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Traditional manufacture of hemp and hop textiles: Why botany and agronomy matter

Git Skoglund[1]

Abstract

Documentation of household textile plant cultivation is sparse and has been largely overlooked in textile research. This is especially true with hemp (*Cannabis*) and hop (*Humulus*). Existing references were rarely written by the growers themselves, and this has contributed to misunderstandings regarding the terminology of plant gender and fibre identity. By contrast, sources concerning those plants as highly valued economic plants of commerce are much more extensive but cannot be reliably applied to household production. Cultivation in small fields such as kitchen gardens combined with manual methods made it possible to extract extremely fine fibres, although yields were lower because only hemp and hop male plants were used to produce fine textiles. Topics covered include botanical factors, manual fibre extraction strategies, and the differences between household and commercial production.

1. Introduction

References describing traditional household production are rare, and few if any were written by the women themselves who could have best described the cultivation and craft processes. In contrast, observations were largely written by menand usually in the contexts of commerce and trade. Therefore, this article relies on archival studies, personal field work, and laboratory investigations to support scant literature references to convertinghemp and hop plants into fine textiles. Here, the term 'fine' describes both the fibres and the fabrics used for production of clothing and interior textiles that were used within the household or in its vicinity. Sources concerning hemp textile production are more abundant than hop, because hop fibre production never reached commercial levels, while hemp fibre production and textile manufacture continue in parts of Asia and eastern Europe today.

1.1 Botanical background

Throughout history bast fibres derived from plants such as hemp (*Cannabis sativa*), hop (*Humulus lupulus*), flax (*Linum usitatissimum*), *stinging* nettle (*Urtica dioica*) and ramie (*Boehmeria nivea*) have been used in household textile manufacturing. The term 'bast' refers to a complex tissue layer located under the bark in both annual and perennial plants (Hamilton: 2007:25). Both hemp and hop are indigenous to Europe and were utilized for fibre, food, and medicine (Clarke and Merlin 2013:154; Boutain 2014:8). The most widely distributed bast fibre plant cultivated in household settings in both Europe and Asia is the annual hemp (Clarke 2010:118; Lavrieux et al. 2013:742). Another common European bast fibre plant is flax, which is the most widely grown commercial fibre used for weaving fine textiles (Ejstrud 2011:23; Viklund 2011:509). In Asia perennial ramie is widely grown and has been imported into Europe since late Medieval time (Hannover 1924:125). In European households both flax and hemp were also used in the weaving of utility textiles (Skoglund 2016:62-66). Other European bast fibre plants are annual stinging nettle and perennial hop, and as with hemp and ramie both wild and cultivated plants were traditionally used to make textiles (Shøning 1910:13-14; Shøning 1926:108; Hald 1942:29-49; Hald 1980:125,130; Lance 1838:17). As whole plants they are easy to differentiate, but once they have been transformed into textiles it is extremely difficult to determine the botanical origin of the fibres. To date, only a few historic bast fibre textiles have been properly analysed with conclusive laboratory methods, and research continues. Distinguishing between hemp and hop fibres is especially difficult because of their close botanical relationships Skoglund et al. 2020) and the same holds true with differentiating between their pollens in archaeological data (Clarke and Merlin 2013:66).

Cannabis and *Humulus* are the primary economic genera of the family Cannabaceae. Both are dioecious with male and female flowers occurring on separate plants (fig. 1-3). Other bast fibre plants such as flax and ramie develop male and female flowers on the same plant. Both hemp and hop are anemophilous (wind-pollinated) and rely on air currents to carry pollen grains from male flowers to fertilize the female flowers and form seeds.

[1] Landsvägsgatan 26, 413 04 Göteborg, Sweden. E-mail : info@gitskoglund.se, mobile : +46 735 92 29 12

Picture 1: Hemp plants, from left one male and two females

Picture 2: Hop male plant

Picture 3: Hop female plants with cones

Before flowering the sexes are indistinguishable. Both hemp and hop begin to flower in late summer as the daylength decreases, and once flowering is initiated males can be identified by their pendulous clusters of small yellowish-green flowers. Once the female flowers are fertilized the seeds usually mature within three to six weeks. In commercial cultivation, only female *Humulus* plants are grown from persistent rootstocks as a perennial crop, no males are grown, and no seeds form. Modern drug *Cannabis* crops are also female and are usually propagated from vegetative cuttings which is essentially perennial production (Clarke 1981:10).

