Substrate growing developments in Europe 2010-2027.

The area of crops like tomato and peppers and roses grown on rooting media is worldwide increasing. The driving force seems the combination of higher yield levels and the possibility to avoid diseases while still mono cropping. Increasingly the possibilities to avoid emissions of crop protectants and nutrients become important too. Finally the need to increase the efficiency with which irrigation water is turned into marketable products is becoming urgent in many parts of the world, including southern Europe. It is therefore a safe assumption that the area of substrate grown crops in the world will remain increasing for a very long time to come. Eventually the area of plants grown on substrates in the field may surpass the area of plants grown on substrates in greenhouses.

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Fruit vegetables and cut flowers.

Materials

Growing fruit vegetables and cut flowers nowadays is predominantly on bags of peat, coir, rockwool, perlite, synthetic foam and many local (volcanic) minerals. Peat was abandoned because of its low available air content. Perlite is used in Greece and Spain quite successfully but is limited by the technical inability to produce dustless, graded granulates larger than 8 mm. Attempts to introduce wood fiber slabs in the past decade failed because of the high degradability but technical possibilities still increase. A novel material with high rewetting capabilities is glass foam from recycled glass bottles (Figure 1, site growstone). An interesting area of development are systems which do not require any substrate but bath the roots in nutrient solution. The New Growing System (NGS) is the most well known (Figure 2, site ngsystem).

Areas

As the market developed from 1970 on, peat bags were the first to surpass the 100 ha limit. They were overtaken by rockwool slabs which materials expanded to 1000 ha around 1985 and much more recently to 10.000 ha of which an estimated 6000 ha in Europe. Still, rockwool may no longer be the world's leading slab substrate as coir has quietly expanded its share of the market too and is the favorite substrate in many of the new areas. Mexico, Korea and the US are turning to substrate growing (often quite confusingly labeled "hydroponic growing"). In Europe the area is growing too but much slower as most lead horticultural areas are already familiar with some form of substrate growing.

Container crops

Materials

Container plants are grown predominantly in organic rooting media. In northern Europe peat is the leading substrate with over 70% of the volume sold in Scandinavia, the UK, Holland, Danmark and Germany (Figure 3 from Blok and Verhagen, 2009). Annually about 25 Million cubic metres of peat are sold for horticultural purposes in Europe alone (Verhagen ea, 2008). This makes peat volume wise the worlds leading single substrate by far! Peat is a quite wet substrate with a maximum water holding capacity of often more than 85% of water. The irrigation strategies are based on mixes with a high water holding capacity. In the south of Europe the mixes used for container plants are predominantly peatless. These mixes contain barks, sand, wood products, volcanic products and composts. They are generally much drier and require quite different irrigation strategies than with peat based mixes!

Areas

It is very difficult to give an estimation of the area involved as this would ask for the addition of area statistics for all European countries while preventing double counts for tree crops and container plants grown in greenhouses as well as outdoors. Arguably bedding plants and propagation materials might be included. Based on the assumption that 15 Million cubic meters of peat are used annually for container plants and also assuming a use of 50 liters per square meter per year and 50% - 100% peat in the mixes Europe wide, this would indicate an area of 30 -60.000 ha.

Developments in certification

Certification is no just longer used to just facilitate trade or ensure proper production and customer reclamation policies. Certifications of growing systems are more and more used to prove to the customer and the consumers that production is sustainable and with respect for people, planet and economical sustainability (Corporate Social Responsibility). In this way there is fierce discussion on the energy consumption of rockwool and synthetic foams. And there is fierce discussion on the use of peat and the related release of carbon dioxide. And there is discussion about the amount of energy used to transport coir around the globe. And there is discussion on the emission of fertilizers and crop protectants in the environment. Tools to evaluate and compare all these different issues are Life Cycle Analyses (Maanen, 1998). These LCA-tools are made by teams of economists and will in the future serve to fight a battle for the sympathy of the consumer (Verhagen and Boon, 1998). These tools already made it clear that it is all about a tradeoff between production and negative aspects of production. In that way the energy consumption of unheated organic growing turned out to be no better than for glass house growing on rockwool (Figure 4). The reason is that the limited input of energy in organic horticulture will be divided by a much lower yield per unit area. Thus the energy input per unit of product weight produced was equal to or worse than for rockwool growing systems.

