



Economic Analysis of Medical Cannabis Greenhouse Production for Cbd in Greece

Stella-Olympia BRAKATSOULA^{1*}, Maria KOUSOULA¹, Christina NIKAKI¹, Antonios MAVROEIDIS¹, Alexandros TATARIDAS¹, Ioannis ROUSSIS¹, Ioanna KAKABOUKI¹, Panayiota PAPASTYLIANOU¹, Kostas TSIMPOUKAS², Dimitrios BILALIS¹

¹Agricultural University of Athens, School of Agriculture, Engineering and Environmental Sciences, Department of Crop Science, Laboratory of Agronomy

²Department of Agricultural Economics and Rural Development, Agricultural University of Athens, Greece

* Corresponding author: S.O. Brakatsoula, e-mail: stellamprak@yahoo.gr

RESEARCH ARTICLE

Abstract

A field experiment was conducted in the Agricultural University of Athens in order to evaluate the effect of different greenhouse cover materials on the CBD yield. Cannabis (*Cannabis sativa* L var. Futura 75) plants were grown in three different greenhouses, each constructed with different polyethylene films by PLASTIKA KRITIS S.A. The overall CBD yield per greenhouse was estimated once the cannabis buds matured. Following this evaluation, a business plan was formed for the greenhouse whose cover materials prompted the highest CBD yield. Out of the three greenhouses (GH1, GH2, and GH3), the highest CBD yield was reported on GH2. Two different cover materials, with different properties, were used for the construction of GH2, EVO 7507 AC and EVO 7526 AC. The results indicate that in a five-year span, cannabis production in greenhouses built with the aforementioned materials, could result in a Net Profit of more than 25.000.000 € ha⁻¹. In conclusion, greenhouse cover materials should always be considered in cannabis greenhouse production. Even though greenhouse cannabis production for CBD oil seems to be a potentially profitable business in Greece, selecting appropriate cover materials can significantly increase producer's profit.

Keywords: business plan; *Cannabis sativa*; CBD oil; dual plastic covers; EVO 7507 AC; EVO 7526 AC; EVO 7551 AC; Futura 75; greenhouse; net profit.

INTRODUCTION

Cannabis (*Cannabis sativa*) is an annual, dioecious plant and it consists one of the first crops domesticated by man (Bauer et al., 2016). The first evidence of cannabis cultivation dates back as far as 12,000 B.C., when it was used for therapeutic, religious and recreational purposes (Li, 1974). *Cannabis sativa* is rich in trichomes, epidermal glandular protuberances, that cover the leaves, bracts, and stems of the plant. In these glandular trichomes secondary metabolites known as phytocannabinoids are biosynthesized (Bonini et al., 2018). Even though more than 100 different cannabinoids have been identified, Δ -9-tetrahydrocannabinol (THC) and cannabidiol (CBD) are the two most widely researched compounds of cannabis (Freeman et al., 2019). These are found in greater concentration in the female flowers (Taura et al., 2007). Nowadays, a growing interest regarding cannabidiol (CBD) has been reported (Kalinowski et al., 2020). Studies indicate that CBD has many medical applications as it relieves pain, stress and many other ailments (Russo and Marcu, 2017). CBD modulates the endocannabinoid system of humans, which is associated with pain, mood,

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appetite and memory (White, 2019). According to a report from Fortune Business Insights, the global cannabidiol (CBD) market size was USD 2,770.8 million in 2020. In the same report it was also stated that the market is expected to grow from 3,675.1 million USD (2021) to 55,791.3 million USD (2028), at a CAGR of 47.49% between 2021 and 2028. This expected growth could be attributed to the increased demand for new cannabis products, the high profitability of CBD products, and the wide adaptation of cannabis as an alternative crop with multiple applications (Agnihotri and Bhattacharya, 2021). Moreover, the increasing demand for cannabidiol in pharmaceuticals is expected to increase the demand of CBD (Corroon and Phillips, 2018). Its therapeutic properties in combination with the legislative changes regarding the legalization of cannabis in Greece (Folina et al., 2019) might create new business opportunities. The aim of the present study was to evaluate the potential profitability of a company with CBD-based products. In order to perform this evaluation, the yield from three different greenhouses was assessed and a 5-year business plan was formed based on the yield reported in the greenhouse that performed the best.

MATERIALS AND METHODS

Study area

A greenhouse experiment was conducted in the Agricultural University of Athens (37°59'N, 23°42'E) from 1th March until 27th May 2021. *Cannabis sativa* L var. Futura 75 plants were grown in three different greenhouses with different dual, soft greenhouse covers made by PLASTIKA KRITIS S.A. Greenhouse 1 and 2 had dual, soft greenhouse covers and the greenhouse 3 had one layer of plastic cover (Table 1).