As *Cannabis* crops begin to flower, the male plants are on average somewhat taller and thinner than the females and rain pollen upon them (fig. 4). Within a month the male plants die, and the females develop thicker stems to support the heavy seed-bearing top of the plant. Primary fiber cells develop first as the stalks elongate, then secondary fibers develop as the stalks thicken. More mature *Cannabis* plants exceeding 180 centimetres (six feet) in height produce coarser fibres (Mauersberger 1947:337). Only the primary fibers are valuable for spinning high-quality fine hemp yarns (Westerhuis 2016:26). The mechanical properties of hop fibers are like those of hemp but hop has shorter fiber cells (Smole et al. 2013:384) and a lower fiber yield compared to hemp (Sellergren 1923:355).

Picture 4: Hemp male plants in flowering, taller than females

The differential development of primary and secondary fibres by male and female plants presents undesirable inconsistencies in large-scale fibre cultivation and processing (Knutson 1943:33). To counter this situation European plant breeders selected monoecious cultivars with male and female flowers on the same plant that ripen more evenly without the developmental differentiation of males and females. One early example was the Swedish variety 'Mona' which was developed during the 1950s to be used in cordage manufacture but when the fibres were tested for spinning fine yarns, they proved too coarse and brittle (Fröier 1959:36 and 1960:82). Most modern hemp cultivars are grown almost exclusively for coarse fibre for industrial use and, or seed production for food and feed (Pollio 2016:234-238). Female plants are favoured to produce secondary metabolic compounds. Unfertilized female *Cannabis* flowers are grown to produce cannabinoids (*e.g.*, THC, CBD, etc.) and associated aromatic terpenes and male plants are entirely excluded so that no seeds form (Clarke 1981:10). The same is true with *Humulus* cultivation, where unfertilized female hop cones produce higher levels of bitter *alpha*-acids and terpenes valued for brewing (Granhall 1952:22, and again male plants are excluded.

2. Method and materials

In this study, historical data comes from European, American, and Asian written sources describing traditional hemp and hop cultivation and processing for spinning and weaving fine household textiles. Historical European sources were published from the late 16th until the early 20th centuries. Until the late 18th century they treated to a greater extent household cultivation (Wisset 1808:48, Holmberger 1774:254) and indicate that it was basically women who cultivated textile plants (Dahlman 1743:203; Markham 2008:152; Tunón 2016:81). Generally, during preindustrial time hemp fibre and cordage were imported into Europe and the New World from Russia (Hannover 1924:118; Attman 1981:180-185; Nilsson 1961:30-32).

Most sources were written in the contexts of commerce and trade, such as coarse hemp fibres made into cordage or hop cones used in brewing, and there are more sources concerning the transformation of hemp plants into textiles than hop. Sources concerning fine household hemp and hop textile production are sparse, and three major works are of note. Britishauthor Robert Wisset (1808) presented a significant compilation of 18th century sources regarding hemp fibre production in his *A Treatise on Hemp*. Swedish author Gustav Sellergren wrote an in-depth study of indigenous Nordic fibre plants in an article series published by the Royal Swedish Academy of Agricultural Sciences (Sellergren 1923). Joseph Needham's *Science and Civilisation in China* includes a study by Dieter Kuhn who provides a comprehensive account of traditional hemp textile technology in China (Kuhn 1988). There are also several mentions from early sources of hop fabrics used in household textiles such as Bromelius (1687:69), Hastfer (1752:35-36), Anonymously written calender (1832), Lance (1838:17), Rodenstam (1918:1), Sellergren (1923:355), Tobler (1938:84-87) and Hald (1980:130), and some record that household hop fabrics were quite common and could be as fine as hemp or flax such as Rudenschöld (1750:217), Holmberger (1774:254) and Fisherström (1781:486).

