Prospects for Gulf Region with closed greenhouse

In countries such as Saudi Arabia and the United Arab Emirates, water is scarce as rainfall is minimal. Growers in the Gulf Region rely on groundwater for evaporative cooling and irrigation. This source of water is running out and growers are deciding to end production. The governments of the Kingdom of Saudi Arabia and the United Arab Emirates want to create new possibilities for horticulture in the region by developing more sustainable and water-efficient techniques.

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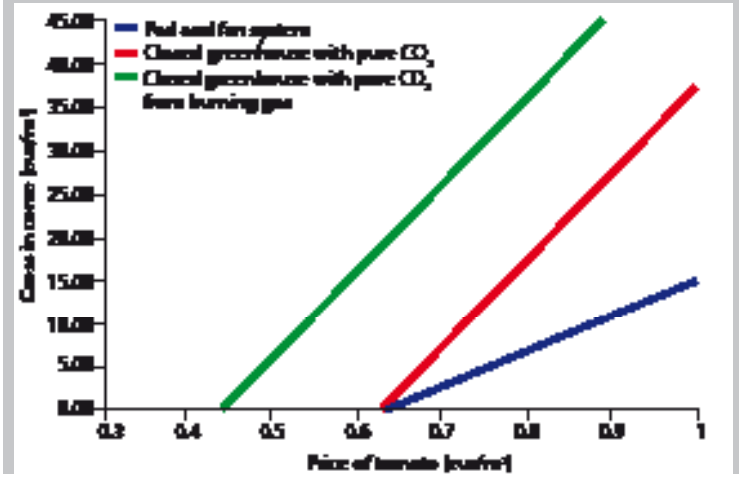
In the Gulf Region, water used for agriculture is usually extracted from deep groundwater sources. However, this resource is starting to be depleted as a result of extensive use, and the quality of the water is decreasing during this process. This has resulted in the decision by several vegetable and cut flower growers to stop their production due to poor water quality.

By applying reverse osmosis, sea water can become an alternative resource. This method to produce fresh water is already applied more extensively for domestic use. The salty water is pumped through a membrane that filters out the minerals. A cubic meter of water can be produced at a cost of about US$ 1.75; 70% of which results from energy costs. Using treated waste water for food production is not considered an option in this region. This water is mainly used for irrigation in parks and forests.

Protected horticulture in this region primarily uses water for evaporative cooling. Pad and fan systems provide a moderate greenhouse climate due to the low relative humidity and are used extensively for this reason. However, as a result of the high outdoor temperature in combination with high levels of solar radiation, the water use of these systems is high. With water resources running out, alternative systems need to be developed.

Figure 1: Gross income per square meter of greenhouse as a function of tomato price in the Gulf Region.



Closed greenhouse

An alternative system that can be applied to reduce water use in Saudi Arabia and the United Arab Emirates can be mechanical greenhouse cooling. This concept is often referred to as a 'closed greenhouse' and has been developed and tested in the Netherlands in the last few years. A closed greenhouse is sealed off from the outside in terms of air exchange, and air treatment units control the humidity and temperature inside the greenhouse.

The air treatment units are installed above and below the crop to provide the optimal climate. No vents are installed in the greenhouse cover. Since there is no interaction with the outside air, CO_2 levels can be maintained at very high levels thus increasing production. Furthermore, the climate can be controlled precisely and pesticides are not used.

As the greenhouse is closed, all the water put into the system remains in the system, so only the water put into the plants coming out of the greenhouse has to be supplied. These benefits come at a price: the investment and operational costs. However, since the heat from the solar radiation entering the greenhouse has to be removed by the cooling system, the electricity use of this system forms a substantial part of the operational costs.

The main advantage of a closed greenhouse is that it drastically reduces water consumption. This advantage has to compensate for the technology being costly and energy consuming. On request of the authorities in the Gulf Region, an inventory study has been made by researchers from Wageningen University. The Dutch Ministry of Agriculture, Nature and Food Quality has been funding the project.

Comparison

The economics of the closed

The Synergy Greenhouse in Bleiswijk: a completely closed greenhouse.

system have been compared with that of the traditional greenhouse operated using a pad and fan. The investment and operational costs have been estimated for both systems in the climate of the Gulf Region. *Figure 1* shows the gross income per square meter of greenhouse as a function of tomato price. The lines represent values for the current pad and fan system and a closed greenhouse using different ways to raise CO_2 levels. CO_2 enrichment can be done by burning natural gas or by dosing pure CO_2. Burning natural gas for CO_2 is more economical than applying pure CO_2. The production of CO_2 by burning natural gas can be combined with production of electricity using cogeneration.

From the *Figure* it can be concluded that, with the assumptions made, the closed greenhouse is more economical than the traditional greenhouse operated by a pad and fan system. The high operational and investment costs are compensated by the increase in yield in the closed greenhouse due to the optimal climate and CO_2 enrichment. So, an economically feasible greenhouse that uses a minimal amount of water seems possible for the Gulf Region.

The closed greenhouse system has not yet been demonstrated in the harsh climate of the Gulf Region. The authorities in the Gulf Region, the Dutch Ministry of Agriculture, Nature and Food Quality and Wageningen University aim to develop a demonstration centre to see whether the technology can also be used successfully in this region. Training, communication, demonstration and research will be the centre's main focus. ■