Is a Sustainable Protected Horticulture in Arid Regions Economically Feasible?

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Abstract

Technology is being presented as a way to save water. This technology comes at a price though. An economical analysis is made based on the operational costs and the investment costs. The application of water saving technology has to be economically feasible for the grower otherwise they will never implement it. Technologies used in this paper are the application of soilless culture and the closed greenhouse. The economical evaluation showed that the application of soilless culture is more profitable then the production in the soil in a pad and fan greenhouse. The investment costs of soilless culture are relatively low and the production increase is high. The closed greenhouse becomes most profitable when the price of tomato is higher than 0.75 Euro/kg.

INTRODUCTION

As concluded from the paper "Towards a more sustainable, water efficient protected cultivation in arid regions" (Campen, 2010), technology increases water efficiency. Less water is used and production is increased. Technologies which have been considered are the implementation of soilless culture and the closed greenhouse. Both technologies are commercially available and can be applied in arid regions. The economic feasible is yet to be investigated in this paper.

ASSUMPTIONS

In order to determine the economics of water saving techniques several parameters have to be specified. Starting with the operational costs related to the price of water, electricity, carbon dioxide and labor (Table 1). The prices given in the table are set after discussion with growers in the Middle East. Fertigation is not included because the costs could not be estimated properly. Reuse of water reduces the use of nutrients largely (Van Os, 1995). Water is charged as it is being produced using reverse osmosis which operates using electricity and maintenance.

Investments on technology can be prized together with maintenance and depreciation (Table 2). These prices have been set through discussion with greenhouse builders. The investment of a newly build pad and fan greenhouse are around 50 Euro/m^2. The application of soilless culture increases the investment with 13 Euro/m^2. The overall investment of a closed greenhouse is almost 300 Euro/m^2. For every component the depreciation and maintenance is given (LEI, 2007) so the annual costs can be determined. The price of land, connection to the grid etc. is not included in this calculation.

The usage of water, electricity, carbon dioxide and labor is specified in Table 3. These figures are based on calculations made with a dynamics simulation model (De Zwart, 1996) and discussions with growers in the Middle East. The labor costs are directly related to the production which is estimated to be 20, 40, and 100 kg/m^2 of greenhouse for the pad and fan system, the pad and fan system with soilless culture, and the closed greenhouse respectively. The production increase due to the application of the technology is based on experimental results. The closed greenhouse, for example showed a 78 kg/m^2 under Dutch conditions without artificial lighting (Groenten en Fruit, 2010). The total solar radiation in Saudi Arabia is twice as high compared to the Netherlands so it theory double the amount of production should be feasible since light is the only limiting factor.

ECONOMIC EVALUATION

The gross income defined by the benefits minus the operational and investment costs in relation to the price of tomato is given in Figure 1. This figure is based on the assumptions made. The pad and fan is system set as the reference situation. A system becomes economically feasible from the point where the gross income is positive. The figure shows that the implementation of a soilless culture in the pad and fan greenhouse is more economical than without since it is already feasible at a tomato price of 0.40 Euro/kg. This is caused by the increase in production and the low investment costs of soilless culture. Even the closed greenhouse is economically more attractive at a lower price for tomato than the traditional pad and fan system with the given assumptions. The closed greenhouse is most economically feasible when the price of tomato is higher than 0.75 EURO/kg.

In some cases the water is not charged since the quality of the water from the well is good. Figure 2 shows the economic evaluation for this case. The application of soilless culture is economically more feasible than the traditional system even when water is not priced. A high tech greenhouse becomes economical feasible at a higher price than the other systems but it is already more feasible than the reference system when the price of tomato reaches 0.80 EURO/kg.

CONCLUSIONS

Technology not only saves water but it can also be more profitable than the traditional pad and fan system. A newly build greenhouse with soilless culture is most profitable at lower prices of tomato due to the production increases production and the low additional investment costs. So newly build greenhouses should apply soilless culture. The closed greenhouse only is most profitable when growers get more than 0.75 SAR/kg for their tomatoes. This price is realistic for regions in the Middle East where high quality tomatoes from The Netherlands are sold in the supermarket for 5 EURO/kg. The quality of the products from a closed greenhouse is much higher than from a traditional greenhouse and the pesticide use is minimal.

Investment costs are high for the new technology which will be an obstacle for growers to make the transition. Advanced technology also needs skilled people. Capacity building is therefore an important issue which has to be addressed for the application to be successful.

ACKNOWLEDGEMENTS

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Tables

Table 1. Pricing of operational costs.

	Costs	Unit
Water (desalinated)	0.25	Euro/m^3
Electricity	0.02	Euro/kWh
Carbon dioxide	0.20	Euro/kg
Labor	2.00	Euro/hour

Table 2. Investments costs and the depreciation and maintenance of individual greenhouse construction components.

	Costs (Euro/m^2)	Depreciation and maintenance (%)
Pad and fan	20	20
Greenhouse low tech	30	10
Soilless cultivation	13	15
Fogging	10	10
Air distribution	10	20
Chiller	150	15
CO_2 supply	15	15
Greenhouse high tech	100	10

Table 3. Operational use parameters per square meter of greenhouse.