This study also relies on the author's research experience with commercial *Cannabis* cultivation for production of textiles, ropes, building composites, foods, and medicines, as well as fieldwork in Europe, Anatolia and East Asia exploring the use of traditional technologies in the cultivation and production of fine hemp textiles. Data has also been collected through extensive investigations of historical European and Asian hemp textiles in museums and private collections. In 18th and 19th century Sweden a few attempts were made to produce commercial hop fabrics. Presently, only two hop textiles are known, a garment (mixed with hemp fibres) from the 19th century (Inv. No. NM.1314747) (fig. 5) and a hop fabric sample from 18th century (Inv. No. NM.0405398-2). Both are accessioned in the Nordic Museum in Stockholm.

Picture 5: Women garment made of hemp and hop

The garment has been investigated and published by the author (Skoglund 2016:88; Skoglund et al. 2020:1-7). Manually produced European fine hemp and flax fabrics cannot be visually distinguished from each other (Skoglund, Nockert and Holst 2013:4-5); Skoglund 2016:73-78; Skoglund 2020:78-80) and additional data come from laboratory analyses and identifications of hemp and hop among other plant fibres (Skoglund, Soumela and Vajanto 2019:154-158).

3. Results and discussion

3.1 Male versus female *Cannabis* plants

Sources from different geographical areas and times indicate that hemp male plants contain the finest fibres used for textiles. There are several terms in older written sources referring to the differing uses of male and female plants. In early Swedish sources male plants were commonly called *tomhampa* or 'empty hemp' because male plants lack seeds, and *sommarhampa* or 'summer hemp' because male plants flower and are harvested in early summer (Sellergren 1923:726). In other European countries 'summer hemp' and 'early hemp' were common terms for males (Zaharia 2008:288). Male hemp plants produce finer and more supple fibres suitable for spinning and weaving into fine fabrics (Anonymous 1774:15). Female hemp plants in Swedish sources were called *bästling* or 'masculine' because they grew larger after the male plants died, *stockhampa* or 'flower hemp', *fröhampa* or 'seed hemp' because female plants produce seed arranged in floral clusters at the top of the stalk, *senhampa* or 'late hemp' because the females were harvested after the males, and *vinterhampa* or 'winter hemp' because females were often harvested when the seed ripened in the late autumn (Sellergren1923:726). In other European countries the terms 'winter hemp' (Zaharia 2008:288) or 'late hemp' (Wisset 1808:51) were commonly used to denote female plants.

Many historical terms predate the wide-spread awareness of plant sexuality, and researchers have noted that in earlier sources plant genders could be reversed (Sellergren 1923:726; Wilson 1979:28). One explanation is that because females become larger and stronger as the seed ripens, so they were called males (Wisset 1808:7-8). In Swedish, male plants are sometimes called *fimmel* (from the Latin *femella*) or 'female' because they are shorter and thinner than the females, which in some cases could be called *Carl* (a man's name) hemp derived from Old Norse language (Hall 1724:5; Wilson 1979:28).

An early mention of hemp gender comes from the book *The English Housewife* first published 1615 (Markham 1994:279).

The author explains that according to the common housewives' customs, male plants for making cloth should be harvested in mid-July when the leaves begin to fall and/or they begin to flower and turn yellow at the top, indicating that the fibre is ripe. The female plants harvested for seed should stand past the end of August. The relationship between the different harvest times is explained by a rhyme;

> Wife, pluck fro[m] thy seed hemp the fiemble [literally female, actually male] hemp clean,
> This looketh more yellow, the other more green:
> Use t´one for thy spinning, leave Mikael [man's name] the t´other,
> For shoe thread and halter, for rope and such other.
> Now pluck up thy flax, for the maidens to spin,
> First see it dried, and timely got in.

The first line points out that the "fiemble" (actually male plants) look more yellow. It is the male plants that become yellow during the time of flowering and females remain green, and the author inverts their genders. The citation also says 'fiemble' should be used for spinning and 'Mikael' (actually female plants) for making coarser products such as rope, indicating that the early harvest was for fine fibres and the latter for coarse fibres, and it is male plants that produce the fibres used for weaving fine textiles. Early sources from China written around 2200 BP, tell us that fibres of male hemp are thin and soft, and were used to spin cloth (Kuhn 1988: 22-29) and in parts of China today early male harvest strategies are still in use (Clarke 2008:59).

