems that allow the use of the exhaust gas during the day to generate CO2. This type of systems are mainly characteristics of Northern Europe

Photocatalyst for water treatment (water photoreactor). This system is designed for a more efficient use of the irrigation water and therefore finds its main applications in the southern Europe, allowing the use of low quality waters to produce CO_2.

Dissemination Plan

The *CarbGrowth* system aim to be disseminated along Europe aiming the facilitation for the implementation and exploitation of the process on industrial scale.

CarbGrowth Consortium aims to penetrate in national and European markets carrying out a series of dissemination actions. The different dissemination activities have been directed to the different stakeholders of the *CarbGrowth* system.

One important tool for the dissemination among stakeholders is the *CarbGrowth* project website (http://www.carbgrowth.eu/) and partner's websites. The major platform for dissemination is the *CarbGrowth* webpage which has been established to provide general information on the project and its activities, guidelines, check-lists, SMEs groups and researchers, information on brokerage events, profiles and partner's searches, list of relevant meetings and conferences.

The second approach to the stakeholders previously identified was via fairs, conferences and/or consortium events where the dissemination material has been presented to demonstrate the functionalities of the *CarbGrowth* system.

The potential groups and audiences interested to install the *CarbGrowth* system to solve their needs:

A) Greenhouse horticulture growers will be addressed presenting *CarbGrowth* as a system to solve their agricultural needs of increasing production though CO2 fertilization.

This group of stake holders includes i) high tech greenhouse growers with cogeneration systems typical from northern Europe; and ii) greenhouses from regions with low water availably typical from southern Europe (where lack of productivity through irrigation with saline water would be compensated by CO2 injection)

B) Aquaponic growers are a small but growing target group that may be interested in increasing horticulture productivity through CO2 injection using the water from their aquaculture activity.

RATHO is part of an aquaponic project since January 2013. This project has been scientifically validated and starts in November 2014. Some of the partners that are involved in this project could have some interest of testing / promoting *CarbGrowth* technology. Related national and scientific organisms involved are: INRA, CIRAD, IFREMER, ASTREDHOR, CTIFL (Centre Technique Interprofessionnel des Fruits et Légumes), ITEIPMAI (aromatics and medicinal plants), Montpellier University, AQUAPONICS U.K, Stirling University, Scotland, Chambre d'agriculture, etc. This aquaponic project is of first interest for *CarbGrowth* technology to be evaluated.

C) Waste water treatment plants will be addressed.

D) Aquaculture farms and associations will be identified to understand better the wastewater management problems and their interest in the *CarbGrowth* system for water treatment.

With that aim the following **fairs, congresses, publications**, have been identified:

1) National and international Fairs will be contacted in order to evaluate the potential interest for presenting *CarbGrowth* technology. As explained previously in this draft, we will focus on several fields : agriculture, aquaculture and environment technologies:

    - POLLUTEC Horizons : annual French show for cleantech, energy and sustainable development – Paris, Lyon - December - http://www.pollutec.com/

- SIVAL : trade show on equipment and services for all plant productions – Angers, France – January - http://www.sival-angers.com/en/

- SIMA : French agri-business trade show – Paris, France – February - http://www.simaonline.com/

- SALON DU VEGETAL : Tradeshow more dedicated to ornamental production – Angers, France – February - http://www.salonduvegetal.com

- AGRIFLANDERS: Belgian agriculture tradeshow– Ghent, Belgium – January - http://www.agriflanders.be

- AGRIBEX : Belgian agriculture and landscape tradeshow – Brussels, Belgium – December - http://www.agribex.be

- HORTIFAIR : Dutch international tradeshow in horticulture – Amsterdam, Netherlands – November - http://www.hortifair.com/

- AGRITECHNICA : exhibition for agricultural machinery and equipment exhibitors for professional plant production – Hannover, Germany – November - http://www.agritechnica.com

- IPM ESSEN : world's leading trade fare for horticulture – Essen, Germany - http://www.ipm-essen.de/world-trade-fair/

- Fish INTERNATIONAL: international aquaculture tradeshow – Bremen, Germany – February - http://www.fishinternational.com

For those defined fairs, *CarbGrowth* consortium can present abstracts to the fair organizers to see the interest to participate in the conference program.

2) **Publications** in horticultural magazines are envisaged. Professional magazines will be contacted to publish *CarbGrowth* technology. Evaluation of potential magazines:

- Lien horticole: French ornamental horticulture magazine - http://www.lienhorticole.fr/

- Atout fleurs: professional magazine of the French research station SCRADH, member of ASTREDHOR. This research station is dedicated for cut flower producers, which is a potential end user

- Campagnes et environnement : magazine dedicated to agriculture and environnment - http://www.campagnesetenvironnement.fr/

- **COPACOGECA NEWSLETTER:** Copacogeca is supporting the project offering dissemination of the results of the project once it is finished. A presentation of the outcomes from our side at their Working Party on Environment will also be facilitated.

3) Websites publications

- Rhône Alpes regional Agriculture Chamber : web portal synagri - http://rhone-alpes.synagri.com

- Astredhor: French national institute of horticulture – www.astredhor.fr

4) Technical days:

- RATHO annual technical day.
- SERAIL (regional and vegetable research station, Rhône-Alpes) annual technical day.

