ADOPTING NEW TECHNIQUES IN PROTECTED ORNAMENTAL PRODUCTION: A FINANCIAL ASSESSMENT

YIANNIS GRAFIADELLIS (*) - KONSTANDINOS MATTAS (**) - ELENI MALOUPA (***)

ABSTRACT

In this study the implementation of a Soilless Culture System (plastic bag system) particularly in Gerbera's (*Gerbera jamesonii H. Bolus ex Hooker*) production was assessed in comparison to the Traditional Soil Culture System. Experimental data from heated greenhouses at Agricultural Research Center of Macedonia & Thrace were used and analyzed. Financial analysis through incremental analysis and discounted measures demonstrated the efficiency of the Soilless Culture System as an important contributor to farmer's income in greenhouse's enterprises of Northern Greece.

RÉSUMÉ

*Cette étude porte sur l'évaluation de l'application du Système de Culture Hors Sol (en sacs en plastique) notamment pour la production de Gerbera (*Gerbera jamesonii H. Bolus ex Hooker*) comparée avec le Système de Culture Traditionnelle en Sol. On a utilisé et évalué les données expérimentales collectées des serres rechauffées de «l'Agricultural Research Centre of Macedonia & Thrace». L'analyse financière à travers la méthode incrémentielle et les mesures d'actualisation ont démontré l'efficacité du Système de Culture Hors sol qui peut fortement contribuer au revenu des agriculteurs des serres dans la Grèce du Nord.*

Protected cultivation is a major enterprise in Greece and contributes significantly to improving individual farmer income and national trade balance (Mattas et al., 1990). Principally, greenhouse production in Greece is concentrated mostly on vegetables 92.4% (Pagoulatos, A. and Tzouramani,I. 1995) and the rest 7.6% mainly in floriculture production, which is considered a fast growing industry. The constant increase in demand of out-of season products leads the farmers to produce under protected systems of cultivation and to accomplish it new techniques are introduced such as the Soilless Culture System (SCS) (Mittider et al., 1982). Nowadays, in Mediterranean regions the interest in SCS is rapidly increasing mainly due to several limitations such as fertility, salinity and diseases (Windsor, 1990; Anon, 1976; Verdonc, 1975) and partly because of the need for improving the economic efficiency of the production and the quality of the products (Maloupa et al. 1992). However, the high initial investment expenses, question the efficiency of soilless culture techniques by hortproducers (Sarooshi, 1987). Currently, in Greece, soilless culture represents only fifty hectares while in Netherlands the correspondent area amounts to three thousand hectares. The share of floriculture in Greek greenhouse sector is relatively low although that is itching upwards mainly due to a growing demand of ornamental plants in domestic and foreign markets. Nevertheless, floriculture is a risky business and requires the growers to have equipped with extremely high managerial and technical skills. In addition to managerial abstracles technical improvements halt the expansion of protected floriculture enterprises. Substrate accounts for a large part of expenses and the adoption of a profitable technique will contribute in the overall efficiency of the enterprise. The Agriculture Research Center of Northern Greece in collaboration with Mediterranean Agronomic Institute of Chania has made an effort to investigate the implementation of a SCS, particularly the plastic bag system, in ornamental plant cultivations. The main objective of the experiment was to appreciate the overall performance of a SCS (with zeolith as substrate), the financial effects on *Gerberàs* (*Gerbera jamesonii H.Bolus ex Hooker*) cultivation and finally the perspectives of such techniques. The article begins with an overview of the soilless culture providing at the same time the basic concepts used in the economic analysis. Then turns to main results completing the article with the conclusions.

METHODOLOGICAL BACKGROUND

Soilless culture

The use of soilless cultures under protection has significantly expanded over the past ten years throughout the world and particularly in USA and in European Union. This spreading is due to some advantages of the soilless culture as:

a.) The production can be timed to avoid seasonal shortages
b.) Uniform premium products can be produced
c.) Significant reduction in energy costs can be achieved
d.) High level quality products can be produced
e.) Producers can optimize the control of water and fertilizer
f.) Negative effects on environment are lessened
g.) High valued products can be cultivated in regions

(*) Mediterranean Agronomic Institute of Chania, Greece.
(**) Professor at the Aristotle University of Thessaloniki, Greece.
(***) Senior Researcher at the Agricultural Research Center of Macedonia and Thrace, Greece.