Several terms were specifically applied to growing male hemp for finer fibres. In Swedish, the terms *gallerhampa* and *gallhampa* or 'thinning hemp' refers to the fact that during the harvest male stalks were thinned from the crop by pulling them first (Dahlman 1743:20; Anonymous 1770). 'Thinning hemp' not only describes the thinning of males from the remaining females, but also when grading the stalks, generally in three different sizes from the shortest and thinnest to the tallest and more robust (Sellergren 1923:731). An older Danish source explains that *gallerhampa* and *gallhampa* are in part derived from the Danish *galdre*, *galler* or *galder*meaning 'infertile' because male plants do not produce seeds, and partly from the Swedish *gallra* in the sense of to 'choose or thin out' (Hannover 1924:117). The procedure of grading hemp stalks was well known in European households and recently was documented in Romania (Zaharia 2008:288) (fig. 6). Grading stalks is also a basic process employed in Asia when different qualities of hemp fabrics are desired (Nagano and Hiroi 1999:346-355; Clarke 2008:59; Skoglund 2019 personal observation) (fig. 7).

Picture 6: Hemp fibers, yarn and hemp fabrics of first grade

Picture 7: Hemp fabric, in wax batik painting (Vietnam)

3.2 Male versus female *Humulus* plants

Commercial hop cultivation for brewing began in Europe in the 9th century, and by the 13th century the cultivation of hop was expanding in central Europe (Behre 1999:35). In Scandinavia, according to Carl von Linné (Linné 1763:52) using hop cones in brewing was a rare process and was not known to the ancients.

He states;

"Humlans bruk är ett sällsamt upptåg, som icke varit bekant hos de gamla. Hvilken hade kunnat tro, at denna örten skulle bliva så oumbärlig til den söta drycken."

Hop[s] use is a rare process that was unknown to the old people. Who could have thought that this herb would become so indispensable to the sweet drink (beer) (translation by Skoglund).

There are few written sources mentioning harvesting male *Humulus* plants for their fibres, but even so it is clear that male plants were used for weaving fabrics. In a Swedish source (von Möller 1881:161-162) from the late 19th century concerned with the history of Swedish agriculture, a description about hop plant nicknames, discusses hop fabrics and cites another source as follows;

"Från förenämnda tid, då således odlingen af denna växt ännu var ganska allmän i Sverige, härleder sig den snart hos landtmannen bortglömda gåtan: skranglig far och kringlig mor, sladdriga döttrar och knubbiga söner. Men äfven den "kringliga modern" visste man då att tillgodogöra sig, nämligen till vävnad."

From the aforementioned time when the cultivation of this plant was quite common in Sweden, it soon originates from the mystery forgotten by the countryman: wobbly father and braided mother, flabby daughters and plump sons. But even the "braided mother" was known to adhere to it, namely to fabrics (translation by Skoglund).

The author added that 'plump sons' means the thicker stalks with cones. Growers were likely aware of hop genders even if the author exchanged the names used for male plants to mother and daughters, and female plants to father and sons. At the same time the citation shows it was a 'mystery forgotten' meaning that farther back in history male hop plants were used to weave fine fabrics. Another English source shows that male hop plants were often referred to as 'seed' hop (Marshall 1798:174).

There were also traditional Swedish names for hop like those for hemp, namely *gallhumle* or 'thinning hop' (Granhall 1952:10). 'Thinning hop' refers to male plants, indicating that those plants were thinned from the crop and sorted to produce fine fibres. Hop plants were cultivated in gardens long before the cones were used in brewing (Mercuri, Accorsi and Mazzanti 2002:264). In a forest in the north of Sweden a relict population of ancient cultivated male hop was found, indicating that it was grown for producing textiles rather than female hop cones (Strese&Tollin 2015:47-48).

Both hemp and flax where so commonly grown for textile production during the 18th century that their names often became synonymous with plant fibres in general, therefore fibres discussed in early sources were sometimes misnamed, and this situation must be considered when interpreting older sources. For instance, in the last sentence of the rhyme (see above) from *The English Housewife* (Markham 1994:154) flax is mentioned, and here 'flax' means hemp fibres suitable for spinning fine yarn. As a further example, Sinclair (1797 cited in Wissett 1808:12) also uses 'flax' to describe fine hemp fibres according to the following;

"The male is more forward in its growth, and rises to a greater height, by about six inches, than the female, whereby the fecundating dust or pollen is easily shed on the latter; and the flax, or fibres of the male, are much more delicate and finer than those of the female."