Consortium members

Partner	Short name	Country
Instituto Murciano de Investigación y Desarrollo Agrario y Alimentario	IMIDA	Spain
Asociación Mediterránea de Organizaciones de Productores Agrarios	AMOPA	Spain
Camera Di Commercio, Industria, Artigianato E Agricoltura Di Milano	CCIM	Italy
Station d'experimentation horticole RATHO membre institut Astredhor	RATHO	France
Riegos y Tecnología S.L.	RITEC	Spain
Damco D.o.o	DAMCO	Croatia
St. Andrews Farm & Bldg Co Ltd	ANDR	Malta
AquaBioTech Limited	ABT	Malta
NOVAMINA Innovative Technology Center d.o.o.	NOVA	Croatia
Tecnologías Avanzadas Inspiralia S.L.	ITAV	Spain
Federatia Nationala A Sindicatelordin Agricultura	AGROSTAR	Romania

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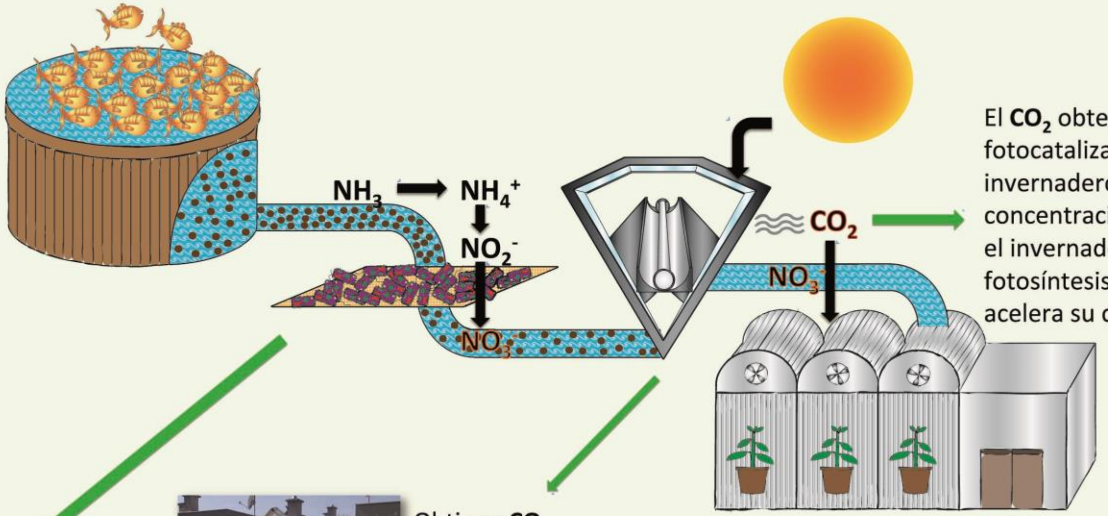
CARBGROWTH: MAXIMIZACIÓN DE LA PRODUCCIÓN HORTÍCOLA EN INVERNADERO CON AGUAS DE MALA CALIDAD FP7-SME-2011-BSG-285854 CARBGROWTH

CARBGROWTH

SEVENTH FRAMEWORK PROGRAMME

AMOPA Asociación Mediterránea de ORGANIZACIONES DE PRODUCTORES AGRARIOS



La tilapia es engordada en estos tanques hasta alcanzar su talla comercial (300-400 gr.)

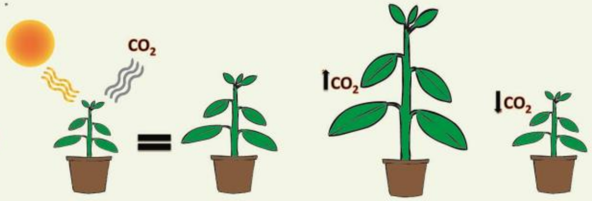
Los excrementos generados por los peces (NH_3 + materia orgánica) son transformados en un biofiltro biológico a nitratos, los cuales son asimilables por las plantas.

Obtiene **CO_2** aprovechando la energía solar para acelerar la reacción de oxidación de la materia orgánica disuelta en el agua.

El **CO_2** obtenido en el fotocatalizador es inyectado en el invernadero. Mantener concentraciones elevadas de **CO_2** en el invernadero incrementa la fotosíntesis de las plantas, por lo que acelera su crecimiento. Al mismo tiempo, se produce un mayor cierre de estomas (poros que hay en las hojas por los que se produce el intercambio de gases), por lo que se mejora la eficiencia del uso del agua.

El agua con los nutrientes en su forma asimilable por las plantas, es utilizada para regar las plantas. Al contener este agua ya nutrientes, la cantidad de nutrientes que hay que aportar será menor.

FOTOSÍNTESIS →



Visite nuestra página web: **www.carbgrowth.eu**

PARTICIPANTES:

AquaBioTech Group; DAMCO Global logistics. Individual solutions.; Inspiralia; CAMERA DI COMMERCIO MILANO; AGROSTAR; novamina Innovative Technology Center; astredhor; St. Andrews Farm & Bldg Co Ltd; imida; AMOPA; RITEC Riegos Tecnificados