with poor quality water or in regions with high level of pollution
h.) Threats of disastrous crop diseases are eliminated
I.) High technology can easily adopted
j.) Greenhouse environment can completely be controlled. On the contrary, only a few disadvantages of soilless cultures are reported in the literature such as the high start up costs of installing the system and the need for extremely skillful labor (Maloupa, 1993).
In soilless culture various types of substrates are used consisting either of natural organic materials like peat, sawdust, volcanic scoria, tree bark or of non - organic materials, as perlite, zeolith, pumice and rockwool (**table 1**). Artificially made materials as polystyrene and polyurethanes can also be used (Manios, B. and Kefaki, M. 1995). One well known non - organic substrate is rockwool which is often placed inside a plastic film and a flowing nutrient solution is used to feed the plant. In Greece Rockwool is imported from France and Denmark. Zeolith is also strongly recommended as substrate and since can be extracted from domestic sources, from the volcanic rocks in Thrace, it has been tested in soilless culture in Agricultural Research Center in Northern Greece. Zeolith can be used in soilless culture either alone or in mixtures with perlite or with pumice (Maloupa, 1993). In Greece protected cultivation is concentrated mostly in vegetables and less in floriculture. However in the last few years the total cultivated area under protection, especially of ornamental plants, has been steadily increasing (**figure 1**). Particular, Gerberàs protected cultivation has increased between 1990-1994 from 34.7 stremmas to 100 stremmas.

Table 1 ***Classification of solid materials for Soilless Culture according to their origin (Manios, B. and Kefaki, M. 1995).***

Classification of materials	Origin	Type
	Non organic	
	Physical Materials	Sand, Gravel, Pumice, Zeoli
Minerals	Processed Materials	Perlite, Vermiculite, Rockwool Expanded Clay
	Waste from Industries	Pieces of Bricks Waste lurgy from Iron Metal
Synthetic	Expanded Plastics	Polystyrene, Polyurethane
	Organic	
Vegetables	Natural Products	Tree Bark, Peat
	Waste from Agricultural Industries	Waste from Oil Industry Cellular Wastes

General background

The basic concept underlying economic and financial analysis of any project is very simple: for alternative projects, costs and benefits are compared to determine which alternative gives a greater return (Gittinger, 1972). In order to decide whether or not to invest incremental analysis which includes the comparison of the net benefits with and without the investment should be carried out. Project analysis measures and compares incremental benefits and incremental costs over time. Three investment criteria will be taken into consideration in order to determine the project's attractiveness: Net Present Value (NPV) (Levy and Sarnat, 1994), Benefit / Cost ratio (B/C) (Gittinger, 1972), Discounted Payback Period (DPP) (Helfert, 1991). According to Levy and Sarnat (1994), the NPV method can be defined algebraically in the following equation:

$$NPV = \sum_{t=1}^{n} \frac{S_t}{(1+r)^t} - I_0$$

where:
S_t = the expected net cash receipt at the end of the year t
I_0 = the initial outlay
r = the discount rate (the required minimum annual rate of the return of new investment) and
n = the project duration in years

Gittinger (1972) stated that the B/C ratio is the Present Values of the benefits over the Present Values of the