Table 1. Polyethylene films used in each greenhouse.

GREENHOUSE	INTERIOR	EXTERIOR
GH1	EVO 7551 AC	EVO 7526 AC
GH2	EVO 7507 AC	EVO 7526 AC
GH3 (Control)	EVO 7551 AC	-

Initially, cannabis seeds were sown in 330 6-liter pots filled with a mixture of soil from the experimental field of the Laboratory of Agronomy and compost (1:2 v/v). The pots were divided in three groups of 110 and were transferred in the greenhouses where they remained until the experiment ended. The plants were watered every 2 days. Floral induction was achieved via a blackout program (12 hours of light and 12 hours of darkness) that was applied for 2 weeks. On hot days, the side windows of the greenhouse were opened for cooling. The weeds were controlled by hand when it was necessary. The properties of each polyethylene film used as cover material are presented on Table 2.

Table 2. The properties of each polyethylene film used as cover material.

	EVO 7551 AC	EVO 7526 AC	EVO 7507 AC
Description	8-layer, long-life, thermic, colorless, high strength, high clarity, anti-dripping, anti-fogging, UV-open, chemical resistant, m-LLDPE, EVA, LDPE	8-layer, long-life, thermic, colorless, high strength, clear, UV-open, m-LLDPE, EVA, LDPE anti-dripping, anti-fogging greenhouse film	8-layer, long-life, thermic, colorless, high strength, medium diffusing, anti-dripping, anti-fogging, UV-open, chemical resistant, m-LLDPE, EVA, LDPE
Nominal Thickness (Mic)	180	150	180
Total light transmission (400-700 nm)(%)	>91	>91	>89
Diffusion (400-700 nm) (%)	18	18	55
U.V.transmission (300-390 nm) (%)	>70	> 60	>60
Infrared Transmission (7-13 μ) (%)	< 19	< 19	< 17

Once the buds were fully developed, their number, mean weight, and CBD content was measured in order to estimate the CBD yield per greenhouse. The CBD content was lab estimated according to the method developed by the Pesticide Metabolomics Group (Kostopoulou et al., 2020). Following the assessment of the CBD yield of each greenhouse, a 5-year business plan was formed based on the results of the greenhouse that performed the best.

Buisness plan

The 5-year business plan concerns the establishment of a vertical production unit for bottled CBD oil in 10 ml containers in Greece. The legal form of the company will be S.A. and will consist of a 1 ha greenhouse and a 2 acres processing and administration facility (Chatzigianni et al., 2020).

By growing cannabis in a greenhouse, two harvests per year could be achieved instead of one (Miriello, 2017), thus higher overall yields. The initial expenses of the 1st year were estimated at 4.821.307 €. These include the purchase of land (13,000 m²), transportation and equipment installing costs, the start-up costs and the fees of the consultants, worker costs and the fixed capital. Also, at the beginning of the business, a loan of 2.410.653,50 € should be taken, which is 50% of the initial capital. Furthermore, a grant of 964.261,4 € should be provided, which is the remaining 20% of the initial capital and could be given in two doses. The remaining 1.446.392,10 € (the remaining 30%) could be equity. The employees' wages and the costs of the asset and working capital were estimated based on the prices prevailing in the Greek economy. In Greece, the interest rate on short-term loans is 8.25%, the long-term interest rate is 9.20%, while the interest rate on loans over € 1 million is 2.92%.

The land that the company will occupy is 10,000 m² for the installation of the greenhouse and 2,000 m² for the offices and the CBD oil extraction facilities. The land could be purchased for 15,000 € / acre, as we believe that the company will be located in an area with a suitable road network, excellent water quality and suitable climatic conditions. The total acres for this business will be 13. The total permanent and fixed value of the employees' wages was calculated at 722.400 € per year and employers' contributions were estimated at a total of 160,000 €. The staff will be employed in the field of plant development and maintenance, in CBD oil processing, in administration and in security services. Also, the total value of the permanent and semi-permanent capital was estimated at 3,890,307 € (Table 3) with a total annual depreciation of 337,804 €.

The working capital was calculated at 763.102 € per year and includes consumables, costs of irrigation, energy (electricity, ventilation and other needs of the special infrastructure for plant cultivation) and the services of third parties for repairs, promotion, advertising, etc. (Chatzigianni et al., 2020).

Table 3. The permanent - semi-permanent capital of the business.