Scandinavian sources dating from the 18th century used the term *lin* or 'flax' when describing other fibres such as hemp or hop (Shøning 1910:13-14). Several other Swedish examples show that *lin* and *hampa* were used as terms describing other textile fibres or plant fibres, such as a letter from Carl von Linné to the Swedish Royal Academy where he writes about the wild plant "Melilotus albus Medik" and how it could be used to make *hampa* or 'hemp' and *lin* or 'flax' fibres (Linné 1761). Another source mentions that the wild plant "Malva rotunda" was used to make *lin* or 'flax' (Hagström 1751:19). Holmberger (1774:254) when discussing hop textiles, says that hop plants were used to make *lin-bast* or 'flax-bast' and *lintyg* or 'flax fabric'.

3.3 Simultaneous harvest of male and female plants for coarser fibre production

Several factors account for differences in fibre quality and yield, and the differing agronomic strategies employed were determined by the intended outcome, such as fine textile production for household use as opposed to commercial production of cordage and coarse fabrics. If the female plants are harvested when the seeds are ripe, the fibres will be less useful (Gadd 1786:11).

In Finland the male plants were left in the fields without thinning and were harvested and dried together with the females. Those stalks were naturally very uneven in height and diameter and were therefore more difficult

to process (Grotenfelt 1914:11). The reason for growing lower quality fibre in this region during this period is not explained, but likely it was intended for coarse cordage or fabric production.

Male hemp plants yield finer fibres than females but also less fibre, and therefore when crops were not destined for fine textile production the whole crop was harvested together to increase total fibre yield. In both Europe and the Americas, another harvest strategy was used whereby the whole crop of both male and female plants was simultaneously harvested in summer (mid-August at northern latitudes) as pollen was being released, and well before the female seed plants were ripe with seed (Wisset 1808:104). Once flowering commences (mid-July at northern latitudes) usually three to four months after sowing (Dodge 1896:13) the male plants begin to drop pollen and turn yellow indicating that harvest time is near (Anonymous 1831). In 19th century Kentucky, where commercial manufacturing of cordage required high yields of strong and long fibres, simultaneous harvest of both sexes was traditionally practiced (Robinson 1943:9). Male plants where not thinned because during the early stage the stalks were more uniform in length and diameter and could more easily be harvested manually or with machines. This harvest strategy is still used for cordage production in Turkey today (Skoglund 2018 personal observation).

Very early harvest produces a finer and softer but weaker fibre (Robinson 1943:9) which is suitable for fine textile production. East Asian hemp farmers harvest at the pre-floral stage in early summer (mid-June at northern latitudes) (Clarke 2010b:245). Fibres harvested at this time are more uniform because the plants have not begun to flower, and there are yet no differences in fibre quality due to the sexual differentiation of males and females. At this time, in the crop's development all plants are in the elongation stage producing finer primary fibres rather than more coarse secondary fibres.

3.4 Household production of fine hemp fabrics

The many steps in the processing of fine and soft hemp fibres cannot adequately be described here, and only agronomic factors of household production will be considered. Sources indicate that fibre hemp was grown by commercial farmers (Wisset 1808:48), as well as in households by women (Dahlman 1743:203; Markham 1994:154; Zaharia 2008:288) and that the yield satisfied household needs (Kuhn 1988:22-29; Zaharia 2008:287). Both in Asia and Europe hemp was commonly grown in small fields situated in mountain valleys near rivers and streams on lighter alluvial soils providing drainage and adequate nutrients (Wisset 1808:33; Dodge 1896:8) and when summer rainfall proves inadequate to support rapid crop growth fields must be irrigated. Hemp prefers more alkaline soils and fine fibre is often grown on land located near limestone outcrops (Skoglund 2019 personal observation). Also, if the soil is poor in lime this can encourage weed growth (Knutsson 1943:22). When hemp is grown on lands that are not overly rich in nitrogen, the fibres will be finer and softer, but the yield will be lower. When the soil is heavily manured and becomes over-rich in nitrogen hemp crops grow more exuberantly and produce higher yields of more coarse fibres that arebetter suited for the manufacture of heavy marine cordage (Wisset 1808:30-31). Traditional sources also inform that hemp crops destined for fine fibre production should be grown in full sun next to a house where they grow quickly and will be sheltered from the wind (Gadd 1763:13; Anonymous 1774:15; Wisset 1808:33-35). When hemp crops are exposed to wind the stalks tend to grow thicker with heavier bark, negatively impacting fibre quality (Skoglund 2019 personal observation).

