



Research Paper

Agricultural innovations in Morocco's cannabis industry

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ABSTRACT

Background: Cannabis cultivation in Morocco's mountainous Rif region is undergoing its most profound development since mass production of hashish began in the early 1980s. The adoption of high-yielding varieties of cannabis, modern agricultural practices, and modern hashish production techniques began in the mid-2000s and accelerated after the mid-2010s, with the result that more potent and varied cannabis derivatives are now being produced and that increased quantities of highly potent hashish are seized in Europe.

Methods: This research was initiated to answer a simple research question: how, and to what extent, is the illegal cannabis industry modernizing in Morocco, now that we know that it explains the THC increase in hashish seized in Europe? To answer this question in the context of a lack of literature and quantitative data, empirical fieldwork was undertaken in cannabis fields and hashish-producing farms in Morocco in July and October 2017. A mostly qualitative approach to data collection was employed through participatory rural appraisals (discussions, interviews, direct observations). As such, this work builds predominantly upon primary research.

Results: Fieldwork showed that, subsequent to very localized, experimental beginnings in the early 2000s, the progressive and varied adoption of agricultural innovations at the cultivation and production stages has spread throughout the Rif during the 2010s. Interviews and direct observations conducted in the field indicate that the ongoing adoption of modern farming techniques has enabled the production of high-quality hashish and potent modern extracts. The still ongoing modernization and professionalization of the Moroccan cannabis industry is a testimony of the country's leading position in global hashish production.

Conclusion: What the future holds for Moroccan cannabis growers is difficult to predict. How legalization processes manifest themselves in Moroccan and European policies, and how upcoming developments will affect the social, economic, political and ecological stability of the region, remains largely unknown. However, the spread of cannabis cultivation in the Rif is clearly pushing economic and environmental limits, and there is an obvious need for innovations that mitigate such pressures.

Introduction

Cannabis cultivation in the northern Rif region of Morocco is currently undergoing its most significant evolution since the hashish industry emerged in the 1960s and dramatically developed in the 1980s (Chouvy & Afsahi, 2014; Clarke, 1998). By the 1990s, the country had reportedly overtaken Afghanistan as the world's largest hashish producer (UNODC, 2003). Now, as shown by what was documented during our recent fieldwork there, Morocco's cannabis industry is transforming once more, following the introduction of feminized¹ seed varieties in the late 1990s, the subsequent development of greatly-improved cultivation methods, and the production of high-potency modern extracts in

the 2010s. This article is the result of a research that was initiated to answer a simple question: how, and to what extent, is the illegal cannabis industry modernizing in Morocco, now that we know (Chouvy & Afsahi, 2014) that it explains the THC² increase in hashish seized in Europe? As a result, this article is the first to describe and explain in details how cannabis cultivation and hashish extraction techniques are being modernized in Morocco, something that is still largely ignored by officials, academics, and journalists.

Morocco's traditional *kif* landrace was reportedly supplanted in the early 1980s by low-water-use varieties from the Near East and is probably long gone (Bellakhdar, 2008: 230). These varieties would become the new Moroccan cultivar and are still called *kif* even though

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E-mail addresses: pachouvy@geopium.org (P.-A. Chouvy), admin@seshatasensi.com (J. Macfarlane).¹ Regular cannabis seeds produce approximately 50% male and 50% female plants. In order to maximize female plants (they produce much more psychoactive substances than male plants) cannabis seeds that generated 95%+ female plants were created in the late 1990s.² Delta-9 THC, the cannabinoid responsible for most of the psychoactive effects of cannabis.

they are grown almost exclusively to produce hashish (compressed cannabis resin³). However, this newer cultivar is now being gradually replaced by modern high yielding varieties (HYVs) with significantly higher resin yields and potency (Chouvy & Afsahi, 2014). This phenomenon began to emerge in the late 1990s and early 2000s, and has rapidly developed since. Significantly, the increased yield produced by the new varieties suggests that an alleged two-third decline in cannabis cultivation (between 2003 and 2013: UNODC, 2015: 5; UNODC, 2015: 57) may have been compensated for by increased yields (Chouvy & Afsahi, 2014).

As shown by this article, based on primary qualitative research conducted in the Rif in July and October 2017, the modernization and diversification of the Moroccan cannabis industry has accelerated in the last few years (since last fieldwork in 2013), with traditional cannabis agriculture being increasingly replaced by modern methods. Fieldwork indicates that the adoption of agricultural innovations varies in scope and pace according to geographic location, as two small areas (Oued Laou and Ketama) appear more prone to adopting HYVs only, while a larger area (around Bab Berred) clearly displays aggregate adoption of the entire modern agricultural package (HYVs, seedlings on nursery beds, specific land preparation, row planting, drip irrigation, mulching, improved harvesting technique).