Developments in systems automation

Energy

System developments in the North of Europe focus on reduction of energy input, reduction of labor input and on emission reduction. The efforts in the field of energy are quite successful and resulted in; the closed greenhouse*, screens, greenhouse decks and heating strategies (Bakker, 2009). Negative effects on crop growth were largely invisible as the yield increase because of the increased in hours with high carbon dioxide levels is much larger. Research now focuses on amending averse effects of the system change on production such as a locally too cold fruits.

Labor

Efforts to reduce labor by automation are much less universally successful. The automation of container plant production is of course on going and impressive. Internal transport without human intervention and image analysis for automated grading are accepted standards. For cut flowers, bulbs, trees and fruit vegetables some costly mistakes witness the failure of break through automation. Growers who nowadays use the systems developed in the past ten years acknowledge that they would not build the same system again when given the choice (Figure 5). The main mistake in automation is to create systems which are inherently less healthy for the plants growing in them than the old system were. Especially minor deviations in the field of irrigation and nutrients create lasting production problems (Figure 6). Growers and researchers failed to appreciate they still do not fully understand the distribution of irrigation and drainage water. Still research into systems automation goes on and it is expected that robotisation of harvest and transport of the crops will eventually be realized without averse effects for the crop (Figure 7, Blok and Shao, 2009).

Emission

Finally there is a lot of emphasis on the reduction of emissions of crop protectants, the emission of nutrients notably nitrate and phosphate and the emission of sodium chloride (Baas and van den Berg, 2004). In Holland a lot of research effort is put into controlling the emission of crop protectants. The risks of these material in the densely populated areas of Holland are clear enough to unite growers and water boards in research into better cleaning techniques. At the same time the number of chemicals allowed is decreasing whereas more and more biological control agents are developed.

Developments in water control.

Water quality

In the South of Europe large regions offer poor water quality for growing. The levels of bicarbonate and the pH are often too high and need to be adjusted with the proper chemicals and equipment. High levels of sodium chloride and sulfate are also common and result in incomplete recirculation as drain water has to be discharged as the levels of these elements become high enough to reduce the crop yield. Pumping quality water from deeper aquifers is a short term solution which is soon to be forbidden everywhere in Europe. It is increasingly difficult for individual growers to overcome water quality problems. The alternative besides moving to a better region is to organize the supply of quality water and/ or treatment in regional and super regional structures.

Water quantity

Whereas water use is not yet of no practical consequence for growers in the north of Europe, in the south of Europe water is increasingly felt to be a scarce product. A tell tale sign is the water supply to growers in the southern United States which in 2008 was temporarily back regulated in favor of civilian demand (Penn, 2008). This put some growers out of business overnight. To avoid this type of competition between agriculture and civilian demand, collective initiative to organize water distribution regionally and super regionally is called for. In addition there is a need for systems which will increase the water use efficiency of the crops.

Water Use Efficiency

The water use efficiency is the amount of water input per unit of product weight produced. The parallel with energy in the previous LCA example is striking. Crops with higher production levels have much better water use efficiencies (WUE) than crops with lower production per unit area (Najafi and Tabatabaei, 2007). Thus the need for high water use efficiencies will promote an increase in substrate grown area based on the related higher yields as well as on the possibility to re-use the drainage water.

Developments in nutrient control.

Regulations in 2027

As stated before, the EU water framework directive on water quality oblige member states to put a fixed output level on all types of agricultural activity by 2027. The typical high input of fertilizers in horticulture will require a lot of effort by producers to keep the emission per hectare of nitrate and phosphate under the maximum allowed levels (site European water) . As there is no direct yield increase or cost or labor reduction related to these efforts, growers are reluctant to individually invest to reduce emissions.

Ion selective sensors

Even substrate growers will have to discharge water now and again as the quality after several cycles of drain water re-use will start to reduce the production. In outdoor horticulture (e.g. container shrubs) the discharge of nutrients is often powered by rain. In all cases considerable higher nutrient efficiencies can be achieved if the composition of the drain water before re-use can be monitored with ion selective sensors and subsequently can be adjusted. No sensors of acceptable quality have been offered on the market yet (Gieling ea, 2005).

Discharge

To eventually discharge water with high nitrate and phosphate levels it might be advantageous for growers to get organized and try to initiate cooperation with water authorities on both; getting good quality input water and collecting and treating discharge water. This type of collective is now emerging in Holland. Typically commercial engineering bureaus with experience in municipal water treatment are able to realize projects this large.

Chances for North and South.

Some obvious topics for cooperation within Europe would be on the reduction of emissions by technical solutions, regional water collection and treatment structures, and the development of ion selective equipment.