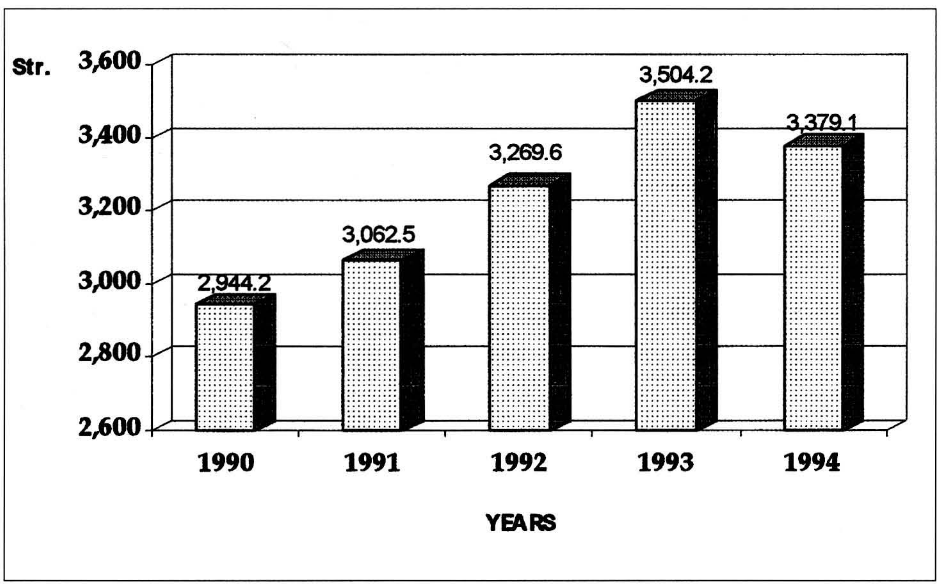

Figure 1 - Annual total area of protected cultivation of ornamental plants in Greece during 1990-1994 (1str. = 0.1 ha).
Source: Ministry of Agriculture of Greece (1990-1994).

costs. The decision rule is the following a) if B/C ratio > 1 the project will be accepted and b) if B/C ratio < 1 the project will be rejected or otherwise we can accept all projects with positive NPV (Pagoulatos, 1992). Selecting the correct discount rate is very substantial in the calculation of the B/C ratio. Brent (1990) stated that the best discount rate is the opportunity cost of capital rather than the social rate of return which may reflect more adequately the time preference of society. The DPP is the period in the project's life when the original investment has been amortized and a return equal to earnings' standard has been achieved on the declining balance, the point at which the project becomes economically attractive. In addition the DPP is based upon the present value of each year's cash flows and it is achieved at the point in time when the cumulative amount of positive present values equals the present values of outlays (Helfert, 1991).

DATA

Data were obtained from two experiments conducted at the Agriculture Research Center of Northern Greece in Thessaloniki a semi- arid Mediterranean region where the summer is hot and dry and the winter is cold and rainy. Variable production costs for cultivars were estimated using experimental data. Fixed production costs were obtained from Salem (1992) for the heating system and from Tzouramani (1994) for greenhouse construction. The experiment conducted from June 1991 to May 1993 in two different greenhouses in order to compare the different cultivation systems of gerbera. In the first greenhouse a SCS was established using zeolith as substrate. In the second greenhouse, the gerbera plants were cultivated directly in the soil, Traditional Soil Culture System (TCS). The two experiments were established in two round arches —type greenhouse, with vertical side walls (single span) (Tzouramani et al., 1995) and were heated with the circulation of warm water in corrugated plastic tubes (Diesel fired —furnace System) (Salem et al., 1993). The greenhouses covered with thermal polyethylene film shielding with a second layer of plastic film (during the cold season). The temperature during the winter (November - Feb.) was kept above 12 °C. During the summer a shading net was placed on the top of two greenhouses. Greenhouses covered an area of 150 m^2. The ground was mulched with a white plastic film of 20 mm thick in order to improve light reflection for the plants. **Table 2** illustrates the main features of the experiment. Plants were established in both greenhouses on 15 of June. In the SCS the plants were placed in polyethylene bags filled with zeolith with 0.15 m diameter and 2.9 m length. On each bag were planted 12 plants of gerbera with a distance between them of 0.24 m. The Nutrient Solution control unit was consisted of one electronic programmer and a pump with total power of 2HP. The distribution of the Nutrient Solution to the plants was managed by two pumps through the trickle irrigation system (Maloupa, 1993). Recirculation of Nutrient Solution was used.

In the second greenhouse the TCS was used and the plants were planted straight into the soil. For an area of 0.ha greenhouse 5,000 plants or (5 plant per square meter) are required.

Table 2 ***Main features of the experiment.***

	SCS [a]	TCS [b]
Greenhouse's Area	1 stremma (0,1 h)	1 stremma (0,1 h)
Heating System	DFS	DFS
Irrigation System	Trickling	Trickling
Recirculation	Yes	No
Plants	6,144	5,000
Plant's density/square m	6.1	5
Varieties	Ximena, Fame	Ximena, Fame
"	Regina, Party	Regina, Party
Bags	polyethylene	
Bag's quantity	512	
Bag's density/square m	0.51	
Substrate	Zeolith	

[a] The Soilless Culture System with Zeolith as substrate.
[b] The Traditional Soil Culture System.