Fieldwork also showed that the adoption of modern techniques is not limited to cannabis cultivation but that it extends to hashish production. While traditional production of sieved hashish remains prevalent in the Rif, modern production techniques are developing, giving rise to very high-quality sieved hashish and various modern “cannabis extracts” of higher purity, quality and potency. Yet, these modern production techniques have not yet been widely adopted in the Rif and are still far from reaching the aggregate level, as various components of the technological package can be and are adopted independently.

Localized experimental beginnings in the early 2000s, followed by a more rapid adoption of agricultural innovations around Bab Berred commencing in the early 2010s, show that the modernization and professionalization of the cannabis industry is well developed in Morocco, which confirms its world leading position in hashish production (Chouvy & Afsahi, 2014). The future of Moroccan cannabis growers is difficult to foresee at this stage, but repression and legalization processes will certainly influence both Moroccan and European policies, and coming developments will affect the social, economic, political and ecological stability of an already fragile Rif region.

About the methodology

This research was initiated to verify a hypothesis proposed to answer a specific research question: that the modernization of the cannabis industry could explain the puzzling increase in yield, quality, and potency of Moroccan hashish seized in Europe during the last decade (Chouvy & Afsahi, 2014; Dujourdy & Besacier, 2017). The research process began in 2012 to better understand what had taken place in Morocco since the last cannabis survey by the United Nations (UNODC, 2005), but also to explain why later official Moroccan hashish production figures were thought to be underestimated (Chouvy & Afsahi, 2014). Considering the lack of statistical data and academic literature on the recent Moroccan cannabis industry, most of the facts presented hereinafter are issued from fieldwork conducted by the authors in July and October 2017, enriched by previous fieldwork (since 2004 by Afsahi and Chouvy). The lack of data and literature is partly due to the fact that cannabis cultivation is illegal in Morocco and is difficult to document. Illegality also implies, and as is the case with opium in

Afghanistan, that hashish production is not “a subject (or a location) that lends itself to quantitative methods or visible research teams” (Pain, 2010: 203).

Fieldwork was therefore mostly qualitative in nature. It resorted to the composite approach methodology detailed by Barakat, Chard, Jacoby, and Lume (2002) on the basis of participatory rural appraisals (Chambers, 1994) conducted through direct observations and interviews in specific farms and by way of visual reconnaissance throughout most of the Rif (in July and October 2017). General but precise observations were made from the roads as cannabis fields cover entire valleys and hillsides of the Central Rif. Specific observations were made possible by visiting four cannabis farms where about ten cannabis growers and hashish producers were interviewed. As this research is concerned with the initial stage of an emerging phenomenon, a broad panel of respondents was not available and farms and farmers were selected according to their early adoption of modern techniques through contacts first initiated from Europe through intermediaries in the underground cannabis industry and by way of social media. All the respondents had a long experience of cannabis cultivation and hashish production. Other minor respondents supplied clarifying or confirmatory details. The rural appraisals involved informal discussions (including indirect questions), partially-structured interviews, and direct observations (both simple and participant observations, including during hashish and rosin production) with Moroccan and European cannabis growers and producers in both July and October 2017.

As such, this work builds upon primary research rather than upon secondary research and stays away from the rather speculative generalisations and broad theories that too often characterise studies of illegal agricultural drug production. This empirical research was of the inductive type and was meant to try “to account for particular phenomena or groups of phenomena”, not to see “under what conditions, if any, such accounts might apply more generally”, including in broad theoretical frameworks (Shapiro, 2005: 188–189). It is indeed difficult at this stage to compare Morocco with other major hashish producers, and generalization or theoretical developments would be clearly premature. As a consequence, this research is not theory-driven and is “not determined to arrive at any particular theoretical destination” (Shapiro, 2005: 188–189).

Specific research questions were organized according to categories and subcategories that included new cultivation trends, contexts and introduction dates of HYVs, origins and costs of HYV seeds, cultivation techniques of HYVs, the reasons behind choosing HYVs and various modern hashish and modern extracts production techniques. Research questions were later used as an analytical framework to determine what data was most significant. The data was then analyzed according to the above-mentioned categories and individual cases as the same questions were asked from different actors. The patterns of modernization revealed by observations and oral testimonies were eventually found to answer the research questions with great consistency (few if any atypical observations and responses in what is clearly a growing regional trend). The general, Rif-wide observation of cannabis cultivation was conducted during the growing season in July 2017 as part of a planned driving itinerary comparable to the one followed during previous fieldwork (summers of 2004, 2013, 2015), allowing visual observations and comparisons (especially: spread of HYVs, irrigation, row planting, and geographic extent of cultivation). Limited quantitative data (related to yields, densities, water use, costs, etc.) was gathered but it was nevertheless of great value, completely new, and conferred a mix-methods status to this research. Despite limits inherent to the topic and the area, this research allowed the collection and analysis of new and valuable data and provided convincing answers to our initial questions. As in previous works, precise village names are not divulged in this article, and human respondents are anonymized for their protection.

