

Summary

The export of cannabis cultivated in The Netherlands An estimate of the size and a discussion of the possibilities and limitations of the research

The purpose of the current study is to assess the possibilities and limitations of estimating the export of Dutch cannabis and – if possible – to come to a new estimate of the amount exported. The Minister of Security and Justice requested the current study to validate the previous attempt to estimate the export, which was performed by the National Police Corps in 2012 for the ‘Criminaliteitsbeeld analyse Georganiseerde Hennepteelt’ (Crime status assessment Organised Cannabis Cultivation). That particular estimate indicated that the Netherlands exported between 90 and 1.163 tons annually, or 48% to 97% of the estimated production, with 85% as the most likely estimate (Jansen, 2012).

Estimating the amount of cannabis exported annually is not a delicate process. The information required regarding the size of the cannabis cultivation industry and the consumption of Dutch cannabis is limited and uncertain due to the nature of illegal markets. The estimate is therefore in part based on assumptions and extrapolations. On the other hand, there are registrations available to base the estimate on, and sources have improved since 2012. This investigation can be considered a next step toward a ‘best’ estimate of the export of Dutch cannabis where future iterations – with new data and further improvements regarding the registrations and data from other sources – can build upon the current research.

Approach to the research

The export of Dutch cannabis was estimated using multiple mathematical models for the production and consumption of cannabis. The production was estimated using three models: one based on confiscation data and the other two on the amount of stolen electricity related to the cultivation of cannabis. The consumption was estimated using studies on the prevalence of cannabis use in the Netherlands. Unfortunately, it wasn’t possible to use multiple independent models to estimate the production and consumption of cannabis. The production models largely rely on the same sources as the variables used to estimate the ‘capture rate’ occurred in every mathematical model to estimate the production. Only one method was used to estimate the consumption of Dutch cannabis because it wasn’t possible to attain sufficiently reliable information on the sale of cannabis through the Dutch coffeeshops. It therefore was not possible to compare the findings to other – independent – approaches.

The export was calculated by subtracting the national consumption estimate from the national production estimate.

The mathematical models are based on those used for previous estimates. The study by Jansen (2012) formed the basis and the registrations, assumptions and mathematical models used were updated and expanded upon.

The variables used to estimate the export (45 in all) were based on an extensive literature study, for which both national and international studies on the procurement, consumption and cultivation of cannabis were studied. Secondary

analyses were also performed, on data from previous studies on cannabis use(rs). Both the mathematical models and the collected data were discussed and validated in an expert group which – where needed – adjusted the values or added an (additional) margin of error to account for uncertainties. The members of this expert group were brought together based on their extensive research experience- and insights pertaining to the field of cannabis cultivation and consumption.

Research methods

The analyses involved comparing the outcomes of the various models. This resulted in an estimate of the export of Dutch cannabis, in absolute tons and as a percentage of the production. No point-estimate of the export was given; the available data is too unreliable and the estimate is too sensitive to variations in a number of variables. Instead, the export of Dutch cannabis is expressed as a lower and an upper bound limit where the export is estimated to lie within this range.

