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MARCANT

Market and Profit Analysis of Illicit Indoor Cannabis Cultivation and Trade

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SUMMARY

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SUMMARY

Over the past decade, police and the judiciary in both Belgium and the Netherlands have struggled to find a reliable estimate of the yield of illicit indoor cannabis cultivation. In the Netherlands, a standard model derived on seized cannabis plants has been used since 2005. Later, in 2011, a new model (YILCAN) was developed in Belgium for yield estimation of Belgian indoor cannabis plantations. The latte model is currently used in Belgium in the prosecution of illicit indoor cannabis cultivation. However, the YILCAN model has strict application conditions. Moreover, in recent years police indicate that the YILCAN model is outdated and that actual indoor cannabis yields are probably higher. For adequate legal prosecution of illicit indoor cannabis cultivation - given the common technical characteristics and intertwined nature of Belgian and Dutch illicit cannabis production - both countries should use the same robust yield model for indoor cannabis cultivation. Furthermore, the judiciary has limited references to reliably estimate prices, revenues and profits at the cultivation, wholesale and retail levels, which prevents adequate seizure of the capital gains obtained in the cannabis value chain.

The MARCANT project is a multi-disciplinary collaboration between Ghent University and KU Leuven that scientifically estimated reliable yields obtained from indoor cannabis cultivation in Belgium and the Netherlands based on the currently prevailing cultivation techniques and varieties. Furthermore, the project mapped prices, revenues and profits at different cannabis supply chain levels and investigated the factors that influence these prices, revenues and profits.

1. We searched both grey and scientific literature sources to establish a **state-of-the-art** on the cultivation factors affecting indoor cannabis yields. We found that the effect of nutrients on cannabis yield depends on the interaction between plant development stage, cannabis variety, assimilation lamp power and the (hydroponic) substrate used. No evidence was found that plant growth regulators such as phytohormones effectively influence cannabis yield. Since 2019, there has been a significant increase in the literature on the use of LED lighting and its influence on cannabis production. Nevertheless, LED lighting is hardly found in Belgian and Dutch indoor cannabis plantations.

   Defoliation and *lollipopping* are techniques based on the assumption that indoor cannabis plants produce more leaves than needed for optimal production. However, their effect on cannabis yields is unclear.

   Police are increasingly reporting the use of CO_2 additives in cannabis plantations, often in combination with water-cooled air conditioners. Several online cannabis cultivation blogs

claim that the application of CO_2 in combination with specific temperature or fertilizer levels can increase cannabis flower bud yields by up to 40 %. It is known that photosynthesis in plants depends on the combination of CO_2 availability in, and temperature and humidity of the atmosphere. We found no scientific references of studies that investigated the influence of CO_2 additions on cannabis yield.

The grey literature and online cannabis forums now increasingly mention the use of so-called 'autoflowering' cannabis varieties in addition to the classic feminized cannabis varieties. These varieties start flowering without reducing the light regime to 12h of light per day, thus have more light available during the cultivation cycle and can therefore reach harvestable flower buds in a shorter period of time compared to classic (feminized) cannabis varieties.

Little is known about the recent trends of cannabis prices in Belgium and the Netherlands. However, some generalizations can be made. Retail prices of any given quantity are higher than wholesale prices. As the cannabis quantity decreases, prices increase disproportionately compared to the related production or transaction costs. The profits of those involved in the supply chain depend on the trade-offs they make in trying to minimize costs (material costs, but also risks) and in maximizing revenues. The choices and opportunities of the individual players in a given the market are also influenced by the broader economic principles of supply and demand and social developments.

2. We conducted a **cannabis cultivation experiment** in which we studied the yield of three cannabis varieties ('White Widow', 'Northern Lights' and 'Himalayan') grown indoors (in containers) in pots filled with potting soil at a density of 16 plants per m² and under HPS assimilation lamps with an electrical power of 600 W. We compared the yield of these plants between two containers, where in one container the atmosphere remained unchanged, while in the other CO_2 concentrations were increased weekly from 400 ppm (normal outdoor air) to 1800 ppm. The experiment thus consisted of a 3 x 2 factorial split plot design in which 6 subplots with 16 plants of 3 varieties were nested in the 2 main plots (containers) with a different atmospheric treatment. We analyzed dry flower bud yield and cannabinoid contents of plants that were produced with the two different treatments.

   The yield per m² in the control treatment was significantly lower (662.57 $\pm$ 72.11 g) than in the CO_2-treated environment (1219 $\pm$ 87.12 g). The lower limits of the one-sided 95% confidence intervals were 517 g and 1044 g for the control and CO_2 treatments, respectively. Both variety and CO_2- treatment significantly affected dry flower bud yield per plant, with

significant interaction between the two factors. In the control environment, the highest average dry flower bud yield was obtained for the variety 'White Widow' (58.33 $\pm$ 3.18 g), while in the CO_2-treated container, the highest yield was found for the variety 'Himalayan' (112.35 $\pm$ 6.56). The yield figures of all varieties were higher in the CO_2-treated containers than in the control container. The highest relative yield increase was observed for the variety 'Northern Lights' (142%).