³ Resin is the sticky coating that is most abundant on the female cannabis flowers and is produced in and exuded from the trichomes. Resin must be distinguished from resin powder that consists of the glandular trichomes removed from the plant by sieving and that is pressed to make sieved hashish, also called hashish resin (Clarke, 1998: 372–373, 370).

Progressive and uneven adoption of modern cannabis cultivation techniques

Interviews of European and Moroccan growers indicated that, after the introduction of HYVs in the country in the late 1990s, most Moroccan cannabis growers have proven slow and/or reluctant to adopt the aggregate package of HYVs and modern cultivation and production techniques. This is confirmed by observations conducted in 2004, 2013 and 2017. They showed that it took a few years after the initial European investments of seeds and money in the region for the first Moroccan cannabis growers to abandon the broadcast method of sowing HYV seeds and adopt modern farming techniques now widely observable in some areas. The modern techniques that we could observe directly include: raising seedlings on nursery beds (often under polytunnels/greenhouses), single row planting (drill and especially transplanting methods, but cloning by cuttings may also occur), drip irrigation and mulching with hay, proper crop maturation, individual harvesting of plants (instead of the widespread method of bulk harvesting), drying plants indoors in dust-free environments, and modern production techniques of high-quality and highly potent cannabis derivatives (carefully sieved hashish, expressed resin such as rosin, and solvent-based extracts such as butane hash oil or BHO⁴) (observations: Rif, July and October 2017).

The comparison of cannabis cultivation patterns between 2013 and 2017 clearly shows that the adoption of all or part of the modern technological package is spreading rapidly, due notably to the obvious success of the growers who first adopted modern farming techniques and to communication on social media (Facebook and Instagram especially). Although the adoption of modern cultivation and production techniques was applied rather late in Morocco's cannabis industry, it should be stressed that Moroccan cannabis growers are clearly the first in the Global South to have undertaken modernization at such a scale (nothing of the like in Afghanistan, Lebanon or India, according to our knowledge). This most likely results from the large size of hashish production in the Rif, the region's geographic proximity to the European market, and the longstanding business relations that some people in the Rif have developed with traffickers, dealers and consumers in Europe.

For example, according to the interviews of a knowledgeable European producer of cannabis derivatives in the Bab Berred area, the first feminized cannabis seeds (an Afghan strain from the Dutch Passion seed company) were introduced in 1998 in Morocco by way of a major *beznassa* (middleman or trafficker, often in a high-ranking social and economic position) in a village west of Bab Berred. As the first feminized seeds were reportedly unreliable (being prone to hermaphroditism, among other issues) it took almost a decade for HYVs to really spread and be commercially cultivated in the Rif (interviews: Rif, October 2017). The Bab Berred area, in Chefchaouen Province, has since remained at the forefront of cultural innovations, with rare experimental plots observed in 2013 and now the largest irrigated row-planted cannabis area in the region (direct observations in 2013 and 2017).

Interviews with different European and Moroccan growers indicated that feminized HYVs from Spain began to be introduced to the Rif on a massive scale in the early 2010s (interviews in 2013 in Spain, and in Morocco in 2017; see also: Chouvy & Afsahi, 2017). Comparison of direct observations made in 2013 and in 2017 showed that the entire Bab Berred watershed has adopted row-planting techniques of HYVs in just four years. This is unlike in the Ketama area (Al Hoceima Province) or the Oued Laou Valley (Tetouan Province) where HYVs have been largely adopted but where broadcasting is still largely dominant. The fact that the early and large-scale adoption of agricultural innovations

first took place in the Bab Berred area can be explained by various factors. The area is one of the two historical cannabis zones (along with Ketama) that have long been visited by European buyers, including Dutch traders, and later on, suppliers to Spanish cannabis social clubs (which emerged in 2001 and developed fast between 2007 and 2011) (Marks, 2015: 4). Cannabis seed companies established in Spain in the early 2000s also played a significant role in the Rif, as many Spanish cannabis social clubs buy Moroccan hashish produced from HYVs imported from Spain. For instance, the Spanish seed company Dinafem was created in 2002, produced its first feminized seeds in 2003 and commercialized its first feminized varieties in 2005. The fact that most of the Rif was previously part of a Spanish Protectorate (1912–1956), and that Spanish is still spoken by many in the Rif, makes contact with Spanish seed banks and cannabis social clubs easier: in fact, Moroccan buyers were interviewed in Spain in 2013 while buying HYV seeds (Chouvy & Afsahi, 2014).