When the intent was to produce fine fibre, seeds were sown in hillocks or along small ridges between furrows, so that a person could walk through the crop (Wisset 1808:51) and those who thinned the male plants should be careful not to disturb the females (Dahlman 1743:205). However, hemp crops must be densely sown otherwise the plants begin to develop branches, the bark becomes woody, and the fibres will be too hard for spinning and weaving fine fabrics (Gadd 1763:11; Wisset 1808:90). Hmong women in northern Vietnam grow hemp in small fields, the sizes of which are determined by the quantity of seeds sown (usually about 2.5 kilograms or 5.5 pounds) while taking into account the woman's ability to weave and her need for new cloth (Clarke and Gu 1998:5). Seeds are sown very closely so that the final crop density is around 200 plants per square meter (Skoglund 2019 personal observation). When provided with adequate nutrients and water hemp crops develop without additional inputs until harvest. Large commercial fields were usually harvested by cutting the plants near ground level either manually or with harvesting machines. After the stalks are harvested and dried, they are retted. The retting process controls the separation of the bark from the stalks and is usually performed by immersing the stalks in water, usually for one to three weeks (or more) depending on the water temperature. When hemp was grown for use in fabrics the plants were often pulled rather than being cut (Dodge 1896:12). The advantage of pulling stalks is that the root ends remain closed, and during the retting process water cannot enter the cut ends, making the retting more even (Knutsson 1943:22).

Hemp farmers in many regions pulled the plants and sorted the stalks into long, medium and short lengths which were tied into bundles destined for different uses (Dodge 1896:13; Sellergren 1923:732; Nagano and Hiroi 1999:349; Zaharia 2008:288-289).

Manually peeling the bark from retted hemp stalks was common in early historic time and is still practised today in Asia (Clarke 2010b:230). Wisset (1808:236) tells that in some provinces of France farmers peeled the hemp stalks, and that the method was so simple; "A description of it would be needless, even children and the aged and infirm may perform it with ease, by taking one stalk after another, breaking the reed and slipping off the bark." The same procedure was used in northern Norway when preparing hemp fibres by taking each stalk and pulling away the bark manually. In Norwegian this was called *att riva hampan* or 'to tear the hemp' (Engelstad 1952:42).

According to a Danish source hemp bark was peeled from dried retted stalks, wrapped in coils, beaten with a wooden mallet, and finally hackled by pulling the bark strips through an increasingly finer series of metal combs called hackles. In Danish such hemp was called *bankningen* or 'the beating', and in German it was called *schleisshanf* or 'wear hemp' meaning fine hemp of clothing quality (Hannover 1924:118). Swedish hemp fibre processed in this way was very long, free of woody hurds (or shives) and highly esteemed (Sellergren 1923:733). After the 14th century a mechanical 'brake' was used to crush the dried stalks and free the bark, rather than manually peeling and beating the bark. Brakes were increasingly used in some regions as hemp rope production was commercialized (Wilson 1979:28).

3.5 Household production of fine hop fabrics

Hop was grown in forests and valleys (Anonymous 1832) and harvested in the autumn (Hald 1980:130). First, all leaves are removed (Rudenschöld 1750:217; Holmberger 1774:254). As the long hop vines (called bines) were harvested, they were cut into uniform 120-180 centimetres (4-6 foot) lengths (Holmberger 1774:254; Hald 1980:130). After this they were graded by separating them into groups of thicker, medium and thinner diameters (as well as ones with branches) after which they were tied into bundles for retting, sometimes along with hemp stalks (Rodenstam 1918:1).