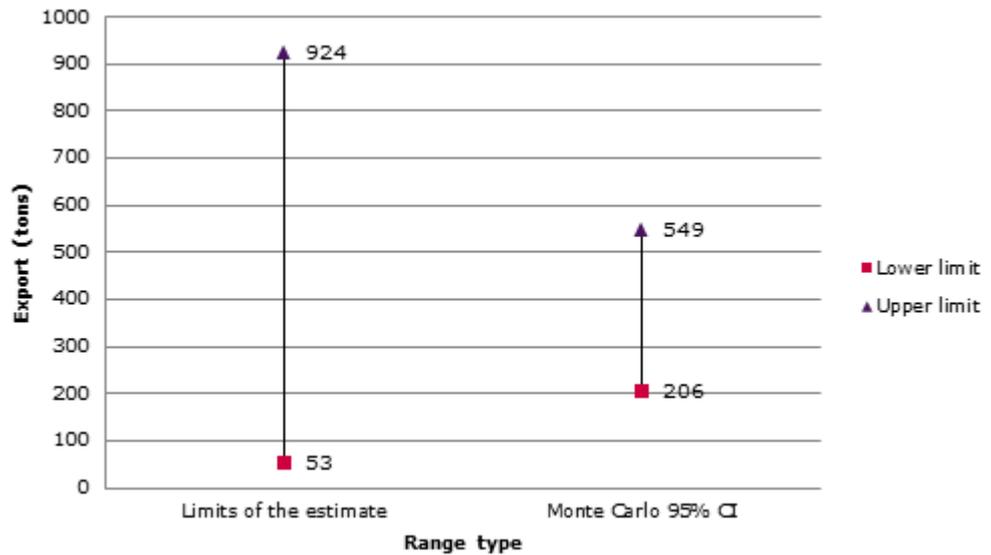
A Monte Carlo-simulation was performed to estimate a 95% confidence interval in addition to the lower and upper limits of the mathematical models. This method relies on additional assumptions regarding the within-variable distribution of values. Most variables were assumed to have a uniform distribution. Only a few variables were assumed to be normally distributed. The Monte Carlo-simulation produced a most likely range for the estimated export of Dutch cannabis, taking into account the assumptions and uncertainties.

Finally, a sensitivity analysis was performed to identify the most influential variables. The sensitivity analysis was also used to determine how much of the variation found can be attributed to these variables.

The export estimates

The consumption of Dutch cannabis by non-residents of the Netherlands can be defined as 'domestic consumption' or as 'export'. Both scenarios were calculated. When the consumption of Dutch cannabis by non-residents is defined as domestic consumption, the export in tons amounts to between 53 tons and 924 tons (see figure S1).

Figure S1 Export of Dutch cannabis when the consumption by non-residents is defined as 'domestic consumption', in tons (2012-2013)

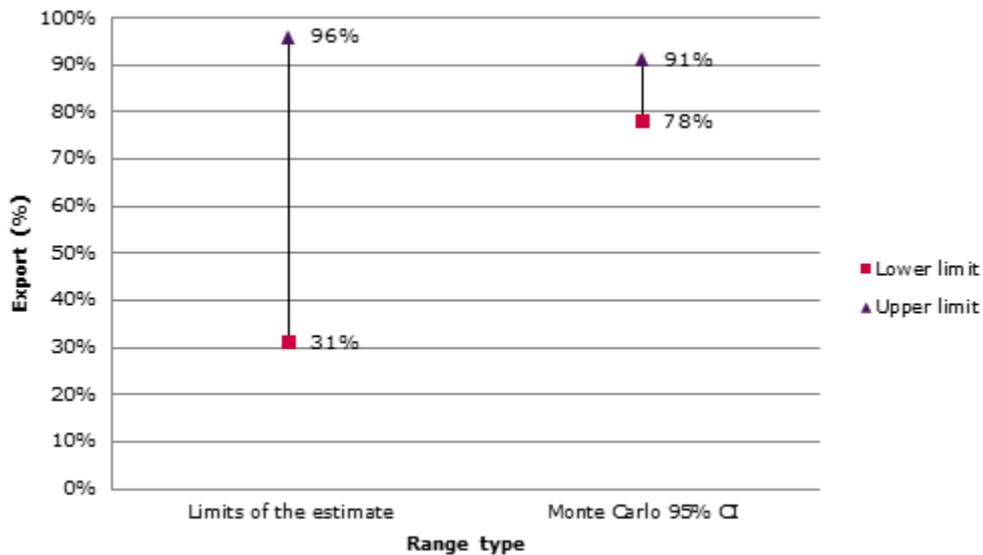


This estimate of the export of Dutch cannabis – expressed in tons – has a very wide range. The highest estimate of about 924 tons is over 15x as high as the lowest of 53 tons. The lower limit is the result of every variable set at the lowest possible value, the upper limit as every variable set at the highest possible value.⁹⁶ However, the likelihood of every variable occurring as the lowest or highest possible value is very low. The Monte Carlo-simulation also resulted in a wide range: from an estimated 206 tons to 549 tons. The upper limit of this range is over twice the lower limit. This wide range is entirely the result of the limited reliability of the available registrations and assumptions. It is not possible to come to a more precise estimate using the data currently available.