Also, the Bab Berred area has long been part of the largest cannabis cultivation area in the Rif, due, notably, to relatively better soils than Ketama, large south-facing slopes, and one large drainage basin and accessible aquifers making water access (off-stream storage and wells) and irrigation easier than in other areas. The area—being more densely populated and richer than Ketama—is also home to some of the Rif's most powerful *beznassas*. As a consequence, the area has always been at the forefront of cannabis cultivation and hashish production: Bab Berred is part of the Chefchaouen province, which accounted for 67,000 of the 134,000 ha of cannabis reportedly grown throughout the Rif in 2003, that is, 39% of the province's arable land; in the Al Hoceima province, where Ketama is located, 27% of arable land was used for cultivation of cannabis (UNODC, 2003: 16).

According to our observations, the Bab Berred landscape has changed drastically in a few years and in 2017 the Bab Berred area had come to distinguish itself from the rest of the Rif, with its entire watershed covered with continuous fields of HYVs planted in single rows and watered by drip irrigation. Large and unburied water-storage ponds with raised dirt walls lined with impermeable polyethylene now dot the landscape and distribute water by gravity pressure (compared observations: Rif, 2013 and 2017). Things have obviously changed very much since 2003 when less than 5% of the Rif's arable land was irrigated (UNODC, 2003: 24). In 2003 and 2004, when we first gained access to the field, irrigation in the Chefchaouen Province was clearly much less developed and efficient than it is now. Then, cannabis growers had access to an average of 1.4 ha of rainfed land and 0.2 ha of irrigated land (observations in 2004 and 2017; UNODC, 2003: 25). While it is difficult to say how much of the arable land is now irrigated, it can be safely be assumed—upon direct observation of the ubiquitous row-planted fields of irrigated HYVs and the many large water reservoirs that dot the Bab Berred landscape—that much of the rainfed land has been converted into irrigated land (direct observations: Rif, July 2017). Developing systems to irrigate water-demanding HYVs was a high priority in the entire Rif region in 2013 and it still is (especially outside of the Bab Berred area) as annual precipitation has gradually decreased since the 1980s (Gauché, 2006).

The drip irrigation that has become widespread in the Bab Berred area enables the most productive farms there to distribute between 75 centilitres to one litre of water a day per plant, as is the case in an exemplary farm that we visited in October 2017. Growers on this farm showed us how cannabis seedlings (or cuttings) were planted in holes dug every meter (constrained by the type of emitter tubing available) in rows also spaced by one meter, which implied a density of 10,000 plants per hectare (one square metre per plant). This compares to the potentially higher density of the 10,000–40,000 or more plants per hectare usually observed with the broadcast sowing method (van der Werf, 1997). But proper irrigation alone is not enough to insure a healthy and productive crop and, according to interviews with various European and Moroccan growers, multi-nutrient fertilizers must be systematically applied to compensate for the Rif's nutrient-poor soils

⁴ BHO is a solvent-extracted, cannabis resin concentrate made with liquid butane forced through an open or closed loop system. Rosin is a solvent-less extract made by combining heat and pressure through the use of a heating hydraulic press (rosin press).

that have been exhausted by decades of poor agricultural practices (including mono-cropping, abandon of rotation crops and fallow systems, and long and heavy use of synthetic fertilizers: up to an estimated total of 600 tonnes for cannabis alone in 2003, or approximately 440 kg per hectare on average) (Fay, 1979; Gauché, 2006; UNODC, 2003: 26). Yet, as the best crops that will give the best end product are grown by the best agriculturalists who adopt the best agricultural practices, one European grower declared during an interview using only organic fertilizers with, for example, 10 kg of manure per plant.

The most skilled and experienced growers also choose to let their crops reach full maturity (usually by mid-September for *kif*; up to late November for some late maturing HYVs), which is something that is rather unconventional in the region. Traditionally, most Moroccan growers harvest both *kif* and HYVs before full maturity, as they fear losing their crop when temperatures start dropping in September (observations from 2004 to 2017). Also, contrary to the careless bulk harvesting that is practiced in the Rif, the best growers harvest their crops one plant at a time without placing them on bare ground, so as not to break the fragile resin-bearing trichomes and contaminate the plants with dirt and dust (interviews: Rif, July and October 2017). Last but not least, the drying process is also of the utmost importance and the best growers avoid the widespread traditional roof-drying technique as it deteriorates the plant's trichomes and terpenes. Instead, they suspend plants individually indoor in a well-ventilated and dust-free environment, before or after properly trimming the leaves (observations: Rif, October 2017). Trimming is crucial to obtain products of the highest quality as it allows for the removal of as much leaf material as possible before extracting the trichomes (leaves are low in overall cannabinoid and terpene content). Yet it is not traditionally practiced by Moroccan growers, most likely because of its labour intensiveness. In addition to the recent widespread cultivation of highly potent HYVs, the even more recent adoption of such best practices in the Rif further explains the very high potency of some of the Moroccan hashish seized in Europe in recent years (Chouvy & Afsahi, 2014; Dujoury & Besacier, 2017). In fact, the various end products that we were shown at multiple occasions in 2017 (including during the production process) were clearly of very high quality (aspect, consistency, smell, colour, etc.) and attest to the best practices mentioned above.