Hop bines were retted to free the fibres in several ways. Cut lengths could be spread on fields over the winter so they would be repeatedly wetted with dew or covered by snow or placed on roof tops from which warm steam rises during the winter (Holmberger 1774:254). Water retting took at least four months and could not be done in freezing temperatures, so it was advantageous to field ret the bines over the winter (Schissler 1750:214-216). When water retted, the bines should be removed from the ret when they become yellowish, and the bark can be easily separated. If they ret longer in water, the fibres may become whiter but will lose their strength (Tobler 1938:84-87). In 18th century Sweden and Austria hop bines were hung on frames in barns, where they were retted by a very slow process involving moisture and warmth that yielded fibres that retained their strength and colour (Ibid). Following retting and drying in the air or in a kiln, the bines were gently beaten with a wooden mallet to free the fibrous bark. After the hop bark is separated from the woody core the fibres are extracted by hackling (Tobler 1938:84-87; Hald 1980:130). When hop bines are handled like hemp, the fibres will be as fine as hemp (Holmberger 1774:254).

3.6 Discussion

Although wild hemp and hop plants may previously have been used for fibre, during historic time their cultivation became intimately connected with household gardens, and only male plants were used in fine textile production. The important role of male hemp plants in Asia is well documented. One reason for this is that in China hemp clothing is wornin Confucian mourning rituals for deceased relatives (Kuhn 1988:22-29).

In preindustrial Europe, fine hemp textile production on a commercial scale was not extensive because of several problems. One was to find largefields with suitable soil. Most household cultivation was situated near houses in villages, but there was a well-known commercial field situated in the Anjou region of France. During 18th and 19th centuries hemp fabrics from this region came from an area called Limagne, a name derived from the Latin *Magnus Lacus* meaning 'the big lake'. The lake had been drained and consisted of fertile black limestone soil which made the fibres particularly flexible (Alcan 1847:11). Hemp from Anjou became famous through fabrics exported to European countries as well as America (Montgomery 2007:278).

Another problem with larger commercial scale production is the time-consuming processing of manually thinning male plants and the grading of hemp stalks or hop bines. Male hemp stalks must be carefully thinned from the field to preserve the females that carry the valuable seeds. Male plants are also uneven in height and must be sorted into different sizes, from the thinnest diameter (first grade) to larger diameters (third or fourth grades).

Thinning and grading were extremely important steps that made it possible to produce very fine fabrics, but commercial production does not allow for these processes. English farms in Suffolk cultivated not more than five or six acres (Wisset 1808:45). Even in traditional households it was important to weave a wide range of fabric qualities for different uses such as clothing, sheets, tablecloths, towels, heavy bedding, rugs, and sacks. In parts of

Romania each family had its own small hemp field which could generate approximately 30 meters (100 feet) of cloth annually, and first grade male plants were approximately 150 centimetres (five feet) tall (Zaharia 2008:287-288) (fig. 8).

Picture 8: Traditional hemp stalks for textiles (Transylvania)

The process of thinning male plants and grading the stalks cannot be done with machines, and today there is almost no fine hemp textile production in Europe. Most commercial hemp textiles are produced in China, where entire fields of juvenile plants are harvested simultaneously, and fibres are extracted by enzymatic retting in factories (Skoglund 2010 personal observation). Modern European industrial hemp crops are often three to four meters (10-13 feet) tall, and are used to produce cordage, building materials, composites, paper, etc.

Reliance on manual labour to produce fine hemp fibre is the primary reason Europe could not compete in the international market economy and discontinued fine hemp textile production in the 20th century. Hop never reached commercial production levels resulting from lower yield and the longer processing time required to obtain suitable fibres.

Although fine hemp fibre could be produced manually, hemp production was not successfully mechanised in Europe as flax production was, and reduced production was a result of manufacturing time constraints, limited access to suitable land, and lower yields of fine first-grade fibres. Both flax and ramie fibres are obtained more economically than hemp or hop. Flax in the West, and ramie in the East were extensively commercially grown during historic time. Flax reaches about one meter (three feet) in height and although harvested only once annually, there are no male and female plants, so the stalks develop more evenly, and no thinning or grading is required

(Ejstrud 2011:9). The shorter stature of flax is better adapted to mechanized harvest and processing. Perennial ramie is commercially grown from perennial roots, reaches a height of 1.0-2.5 meters (three to eight feet), can be harvested two or three times a year, yields double or triple the amount of fine fibres annually once established, and a field can be exploited for 15 to 20 years without reduced productivity (Kuhn 1988:17).