PERMANENT - SEMI-PERMANENT CAPITAL	
Greenhouse (arched gothic with side height 4 m.)	520.000 €
Greenhouse equipment: black out curtain systems, irrigation, ventilation, climate control, benches, insect nets, drilling, fencing etc.	800.787 €
Processing and office building	400.000 €
Electrical, hydraulic, air conditioning, ventilation, firefighting, lighting, etc.	600.000 €
Office equipment	24.000 €
Alarm system-cameras	80.000 €
Printers & traceability SCANNERS	12.000 €
Cannabis oil extraction production line	1.448.520 €
Tracking software	5.000 €

RESULTS AND DISCUSSION

The greenhouse with the highest yield was the GH2 (cover materials: the EVO 7507 AC and the EVO 7526 AC). We consider that in each m² 4 plants are placed. Each acre of greenhouse consists of 200 m² of corridors, therefore in the remaining 800 m² are available to the plants. Thus, 32,000 plants can be grown per ha. Based on the measurements obtained from GH2, the plants reported an average of 4.3 buds/ plant, with a dry bud weight of 60.1 g. and CBD content of 2.14% per bud. A simple multiplication of these values with the sale price of pure CBD oil

(22.500 €/kg), indicates that one harvest will result in a revenue of 3,981,889.44 €. We assume that this yield will be stable over 5 years and that 2 harvests per year are possible. Therefore, each year the sales will reach 7,963,778.88 € (Table 4).

Table 4. Sales revenue

GREENHOUSE	Buds/plant	Buds mean weight (kg)	Plants/ ha	CBD%/buds	€/kg oil CBD	Revenue/ ha/ year
1	4.5	0.0645	32000	1.71%	22500	7,147,116 €
2	4.3	0.0601	32000	2.14%	22500	7,963,779 €
3	3.7	0.0491	32000	2.03%	22500	5,310,577 €

According to the financial results, the company from its first year of operation will achieve a net profit of 5,226,253 € (Table 5), while the cost of CBD oil production is estimated at 7,734.31 € and the selling price at 22,500 € (Wachira et al., 2014). By the 5th year the business will have achieved a total net profit of 27,547,001 €. As the capital will be depreciated, the production costs will decrease and therefore the production cost of the oil will decrease from 7,734.31 € during the 1st year, to 7,224.09 € during the 5th. During the 2nd and 3rd year the gross income, the net, and gross profit will be higher compared to the 1st, 4th, and 5th year, as a subsidy of 964,261.4 € will be granted.

Table 5. Estimated financial results of the cannabis CBD oil business in 5 years

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL
Gross income	7,963,779 €	8,445,910 €	8,445,910 €	7,963,779 €	7,963,779 €	40,783,156 €
Net Profit	5,226,253 €	5,753,531.20 €	5,798,678.65 €	5,361,695.39 €	5,406,842.84 €	27,547,001 €
Gross profit	6,988,021 €	7,470,152.12 €	7,470,152.12 €	6,988,021.42 €	6,988,021.42 €	35,904,369 €
Net income or capital income	5,657,617 €	6,153,259.96 €	6,166,772.10 €	5,698,153.54 €	5,711,665.68 €	29,387,468 €
Capital return (%)	145.01%	172.67%	191.17%	197.30%	223.97%	-
Cost of CBD oil production (€/kg)	7,734.31	7,606.75	7,479.20	7,351.65	7,224.09	

The net present value (with a discount rate of 10%) for the investment of the greenhouse for medical cannabis production is positive and equal to 17,376,528.75 €. The resulting IRR is 114% (much higher than the discount rate), which means that the investment is worth the risk and becomes advantageous according to the IRR and NPV criteria. The increased prices of both IRR and NPV are mainly due to the much lower oil production cost, compared to the sale price and the investment subsidy that the business will receive.

The average sales were estimated based on the yields recorded in the greenhouses of the Agricultural University of Athens. In any case, these yields can be increased if a more suitable variety of cannabis is used, with higher CBD content. State-of-the-art equipment, the year-round controlled production, the increased demand for CBD oil and of course the high selling prices of the product, are some of the factors that ensure the viability and profitability of the business. In addition, it is worth mentioning that the low competition in the production of Greek CBD oil and the possibility of reducing the selling price due to the margin that exists in the selling price with the production cost of oil are encouraging. For these reasons, this company is expected to become competitive even abroad and to occupy a large market share in the production of CBD oil in Greece.

CONCLUSIONS

The results of the present study indicate that GH2, the one that was constructed with the double covering plastics (EVO 7507 AC and EVO 7526 AC), reported the highest economic efficiency. The installation of a 10.000 m² greenhouse for the production of CBD oil from cannabis could be a very profitable business as the potential profits could exceed the initial installation costs even from the first year of operation. By the 5th year the business could

have received a total net profit of 27,547,001 €. Furthermore, the Net Present Value and Internal Rate of Return suggest that this investment is worth the risk.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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