According to the Moroccan and European growers interviewed during this research, implementing the best cultivation techniques is as important as the adoption of modern and efficient extraction techniques to obtain the highest resin yields and end products of the highest quality. Achieving the highest possible yields is very important to growers when the land at their disposal is limited and when production costs increase (seeds, irrigation, etc.). Of course, yields vary depending on which HYVs are cultivated. None of the growers we have interviewed in 2017 were cultivating the now famed *khardala* HYV that was still widely cultivated in the region in 2013 (Chouvy & Afsahi, 2014). Instead, as was verified visually in the fields, they all cultivated HYVs of more precise pedigree such as the now widespread Critical and Amnesia varieties (reportedly better adapted to the Rif than *khardala*). Yet, the most productive and technologically advanced organic farm (Bab Berred area) that we visited in 2017 cultivated the feminized Clementine Kush strain and produced a maximum yield of 200 g of trimmed dried flowers per plant (including seeds: even if all plants in a particular field are female, pollination will still occur due to the ubiquitous presence of male pollen from other fields). During an October 20017 interview, the European grower and producer who runs this farm with his Moroccan associate (the owner of the land) declared that he cultivated one hectare of row-planted and drip-irrigated cannabis, yielding approximately 2 tonnes of trimmed and seeded dried flowers per hectare (on the basis of about 200 g per plant and 10,000 plants per hectare). By comparison, in the late 1980s, the *kif* plant reportedly yielded a

maximum of 30–60 g of dried flowers (trimmed but seeded⁵) per square meter or, 300–600 kg per hectare (Clarke, 1998: 189), that is, only 30% of what the modern Clementine Kush strain can produce in ideal conditions. Furthermore, 200 g of Clementine Kush will produce a substantially higher quantity of more potent hashish than the equivalent amount of *kif*, due to its higher trichome content and a much higher cannabis potency (2.4% THC for *kif* vs. 21% for the Clementine Kush strain⁶) (UNODC, 2004: 5).

To take advantage of the agricultural innovations that they have helped to introduce to the Rif, European actors such as the ones we have interviewed must find Moroccan associates with whom to enter into business partnerships, and who will grant them access to agricultural land. European and Moroccan growers interviewed in July and in October 2017 described various business agreements depending on various factors, including personal preferences and affinities, but most European growers seem to provide the HYV seeds and some if not all of the modern agricultural equipment (drip irrigation systems, organic fertilizers, modern extraction technologies and tools). European growers explained that they enter into various deals with their Moroccan associates, such as paying for all expenses and sharing the crop or the end products, or their value, or by providing only seeds and receiving a share of the hashish production, depending on who pays for labour, export and bribing costs.

Financial investments can be very high with wholesale HYV seed prices ranging from around €0.20 for large bulk orders of non-feminized varieties to over €1 per seed for feminized varieties (depending on the reputation of both varieties and breeders, and the quantities involved), or €2000–€10,000 per hectare of row-planted fields, or even more for denser but less-efficient broadcast-sown fields (interviews: Rif, October 2017). Irrigation costs are also very high but are difficult to estimate since they include constructing ponds, digging wells, and purchasing drip irrigation systems. However, the cost of irrigation equipment has largely decreased in recent years, down to €500 per hectare, which is likely to make drip irrigation more widespread in the Rif (Benouniche, Errahj, & Kuper, 2016). Last but not least, comparatively high financial investments are also needed at the extraction stage, with professional water extraction systems (Ice-O-Lator, Bubbleator), dry sieving tools (quality sieves of various sizes), heated hydraulic presses for rosin production, or closed-loop solvent extraction systems for butane hash oil further increasing the costs.

Slow and limited adoption of diverse modern hashish production techniques

Morocco produced limited amounts of high-quality sieved hashish between the mid-1960s and the mid to late 1980s, when mass production of a lower-quality hashish commenced. Then Moroccan hashish production became an industry that clearly favoured quantity over quality (Clarke, 1998: 184). As a result, Moroccan hashish increasingly suffered from a very bad reputation. According to the Cannabis Resin Impurities Survey Project (CRISP), a British research project combining social anthropology and chemical analysis, samples of Moroccan cannabis resin seized in the United Kingdom between 1999 and 2001 often showed very high levels of impurities, sometimes up to 80% of the final product (unpublished CRISP data and personal communication by Neil Armstrong in July 2015: Chouvy, 2016). Mass-produced commercial Moroccan hashish eventually became so bad that it got increasingly

⁵ During a 1987 experience in the Rif, trimming 30 kg of brut cannabis took 45 h (removing 25% of total weight in leaves and 15% in seeds) and 44 g of extremely pure resin powder was obtained (plus 100 g of zero-zero powder, the usual best local quality), an extremely time-consuming process that is very rarely or ever done in the Rif: Clarke, 1998: 189, 318.