Even if manually producing hemp textiles was hard work, it well repaid women's efforts (Hagström 1751:15). Hemp was not only grown in cottage gardens or on small farms, but as well in mansions and castles (Dahlman 1743:203; Broocman 2016:81). The cultivation was left exclusively to housewives, the women being more sensible in this matter than the men (Dahlman 1743:203). Women cultivated hemp and made fine textiles, and most probably it was the same with hop. High-quality hemp fibre production depends on several factors such as selecting suitable land with adequate lime, available nutrients, and sufficient water, densely sowing the seed, thinning male plants and grading them into three or four different size classes, slowly retting and/or steaming the stalks, and peeling the bark from the stalks. Thinning, grading, steaming, and peeling are still practiced in China, Japan, Korea and Vietnam where juvenile hemp crops are harvested before flowering to produce finer and more uniform fibres (Nagano and Hiroi 1999:348-349; Clarke 2006:63; Clarke 2010b:144). In this case the taller branched plants around the edges of the field or in separate gardens are left to produce seeds for the next growing season, and those grow tall with thick stems and many branches (Skoglund 2019 personal observation) (fig. 9).

Picture 9: Hemp female plant with seeds in February

4. Conclusion

Traditional household cultivation, the craft practises of making fine hemp and hop textiles, and the women's roles in the cultivation and transformation of plants into textiles are underrepresented in historical sources. Records were largely written by men with solely economic interests who were not directly responsible for household activities, a factor that must always be considered when investigating historical crafts in general. In this circumstance,

primary household production and the women growers themselves were historically marginalized, and secondary observations contributed to misunderstandings about plant gender as well as misidentification of hemp and hop fibres as flax. Hemp and hop textiles can reach very fine qualities identical to flax or ramie when manually produced on a small scale. Manually produced European fine hemp and flax fabrics cannot be visually distinguished from each other and exhibit the same qualities and fineness when compared with Asian ramie textiles. Women's household knowledge from East and West shares many similar elements, and the manual techniques of thinning male plants, grading the stalks, and peeling the bark from the stalks were likely the common methods to extract fibres inprehistory. Both hemp and hop can be used to produce fine textiles, they only failed to reach the economic thresholds of commercial production. European reliance on manual labour was a major reason that hemp, and hop even more so, could not compete in the international market textile economy. The production of fine hemp and hop fibres involves only the male half of the crop, and to produce very fine fibres only one third of the male plants are used.

The other half of the crop consists of female plants with more but coarser fibres that cannot be used for fine fabrics but were commonly used in the production of cordage and rough textiles. Monoecious hemp varieties were developed to obviate the developmental differences between male and female plants, but they do not produce such high-quality fibres. Farther back in time it is likely that household textile production was of equal or greater importance than cordage, herbal medicines, or beer. Commercial interests have focused on only female hemp and hop plants, male hop plants have disappeared from present-day agriculture, and apart from seed production this has also occurred with hemp.

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Museum collections

Inv. No. NM.1314747. Woman´s upper garment of hemp and hop, stored at The Nordic Museum in Stockholm, Sweden

Inv. No. NM.0405398-2. Fabric sample of hop, stored at The Nordic Museum in Stockholm

Figures

Fig. 1: From the left, one hemp male plant and two female plants. Photo: Git Skoglund

Fig. 2: Hop male plant with flowers. Photo: Git Skoglund

Fig. 3: Hop female plant with cones. Photo: Git Skoglund

Fig. 4: Hemp field with taller flowering male plants. Photo: Git Skoglund

Fig. 5. Woman´s upper garment of hop fibres, mixed with hemp fibres (Inv. No. NM.1314747). Photo: Emma Fredriksson, Nordiska museet, Stockholm

Fig. 6: Hemp fibres and textiles of first grade fibres, cultivated and produced in Transylvania. Photo: Git Skoglund

Fig. 7: First grade hemp textile, cultivated and produced in Vietnam. The lady waxes the fabric before the dyeing bath. Photo: Git Skoglund

Fig. 8. Size of first grade hemp stalks, Transylvania. Photo: Git Skoglund

Fig. 9. Female plant of hemp, left in the garden during several months, grown thick with many branches filled with seeds. Photo: Git Skoglund