Figure S2 illustrates which *percentage* of the Dutch cannabis is exported if the consumption by non-residents is defined as domestic consumption.

⁹⁶ 'Lowest' and 'highest' refer to the values that would result in the highest- and lowest possible export estimates, which is not necessarily the lowest or highest value for that particular variable.

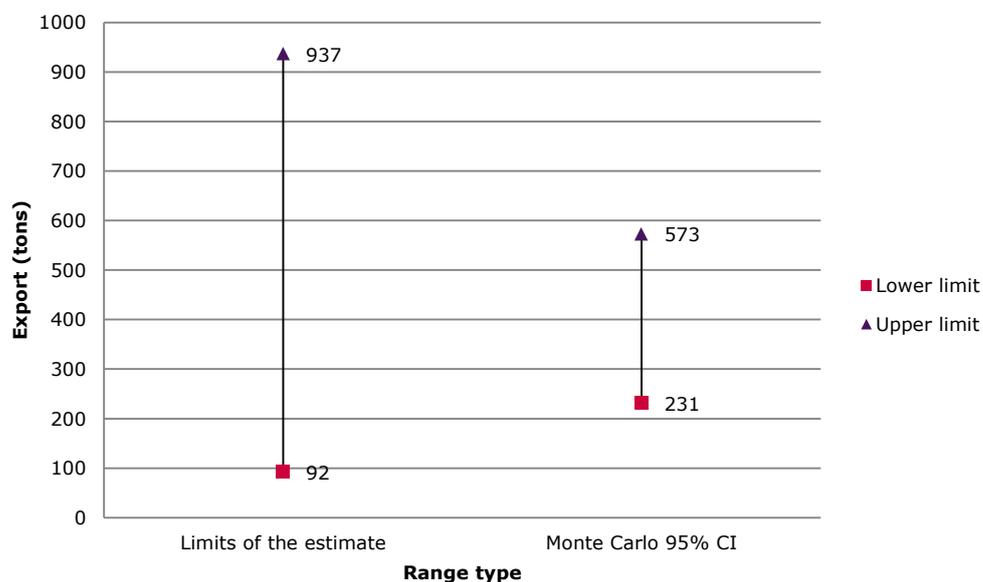
Figure S2 Export of Dutch cannabis when consumption by non-residents is defined as 'domestic consumption', as a percentage of production (2012-2013)



According to this estimate the Netherlands exports between 31% and 96% of the cannabis produced. The range of this estimate – 65% – illustrates the great uncertainty inherent in the estimate. However, the likelihood of every variable occurring at the lower or upper limit is very limited. A Monte Carlo-simulation was used to estimate a 95% confidence interval. The export of Dutch cannabis would then amount to 78% to 91% of the production. Only 5% of the 100.000 iterations of the Monte Carlo-simulation ended up lower or higher than this interval.

Figure S3 illustrates the estimate of the export – in tons of cannabis – when the consumption of non-residents is defined as 'export'.

Figure S3 Export of Dutch cannabis when consumption by non-residents is defined as export, in tons (2012-2013)