⁶ <https://www.leafly.com/hybrid/clementine-kush>. Page consulted on 11 December 2017. Of course, these high percentages are maximum potentials of seedless flowers grown indoors in ideal conditions.

difficult to sell, leading to unsold stocks accumulated in the early 2010s in the Ketama and Bab Berred areas, as European consumers starting having access to high-end marijuana and largely shunned the North African hashish (interviews: Rif, 2013, July and October 2017; Chouvy & Afsahi, 2014; Chouvy, 2016).

But, as we could directly and repeatedly observe in 2017, quality is now clearly on the rise again in Morocco, something that has been encouraged by European demand, along with the adoption by Moroccan growers of HYVs and the production, also initiated and mostly undertaken by Europeans, of modern cannabis extracts. In fact, it is likely, for reasons explained below, that the best specimens of hashish currently produced in Morocco are the highest quality that has ever been produced in the country—although not all Moroccan and European growers and consumers appreciate the new tastes and effects of these new end products, despite recognising their potency (interviews and direct observations: Rif, 2013 and 2017).

Indeed, quality is not limited to taste. Quality refers to the pragmatic interpretation of the non-inferiority or superiority of a product obtained when production is undertaken according to best practices or best rules of the art, in particular with regard to the choice of techniques and materials. Hashish is an end product and derivative of cannabis and its quality is directly and logically affected by the qualities of the cultivated strain/variety and, as we have explained, how the plants themselves were cultivated, harvested, dried, and processed. The highest-quality hashish now produced in Morocco by an increasing number of Moroccans and Europeans is arguably superior to any previously produced, not solely due to increased potency but also because of the care brought to cannabis cultivation and hashish production (direct observations in July and October 2017; Chouvy & Afsahi, 2014; Dujourdy & Besacier, 2017).

To produce the highest-quality hashish, carefully-sieved cannabis resin must be obtained from (preferably) organically-cultivated cannabis plants, harvested at full maturity and properly trimmed and dried. Hashish with a very high trichome content is of course potentially more potent, but potency is not the only measure determining quality. Quality can also be assessed in purely quantitative terms, based on purity. Purity is directly determined by the concentration of heads of capitate-stalked or glandular trichomes⁷ in a given amount of resin powder extracted from dried plant matter. The less contaminants (plant debris, insects, dirt, dust) a resin powder contains, the more pure it is. On a more subjective level, hashish quality is something that can be assessed through hashish tasting protocols very much similar to wine tasting, as exemplified by an existing “Resin quality scoring sheet” that includes not only the quantity and spectrum of cannabinoids, and the terpenes contents, but also refers to the more qualitative (vs. quantitative) criteria of: melt, stability, appearance, bouquet or aroma, taste, smoothness, body, balance, intensity and duration of the flavours, which, together, make for the overall pleasure and uniqueness of a given hashish.⁸

It can now be safely estimated, on the basis of fieldwork conducted in 2013 and 2017, that the widespread cultivation of HYVs and the much improved cultivation and production techniques now observed in a large part of the Rif are responsible for the high THC contents of the recent Moroccan hashish (confirmed by seizures in Europe) as well as for significantly improved yields that potentially compensate for some of the reduced cultivated areas. The highest-quality hashish samples now produced in Morocco are clearly of much higher potency and purity than what was produced before the HYVs were introduced and possibly represent the best hashish ever produced in the Rif (direct observations and interviews: Rif, 2013, 2017). In fact, the highest

purity hashish that we had direct access to in the Rif in 2017 reportedly (interview with a European producer) contained up to 95% glandular trichome heads and only 5% of contaminants such as plant debris, dust, etc. In terms of comparison, in ideal conditions—that is, when produced from indoor cannabis grown and processed in a dust and contaminant-free environment—it is possible to achieve 99% purity or even higher.⁹ The same European producer affirmed that a sample of his “fresh frozen”¹⁰ sieved hashish produced in 2016 in the Rif was analysed in Spain (where it was commercialized) and rated at 68% THC content, with the remaining 32% being composed of trace amounts of other cannabinoids, as well as terpenes, waxes and plant debris (interview: Rif, October 2017). Such high THC contents in sieved Moroccan hashish are confirmed by a 2017 study that concludes that “the potency of both resin and herbal cannabis seized in France has increased for the last 25 years”, with the THC content of cannabis resin rising slowly from 1992 to 2011, “which is in line with other studies in Europe and Morocco”, and then dramatically increasing until 2016 with “a 92% growth in mean THC content from 2011 to mid-2016”. The mean THC content was 23% in mid-2016 (compared to 10% in 2009), with an 81% THC peak value in one hashish sample in 2014 (Dujourdy & Besacier, 2017: 79, 72, 73).