- Closed greenhouse: a greenhouse which harvests heat in the summer, stores the heat in subsoil water layers (aquifers) and then re-uses the stored heat in the winter period. Because the temperature in the summer does not get as high as in a traditional greenhouse, ventilation can be reduced or left out; the greenhouse windows remain closed. A big advantage of closing the ventilation is that the level of carbon dioxide can be maintained during a larger part of the day. This increases the yield enough to pay for the techniques involved.

Figure 1. A novel substrate, glass foam, with a high rewetting capacity.

Figure 2. A lettuce system without substrate in a multiple plastic layer structure. Irrigation by an aeroponic misting system.

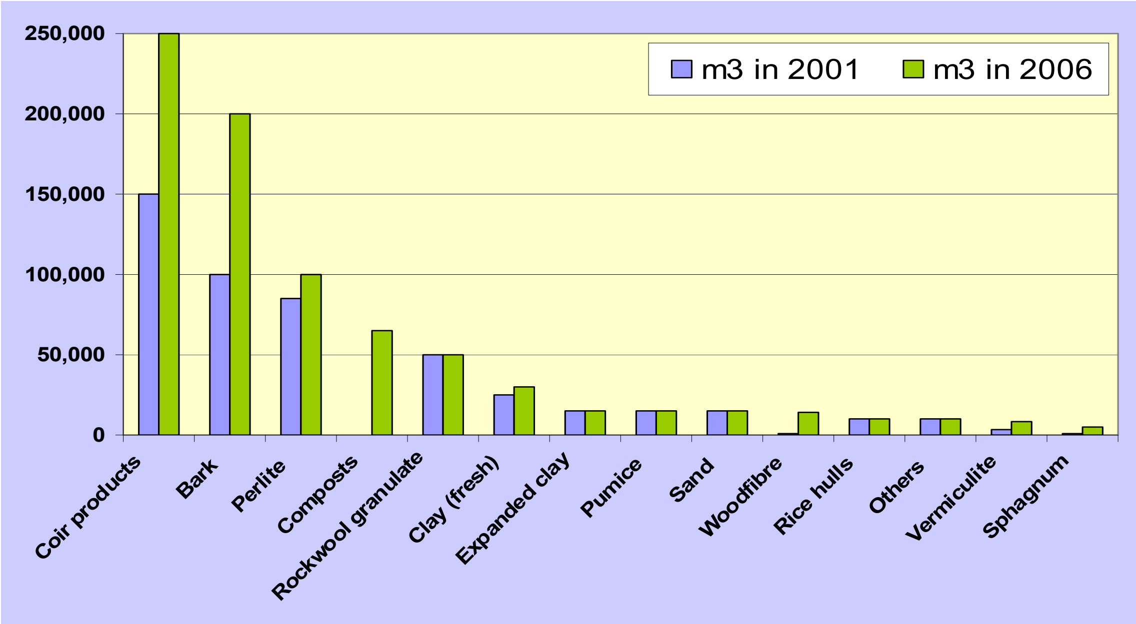

Figure 3. The amount of various container media other than peat.