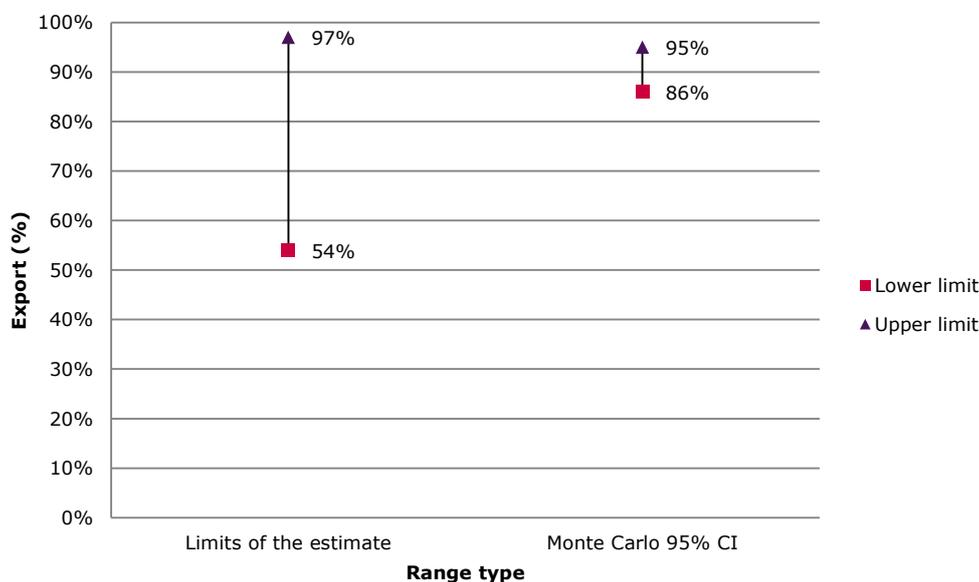


This estimate of the export of Dutch cannabis – expressed in tons – also has a very wide range. The highest estimate of about 937 tons is over 10x as high as the lowest of 92 tons. The lower limit is the result of every variable set at the lowest possible value, the upper limit as every variable set at the highest possible value.⁹⁷ However, the likelihood of every variable occurring as the lowest or highest possible value is very low. The Monte Carlo-simulation also resulted in a wide range: from an estimated 231 tons to 573 tons. The upper limit of this range is over twice the lower limit. This wide range is entirely the result of the limited reliability of the available registrations and assumptions. It is not possible to come to a more precise estimate using the data currently available.

Figure S4 illustrates what *percentage* of Dutch cannabis is exported when consumption by non-residents is defined as 'export'.

⁹⁷ 'Lowest' and 'highest' refer to the values that would result in the highest- and lowest possible export estimates, which is not necessarily the lowest or highest value for that particular variable.

Figure S4 Export of Dutch cannabis when consumption by non-residents is defined as export, as percentage of production (2012-2013)



According to this estimate the Netherlands exports between 54% and 97% of the cannabis produced. The range of this estimate – 43% – illustrates the great uncertainty inherent in the estimate. However, the likelihood of every variable occurring at the lower or upper limit in reality is very limited. A Monte Carlo-simulation was used to estimate a 95% confidence interval. The export of Dutch cannabis would then amount to 86% to 95% of the production. Only 5% of the 100.000 iterations of the Monte Carlo-simulation ended up lower or higher than this interval.

The current findings in an international context

The current estimate was placed in a European context to roughly assess its likelihood. This comparison used research on the consumption of cannabis in Europe. When the number of annual users is multiplied with the amount of cannabis consumed annually that was used for the Dutch in the current estimate (69,12 grams to 92,9 grams) the cannabis consumption in Western and Central Europe is about 1500 to 2100 tons per year. Because the Netherlands exports about 206 tons to 573 tons annually (assuming the 95% CI) that would mean the cannabis cultivated in the Netherlands (mostly 'nederwiet') could supply about 10% to 38% of the cannabis consumed in Western and Central Europe. If we use the same method to estimate the consumption for all of Europe, the Dutch cannabis cultivation could meet roughly 8% to 28% of the European demand.

Previous estimated of the European cannabis consumption vary between 1000 tons and 7000 tons (EMCDDA, 2012).⁹⁸ When this very wide range is used the cannabis cultivated in the Netherlands (mostly 'nederwiet') could supply roughly 3% to 57% of the demand in Europe.

The upper limit of 57% seems unlikely considering the national production of cannabis is increasing in most European countries, allowing these countries to increasingly

⁹⁸ The lowest estimate was calculated by Kilmer & Pacula (2009), the highest estimate by the UNODC (2005).

meet domestic demand (EMCDDA, 2012b). On the other hand, most Western European countries note that cannabis is still imported from the Netherlands (Carpentier, Laniel & Griffiths, 2012) and in 2006 22% of the European countries stated that the Netherlands was still their largest supplier for marijuana (UNODC, 2008). Though it is not clear how much the Netherlands does in fact export, these findings do seem to support the range found in this study. This is however a very rough indication and further research is required.