A new trend that we could directly observe in a few different places is that some hashish makers in the Rif now produce very small quantities of modern and highly potent extracts such as BHO and rosin. Yet traditionally-sieved hashish is still by far the most produced cannabis product in the Rif as the dry-sieving technique is far more accessible and affordable to most Moroccan hashish makers in terms of technical knowledge, skills and workload (interviews and observations: Rif, October 2017). In the end, the adoption of HYVs, along with modern agricultural and production techniques, appears to be highly beneficial. Compared (see Table 1 below) to *kif*, HYVs potentially yield a lot more flowers (up to 230% increase: 60–200 g per square meter) that contain far more THC¹¹ (by dry weight: 2.4% for *kif* vs. 21% for the Clementine Kush strain and 35.6% for the Nova OG strain,¹² the most potent strain tested so far) (interviews: Rif, July 2017; UNODC, 2005: 7). The most modern sieving techniques that we were given to observe in the field allow for an extraction rate of 3.5% of a highly pure (trichome content) resin powder that, once pressed into hashish, can be vacuum-sealed and frozen to preserve its potency and flavour until exported to Europe (interviews and direct observations: Rif, October 2017). Yielding approximately 70 kg per hectare (estimated on the basis of a 3.5% return on 2 tons of dried flowers per hectare), the potential yield of such a high-quality hashish is significant, compared to the gross estimate of 14.7 kg per hectare of lower-quality hashish that can be derived from the 2005 UNODC data (on the basis of 1066 tons of hashish produced out of 72,500 ha of predominantly rainfed cannabis fields) (UNODC, 2005: 4).

Yet most of the sieved Moroccan hashish presently produced is still far from being of the highest quality as many Moroccan growers obviously continue to utilize inefficient cultivation and processing techniques (observations and interviews: Rif, July and October 2017). Moroccan and European growers interviewed during this research explained that most Moroccan cannabis growers and hashish makers are

⁹ <https://www.bubblemanbrand.com/products/fullmelt-dry-sift-99>. Page consulted on 13 December 2017.

¹⁰ Made from fresh, undried flowers that have been frozen for several hours (in a freezer) before being threshed and sieved. Low temperatures (below 12 °C ideally) ensure that the oily trichomes do not stick together or to plant debris, dust, etc. They also make the trichomes more brittle, which helps them detach more easily from the plant (interviews: Rif, October 2017).

¹¹ Potentially only because cannabis yield and potency can vary considerably depending on phytochemistry, the type of cannabis product, cultivation method and conditions (temperature, humidity, light and soil acidity matter a lot in the outdoors), sampling and stability (UNODC, 2009).

¹² <https://herb.co/2017/04/01/strongest-strains-2017/>. Page consulted on 11 December 2017.

⁷ Where most of the plant's cannabinoids and terpenes, respectively responsible for potency and flavour, are concentrated.

⁸ <http://www.frenchcannoli.com/cannabis-scoring>. Page consulted on 13 November 2017.

Table 1
Extrapolated potential yields and extraction rates of the kif variety and HYVs in Morocco.

	Number of plants	Dried flowers (kg)	Hashish (kg)	Extraction rate	THC content
Traditional farming of kif/ha	Highly variable (from 10,000 to 40,000) (1)	Maximum of 600 (trimmed with about 50% of weight in seeds) (2)	14.7 in 2005 (3)	0.14%–0.44% of trimmed flowers (25% in weight) with about 50% of weight in seeds (4) 2–2.8% of brut cannabis (5)	2.3% in dried brut cannabis and 8.3% in hashish in 2004 (6)
Modern farming of HYVs/ha	About 10,000 (7)	Maximum of 2000 (trimmed with about 50% of weight in seeds) (7)	70 (7)	3.5% of trimmed flowers with about 50% of weight in seeds (7)	Maximum of 68% (7) By comparison, mean content of hashish seized in France in 2016 was 23% and the highest content was of 86% in one 2014 sample (8)