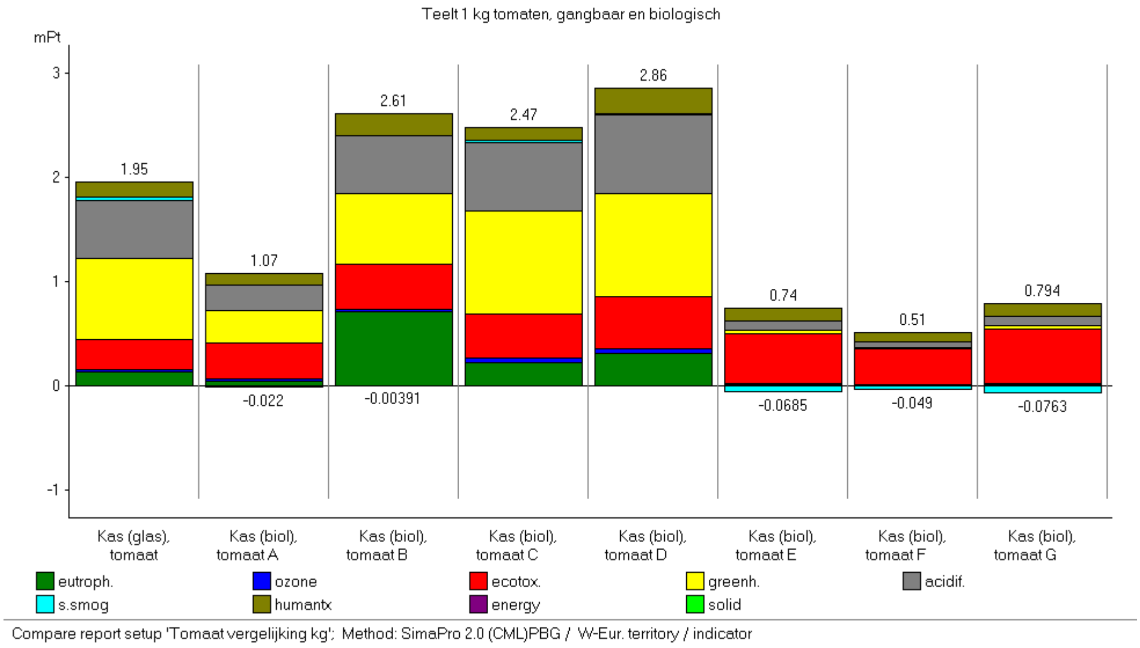

Figure 4. A life cycle analysis (LCA) comparison of tomato on rockwool versus tomato organic growing per kg tomatoes produced (Ruijs, 2000).

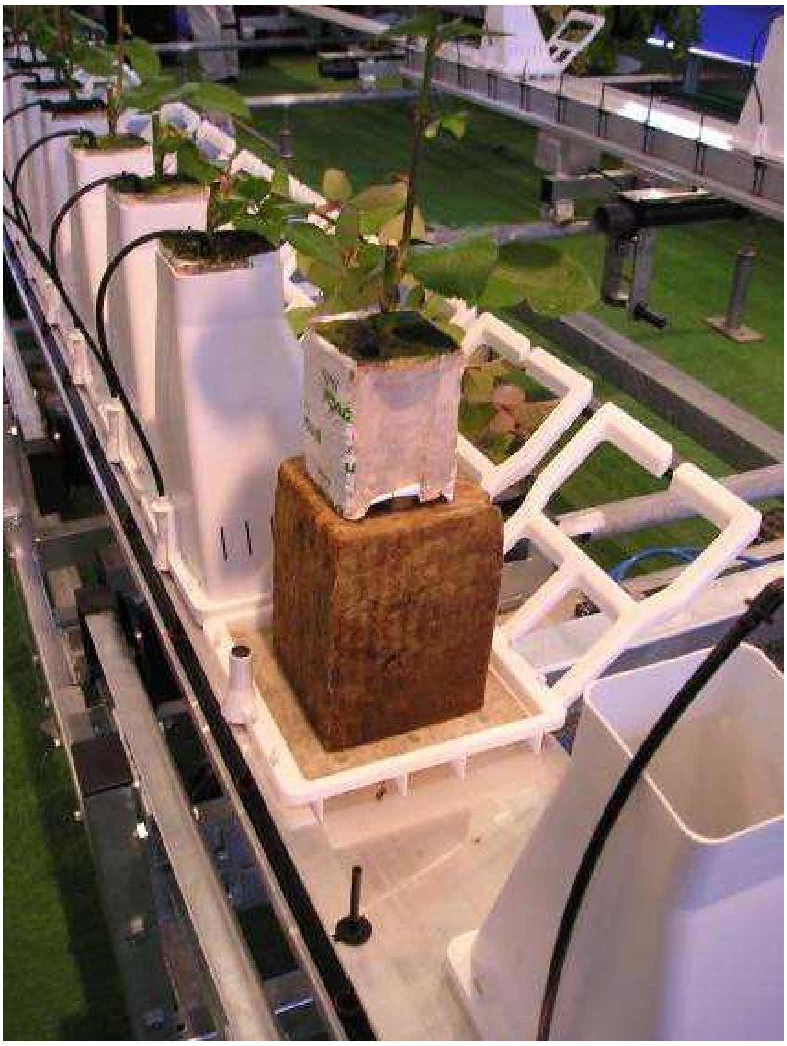

Figure 5. A mobile rose growing system with individual units (one plant per substrate unit).

Figure 6. A mobile chrysanthemum growing system with 8 meter long 5 cm wide units for subirrigation.

Figure 7. A mobile cucumber growing system with stationary heads. Stems are pulled into the rooting space. Irrigation by an aeroponic misting system. Roots are periodically cut and the stem in the rooting space is allowed to form the next batch of roots.

Literature

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Additional information

http://growstone.com/

http://www.ngsystem.com/

http://ec.europa.eu/environment/water/index_en.htm