Which variables have the greatest effect on the outcome?

A sensitivity analysis was conducted to determine how much the export varies when variables are increased or decreased by 1%(point). This revealed that the export percentage is very sensitive to the following variables: the percentage of total electricity lost that is administrative, the percentage of this electricity loss related to energy fraud and the prevalence of recent cannabis use for the general population 15-64 years of age.

The extent to which variation can be attributed to specific variables was also determined. The majority of the variables do not greatly affect the outcome of the export estimate. This study revealed that ten variables are responsible for roughly 86% to 93% of the variation found. The average yield per plant and the percentage of electricity loss related to energy fraud are the most influential: these two variables are responsible for roughly 50% of the total variation in the current export estimate. Though the yield per plant is a well-researched subject, the findings required the use of a very wide range for this particular variable. This is due to the multitude of potential cannabis cultivation circumstances and methods (the type of lamps used, cannabis variety, etc.) and fact that the majority of the available research was performed abroad and therefore not necessarily applicable to the Dutch situation. The data on electricity losses and energy fraud were incomplete and in part based on assumptions and estimates by the regional energy networks. Moreover, there is a *dark figure* regarding the energy fraud and energy fraud related to the cultivation of cannabis. It is because of these uncertainties that very wide margins were used for these variables. The 'capture rate' of Dutch cannabis was estimated using a combination of other variables, just as was the case in previous research. Most of the variables used for the 'capture rate' were among the ten most influential variables discussed previously. The 'capture rate' is therefore very influential.

Possibilities and limitations of the research

Other than the uncertainties at the variable level, the estimate was also hampered by limitations at the (mathematical) model level: it wasn't possible to triangulate an outcome using independent models. The three production models are not independent because a number of variables – in particular the ones used to approximate the 'capture rate' – occurred in every model. Moreover the consumption estimate could be based on only one model because the originally planned estimates based on the sale- and income data of coffeeshops proved unattainable for the current study. On the other hand, some variables are now more reliable than they were a few years ago. This applies to the number of harvests confiscated and the amount of confiscated cannabis and cannabis plants. These registrations have been improved since 2012. There is also more information available regarding the cultivation of cannabis and a number of variables were updated, such as those pertaining to the number of coffeeshops in the Netherlands, drug tourism and net losses. The added

value of the current research lies in the improved assessment of the validity of the variables and the systematic approach which included a sensitivity analysis. Lastly, the added value in relation to the previous attempts to estimate the export of Dutch cannabis also lies in the fact that the reliability of all the variables and their potential for improvement were evaluated.

Recommendations

Further research should focus on updating the registrations and improving the reliability of the available data. There is also much to gain by improving the independence of the mathematical models. Such improvements should focus on the approximation of the 'capture rate' of Dutch cannabis. It may be possible to apply a capture-recapture methodology to determine the prevalence of cultivation. This method was used previously by Bouchard to estimate the size of the cannabis cultivation industry in Québec (Bouchard, 2007, 2008). A repetition of such an analysis in the Netherlands could be considered.

A large number of variables is rather unreliable and potentially outdated, necessitating a very wide error margin for these variables. A few of these variables could be the subject of future research. This applies in particular to the yield per plant, the percentage of total electricity lost that is administrative, the percentage of this electricity loss related to energy fraud, percentage of energy fraud related to the cultivation of cannabis and the specific cannabis cultivation situation in the Netherlands. Further research regarding the consumption estimate – particularly regarding the cannabis related sale- and income data of coffeeshops – is warranted.

To properly compare the current findings with the European consumption of cannabis further research is required. To get a better idea of where and to what extent the Dutch cannabis is exported, the estimate of the export of Dutch cannabis would have to be compared to the presence of Dutch cannabis in the EU.

In conclusion

Lastly, it should be stated – again – that estimating the amount of Dutch cannabis that is exported is, and will for the foreseeable future remain, a *best* guess due to the complexity and hidden character of the cannabis market. This research can be considered a next step toward a 'best' estimate of the export of Dutch cannabis where future iterations – with new data and further improvements regarding the registrations and data from other sources – can build upon the current research.