RESULTS

Productions and gross returns of both the SCS (using zeolith media) and of the TCS were estimated and compared (**table 3**). These comparisons are based on statistical means of the whole experimental period for three years. No distinctions among cultivars were taken into account. Production and gross returns were estimated for the total area of the greenhouses and they referred to 0.1 ha. Gross returns were computed utilizing actual daily price data from Thessalonikìs floriculture market which is considered the second more important in Greece. The comparisons clearly manifest that the annual average production of SCS using zeolith media exceeds the annual average production of TCS by 20.22% (table 3).In addition, the gross returns of the SCS topped the gross returns of the TCS by 21.13% (**table 3**). The higher production and gross returns presents a strong indication that the use of zeolith as substrate

Table 3 ***Average annual production of flowers and average annual gross returns (Drs) in different production systems, 0.1 ha.***

	TCS[a]	SCS[b]	Index [c]
Annual average production	140,762	169,222	120.22
Annual gross[d] returns	11,113,441	13,462,057	121.13

[a] The Traditional Soil Culture System.
[b] The Soilless Culture System with Zeolith as substrate.
[c] as 100 is considered the correspont production in Soil Culture System.
[d] All prices are expressed as 1995 Drs. (1 $ = 235).

might be proved more cost efficient than the TCS. However, net profitability cannot be determined by looking only at gross return and a more thoroughly analysis is required. NPV (Levy and Sarnat, 1994), B/C ratio (Gittinger, 1972), DPP (Helfert, 1991) were estimated in order to access the economic efficiency of the SCS (using zeolith media) in comparison to the TSC. Therefore monetary flows of the two systems were considered and discounted at 10% for a period of nine years (**table 4**). A positive NPV (12,726,954 Drs.) indicates a significant increase in the earnings of the farmer due to the adoption of the new technique. The Bratio was greater than one (4.25) as it is required by the rule of acceptance (B/C > 1). NPV and B/C figure clearly demonstrates that the implementation of soilless culture system using zeolith as substrate is beneficial for the farmer's income. The calculation of DPP is based upon the present value of each year's expected returns. Thus the estimated short DPP of 2.66 years indicates that the adoption of the new technique is profitable and the additional capital investment would be recovered by the discounted cash inflows in almost two and a half year (2.66).

Table 4 ***Money flows in (Drs) of the Soilless Culture System in comparison to the Soil Culture System.***

Years	C.O.F[a]	C.I.F[b]	C.F[c]	D.F[d]	D.C.O.F[e]	D.C.I.F[f]	D.C.F[g]
1	1,371,059	– 418,786	– 1,789,845	0.909	1,246,417	– 380,714	– 1,627,132
2	87,491	2,404,100	2,316,609	0.826	72,307	1,986,860	1,914,553
3	1,085,408	4,641,748	3,556,340	0.751	815,483	3,487,414	2,671,931
4	287,491	2,404,100	2,116,609	0.683	196,360	1,642,033	1,445,673
5	1,085,408	4,641,748	3,556,340	0.621	673,953	2,882,160	2,208,207
6	211,491	2,404,100	2,192,609	0.564	119,381	1,357,052	1,237,671
7	1,285,408	4,641,748	3,356,340	0.513	659,618	2,381,950	1,722,333
8	87,491	2,404,100	2,316,609	0.467	40,815	1,121,530	1,080,715
9	201,173	5,089,206	4,888,034	0.424	85,317	2,158,320	2,073,003
Total	**5,702,420**	**28,212,064**	**22,509,644**	**5.759**	**3,909,651**	**16,636,605**	**12,726,954**

NPV at 10% = 16,636,605 Drs-3,909,651 Drs = 12,726,954 Drs
[a] C.O.F: Cash Outflows.
[b] C.I.F: Cash Inflows.
[c] C.F: Cash Flows = (C.O.F – C.I.F).
[d] D.F: Discount Factor.
The general form which was used in order to determine each year's discount factor was the following:

$1(t,k) = 1 \backslash (1 + r)^t)$

where t: denote the year
k: the discount rate
[e] D.C.O.F: Discounted Cash Outflows = (C.O.F × D.F).
[f] D.C.I.F:Discounted Cash Inflows: (C.I.F × D.F).
[g] D.C.F: Discounted Cash Flows = (D.C.O.F - D.C.I.F).