(1) Clarke, 1998: 187; UNODC, 2006: 19. Also, “Cannabis crops are grown at a wide range of plant densities, depending on the goal of production and the expected yield level. For the production of cannabinoids, a density of 10 plants/m² may be economically optimal, for seed production a density of 30 plants/m² may be used, whereas for stem or fibre production, densities between 50 and 750 plants/m² have been recommended” (van der Werf, 1997). (2) Clarke, 1998: 189. (3) Based on 1066 tons of hashish produced out of 72,500 ha of cannabis in 2005 (UNODC, 2005: 4). (4) Clarke, 1998: 189. (5) The UNODC gives an extraction rate of 2.8% (three qualities of resin powder) in 2004, revised down to 2% in 2005 (larger sample and more precise estimate), and Clarke gives a very similar estimate (three to four qualities of resin powder): 2.05–2.6% (UNODC, 2004: 5; UNODC, 2005: 4; Clarke, 1998: 317). (6) UNODC, 2004: 5. (7) Fieldwork: Rif, October 2017. (8) Dujourdy & Besacier, 2017: 72, 73, 79. Note: yields and extraction rates were calculated according to very different data (obtained in different areas, at different times, and from different methodologies) but these are the best estimates that can be provided at this stage.

interested in higher yields and quality, but are discouraged by the steep learning curve and increased labour costs of making high-quality hashish (interviews: Rif, October 2017). As a consequence, although many Moroccan growers now cultivate HYVs on irrigated fields, only a few grow, harvest, dry and process cannabis according to the best available practices. According to our repeated observations, most still apply synthetic fertilizers, harvest plants before resin maturity is reached, and dry the plants on rooftops exposing them to dust contamination. Also, very few growers trim the plants before producing hashish, and dry plants are often threshed to maximize extraction rates, thereby increasing the percentage of plant matter in the end-product (interviews: Rif, July and October 2017).

Conclusion

The introduction of HYVs by European producers and buyers with outlets in either Amsterdam’s coffee shops or Spain’s cannabis social clubs clearly initiated a renewal of production of better quality Moroccan hashish in the early 2010s, as shown by the increased potency of Moroccan hashish seized in Europe (Chouvy & Afsahi, 2014; Dujourdy & Besacier, 2017). The interviews we conducted with European growers and producers installed in the Rif indicated that they started producing high-end sieved hashish and other extracts by vertically integrating the entire production and sales process, from the choice of seeds and land, to the choice of extraction techniques, and to the commercialization stages. According, notably, to direct observations of various end products in Morocco, such highly-skilled and knowledgeable European producers invested time, money, and tools in the production of high-quality hashish in the Rif, and now arguably produce the purest sieved Moroccan hashish ever. Fieldwork also revealed that while more modern extracts such as BHO and rosin are now also produced in the Rif, HYVs are still predominantly used to make dry-sieved hashish, as producing modern extracts is very labour intensive and expensive.

The future of cannabis cultivation in the Rif now seems to depend on multiple factors. While the widespread adoption of HYVs is increasing the pressure on the Rif’s fragile ecology, especially on its water resources, the large-scale development of irrigation in the region (ubiquitous in the Bab Berred area and likely to spread beyond that) risks accelerating and worsening the threat to water resources, although the adoption of efficient irrigation techniques (such as drip irrigation and mulching) is a reassuring phenomenon (direct observations: Rif, July 2017). There is, however, the possibility for Moroccan growers to adopt not just the most renowned and water-demanding HYVs, but also HYVs that are less water-demanding, as there are now many reliable and popular varieties that require less water than others. Of course, the adoption of modern water-saving farming techniques can also help alleviate the pressure on the Rif’s water resources.

From an economic perspective (void of legal considerations), the fact that European cannabis growers and hashish makers are investing again in the Rif is also reassuring in the light of the recent difficulties encountered in selling traditional low-quality Moroccan hashish (Chouvy & Afsahi, 2014; Chouvy, 2016). It clearly shows that the Rif remains competitive, even if that is mostly due to cannabis still being illegal in most of Europe and to Moroccan toleration of large-scale cultivation in the Rif. Of course, cannabis cultivation and hashish-making in the Rif also remain competitive because of the low income and wages in the region. But the competitiveness of the Moroccan cannabis industry will eventually be tested by the inevitable legislative changes that will undoubtedly take place in Europe (and maybe in Morocco). Cannabis legalization in Europe will clearly affect the already fragile economic and political stability of the Rif, whether or not Morocco also ends up legalizing cannabis cultivation (the legalization debate has gained momentum in Morocco, reaching even the parliament in 2013). It is very difficult at this stage to foresee what socio-economic and political impacts the various possible legalization or

decriminalization schemes will have in the Rif. The trend toward legalization or decriminalization of the cannabis industry that takes place in different parts of the world is too recent and limited at this stage to potentially compare to the Moroccan situation.

In the end, the fact that the massive adoption of HYVs and the production of high-quality hashish in the Rif remains ignored and unaccounted for, in official reports such as the UN World Drug Report but also in Moroccan and European development schemes, is rather alarming. Ignoring or misunderstanding the drivers of the hashish economy does not bode well for the success of the important development programmes that are underway in the region, despite the millions of Euros that are being spent in the Rif on integrated development programmes that are highly unlikely to take into account the important changes taking place in the Moroccan cannabis industry.

Conflicts of interest

None.

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