For all varieties, **THC concentrations** of cannabis plants grown in the CO_2-treated environment (11.60 $\pm$ 2.99 %) were on average **54 % higher** than those of plants of the same varieties grown in the control environment (7.54 $\pm$ 1.95 %). The THC concentrations of the 'Northern Lights' variety were significantly different from those of the 'White Widow' and 'Himalayan' varieties, while the THC concentrations of the latter two varieties were not significantly different from each other.

3. In order to compare the results of the cultivation experiment with cannabis yield obtained in real cannabis plantations and in an attempt to use linear regression to determine a yield model based on parameters measured at seized cannabis plantations, a **screening** of 58 (35 from Belgium, 23 from the Netherlands) seized cannabis plantations was conducted in collaboration with the Belgian and Dutch police. In addition to data collection for 16 parameters (plantation characteristics), samples of 6 non-neighboring cannabis plants were taken in each plantation from which dry bud yield was measured.

   Our linear regression model could not reveal significant contribution of any the 16 independent variables (plantation characteristics) to cannabis yield per plant or per m². The mean yield determined from the seized samples was 1013 g $\pm$ 90 g per m², with a 95% confidence interval of 823 - 1203 g per m². Since the latter interval is within the range of the earlier mentioned yield data of the standard control and CO_2-treated environments of our own cultivation experiment, we conclude that the assumption of a dry cannabis flower bud yield of 517 g and 1044 g per m² for cannabis plants grown in standard and CO_2-treated environments, respectively, are reliable estimates consistent with actual cannabis yields of contemporary cannabis plantations in Belgium and the Netherlands.

   Since the conservative yield estimate of the 'standard' situation (517 g per m²) is lower than the yield currently used in Belgium for plantations with the same growth parameters (i.e. use of HPS lamps with an electrical power of 600 W, with 1 lamp per m² of growth area, a plant density of 16 plants per m² of growth area and an air temperature of at least 28 °C), we

recommend that police and the judiciary in Belgium and the Netherlands continue to use the YILCAN yield estimate of **575 g per m² for a standard cultivation without CO_2 addition** and a yield estimate of **1044 g per m² for a plantation with evidence of CO_2 addition** to the atmosphere in the cultivation area.

4. To gain insight into prices, income and profits, 43 **inmates** convicted of drug-related offences were **interviewed** in four Flemish prisons. The respondent group consisted of 40 men and three women (aged 21-65 years), whose roles and experience in the cannabis supply chain varied from cannabis growing to retail and wholesale trafficking. When trying to persuade them to participate in the interview, as well as during the interviews, we paid extensive attention to gaining the inmates' trust. Depending on the respondents' willingness to share information and knowledge, information on different topics collected, ranging from the exploitation of large-scale plantations to small-scale dealing. Respondents were only allowed to report on the illicit cannabis chain level he or she was familiar with.

   Results show that a fixed average yield per plantation size as well as an average number of annual cultivation cycles and harvests cannot be determined. The set-up and choice of modus operandi and thus the growers' yield depend on a variety of choices and circumstances. Some individuals try to achieve higher yields not only with what they believe to be the best techniques tailored to their capabilities, but also through knowledge, experience and dedication. Setbacks during cultivation, early discovery of the plantation or harvest theft can reduce the yield.

   For different quantities of a given cannabis quality, we determined a price range, consisting of a minimum and maximum price, as well as an average price. E.g., **a kilogram** of a standard quality is currently sold for an **average price of 4.6 euros per g**. However, the price in a transaction of this kg of cannabis can fluctuate between a minimum of **4.3 euros** and a maximum of **4.9 euros per g**, with a confidence of 9 5%. Price ranges are higher for smaller amounts (i.e. some grams), and lower for larger amounts (i.e. several kilos). Minimum and maximum prices are predominantly determined by supply and demand. Assuming equal cannabis demand, the intended or unintended movements of the competitors (e.g. leaving the market, keeping stocks behind, taking a break between growth cycles, prices in coffee shops, etc.) will determine cannabis volumes supplied to the market, and therefore also cannabis prices. Within the thus obtained price range, the competitors will closely monitor the minimum price. Dealers who sell below that minimum price are being reprimanded, or even punished more severely.

As a rule, people try to produce or purchase cannabis as cheap as possible and sell it as expensive as they can. In deciding his (or her) own sales price, each trader takes the following elements into account: (1) the financial costs incurred to buy/produce the drug, (2) a financial compensation for the risks taken, including potential future material and immaterial costs, and (3) a number of personal characteristics that enable a certain price setting, such as one's own reputation, customer knowledge, experience and financial means.

The traders' profit margins depend heavily on the opportunities they see or have and the risks they are willing to take. Risks that a trader is not willing to take can be passed on to another actor - although this usually also implies reduction of the profit margin. Cannabis traders do not aim at full profit maximization. Most rather opt for profit optimization with a profit margin that is in proportion to their own possibilities and comfort zone. As a result, profit margins vary, depending on the individuals involved.

According to the interviewed convicts, the key to determining profit margins lies in mapping out the volume and quality of transactions, in order to assess the actual production costs and the purchase and sale prices for a range of transactions. In their view, this assessment must also duly consider the actual situation of the suspects as well as their possibilities and the modus operandi they have adopted. According to our interviewees, cannabis growers and trafficking suspects will only be willing to share the related pieces of information, if all these aspects are taken into account. This is because only a correct assessment of their revenues and profits can lead to sentence that they can perceive as fair.