CONCLUSIONS

Financial analysis results strictly depend on the assumed product price values and the level of discount rate, hence to strengthen the conclusions' sensitivity analysis was performed. Thus, changes of the estimated NPV can be traced out in relation to changes either in product prices or in the discount rate magnitude. The NPV's magnitude was sensitive to discount rate changes. More analytically when the discount rate was diminished by 50% the NPV's magnitude was increased by 31.51%. An augmentation by 50% of the discount rate generates a reduction in NPV's magnitude by 22.46% (**figure 2**).
In addition, the NPV was very sensitive in changes of the product price. The increase of the price by 50% yielded a higher NPV magnitude by 65.31%. A cut down in price by 50% cause a decrease in NPV by 65.31% (**figure 3**). The efficiency of a Soilless Culture System (SCS) with zeolith as substrate in gerbera cultivation is examined and compared with the Traditional

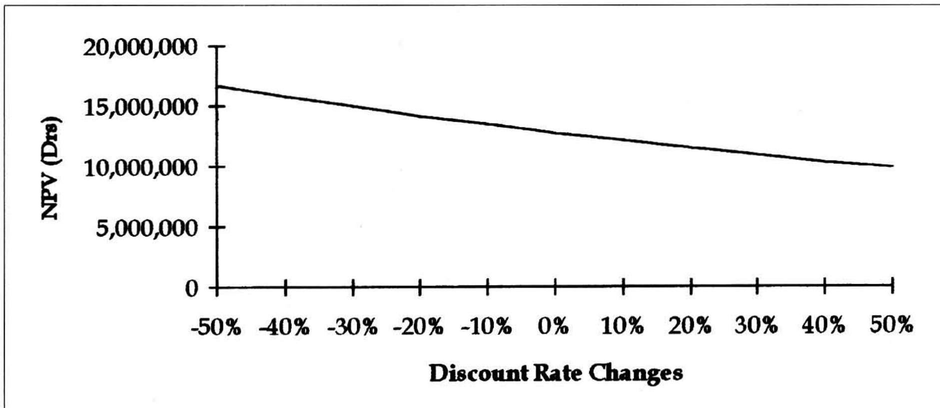

Figure 2 - The effect of a change in discount rate on NPV.

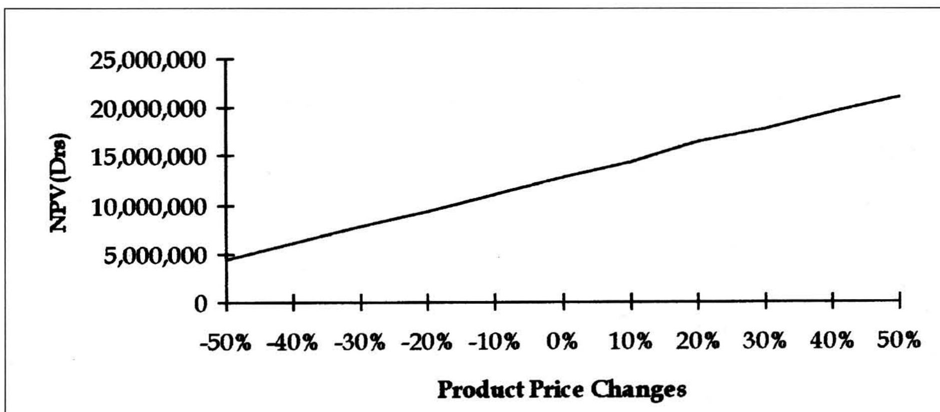

Figure 3 - The effect of a change in product price on NPV.

Soil Culture System (TCS). The adoption of this sort of technology garner essential benefits to protected ornamental enterprises. The comparison of the two systems shows that the adoption of the SCS adds substantial gross revenues. Moreover, the carried out financial analysis proves the overall effectiveness of the SCS for the entire cultivation period. Sensitivity analysis clearly demonstrates that product price and discount rate changes do not alter the main conclusion that the soilless culture system using zeolith as substrate has brought significant profits to the farmer's income under the present status of costs and returns in Northern Greece. ●

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