	Electricity (kWh)	CO_2 (kg)	Water (m^3)	Labor (hours)
Pad and fan	30	0	8	0.5
P&F + Soilless	35	0	6	1
Closed greenhouse	361	30	0.5	2.5

Figures

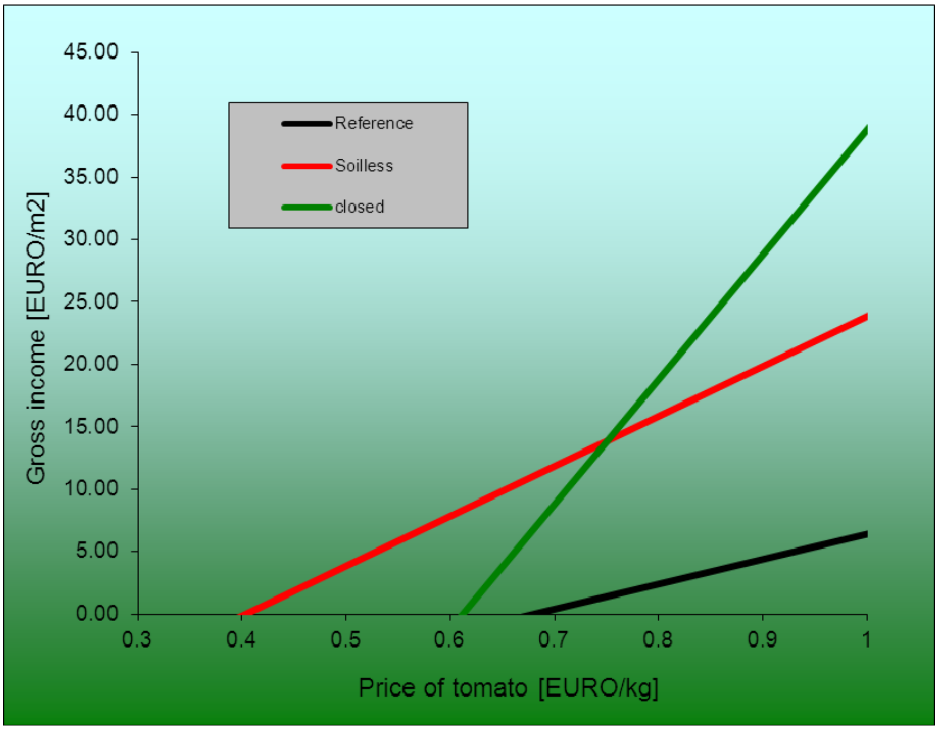

Fig. 1. Benefit minus the operational and investment costs in relation to the price of tomato.

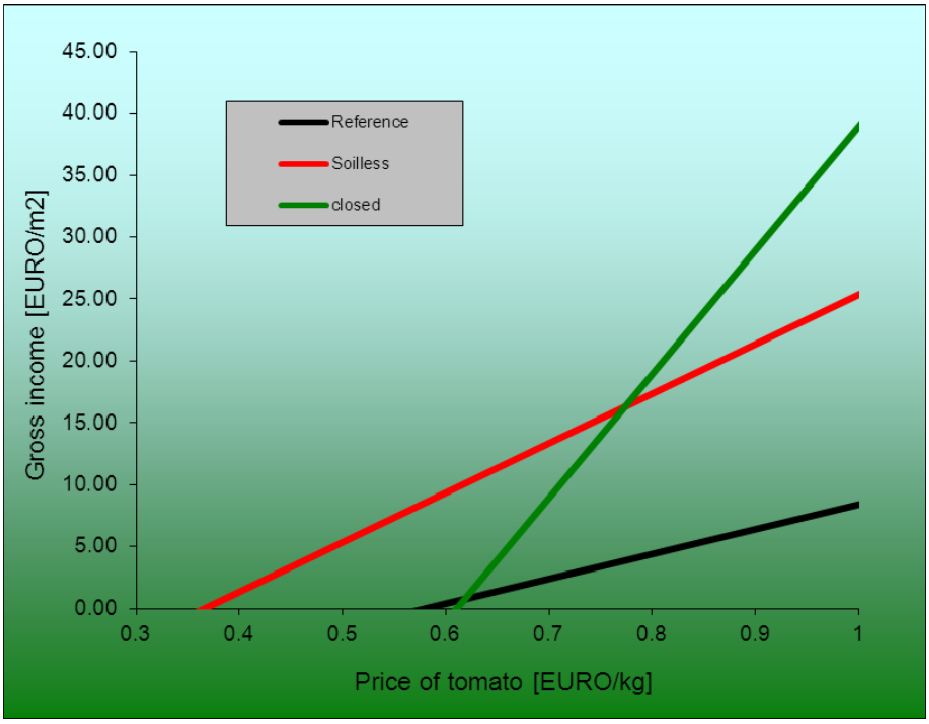

Fig. 2. Benefit minus the operational and investment costs in relation to the price of tomato when water is not charged.