

Hemp Textiles in Britain - Opportunities for bioregional development

by Sue Riddlestone, MD BioRegional MiniMills

(This paper was first presented at a conference "Industrial Hemp: Economic Opportunities for Canada", held on March 25 1996 at the Design Center in Toronto, Canada.)

ABSTRACT.

Hemp textiles in context.

THE "HEMP FOR TEXTILES" PROJECT.

Hemp textiles in context.

The hemp for textiles trial cultivation and processing.

Retting.

Extracting the fibre from the retted stems.

Processing the fibre produced into a yarn.

Weaving.

A British grown and designed hemp garment.

What niche will hemp find in the textile market?

Technical problems to be overcome.

Potential Yields.

In conclusion - Opportunities and challenges.

REFERENCES.

ABSTRACT

Hemp (*Cannabis sativa*) could be an important crop enabling the production of environmentally friendly, locally produced, high quality textiles in the UK and around the world. Hemp is a traditional fibre crop which for centuries was important in meeting our needs for textiles, paper and oils. It is easy to produce organically, growing so fast that it smothers weeds whilst robustly shrugging off pests. As a locally grown, low input textile fibre crop hemp could make an important contribution to a sustainable future. Currently, the bulk of our demand for textiles is met by cotton and synthetics - both of which have serious environmental problems associated with them.

The once major hemp textile industry has now completely disappeared from the western world. At BioRegional Development Group we have been investigating the potential for reviving hemp and flax cultivation and integrated processing to produce textiles, paper, particleboard and oils on a sustainable basis in the UK.

As part of this work, and as a practical experiment, we grew a small trial crop of hemp specifically for textile production. We extracted the fibre from the crop in a variety of ways, by hand, using conventional flax machinery and a novel decorticator. The fibre was machine spun into yarn which was woven into the first UK grown pure hemp fabric for generations. Our experiments have demonstrated the very real potential for this crop in the UK and around the world as a truly sustainable textile fabric.

Hemp textiles in context

Hemp was an important traditional crop in many countries. We believe that a revival of hemp cultivation around the world will make an important contribution to sustainable development provided it is done on the basis of local production for local needs.

The significance of hemp to the economic and day-to-day lives of our ancestors is increasingly being recognised. It was important for textile, paper, rope and oil production. Indeed, hemp was so important in England in the sixteenth century that King Henry VIII passed an Act of Parliament, which fined farmers who failed to grow the crop. Although hemp was mainly used to produce ropes, sailcloth and sacking, the fabric which can be produced from hemp is comfortable to wear, and this feature, combined with its durability, meant that hemp was a fabric of choice for many working clothes, often in blends with wool. It is interesting that Levi Strauss made his first jeans from hempen cloth imported from Nimes in France, hence the name "denim" which comes from "Serge de Nimes". Also, within living memory Italian women were wearing linen-like dresses made from hempen cloth, sold in all drapers shops in Italy (1).

Today, textile production from hemp has been supplanted by imports of cotton and synthetics. Most cotton production today is highly intensive, heavily dependent on inputs of pesticides, fertilisers and water. The environmental and social costs of modern intensive cotton production are very high. However, in parts of China and Eastern Europe, a small hemp textile industry remains to this day. Samples of Chinese and Hungarian hemp fabric show the quality which can be achieved.

Hemp, as a fibre crop is like flax (which is used to make linen). Both hemp and flax fibres are known as "bast fibres", that is the fibres are contained in the stem. The processes and machinery required to produce fabric are similar in principle for both crops. Whereas the hemp textile industry has died out in the western world, the flax industry continues with machinery and expertise readily available.

Hemp growing never ceased in France, and in response to concerns about the narcotic uses of the hemp plant low narcotic strains were developed. In recent years hemp has been grown in France to produce paper from the fibre and animal litter and bedding material from the woody core, also known as 'hurds'. Since 1993, hemp has once again been grown in the UK under licence from the UK government. Hemcore, an Essex based agricultural merchant successfully argued that under European Community law, if the French could grow low narcotic hemp then why not UK farmers? In 1995, 1,000 hectares of hemp were grown, 2,000 hectares are being planted this Spring. Hemcore are growing hemp primarily to produce a non-allergenic and absorbent horsebedding from the hurds. Some fibre is being pulped to make tea-bags, cigarette papers and banknotes, but the production of hemp textiles has proved more problematic.

Growing consumer demand and interest in hemp fabric has stimulated research in this area. BioRegional Development Group, have been working with Hemcore and other organisations to produce experimental quantities of 100% hemp fabric.

Hemp merits consideration as a new linen-like, environmentally friendly, textile fabric. Hemp can be grown easily under organic cultivation as it grows so fast that it smothers weeds. Indeed, studies have shown that organically grown hemp has higher fibre yields (2) and improved fibre fineness (3). In addition, hemp is a multiple use crop. The high value, long "bast" fibres are used to produce textiles, twine, geotextiles and paper. The shorter "tow" fibres from textile processing are also suitable for geotextiles and paper making. The woody core or hurds are also fibrous and can be used for animal bedding, paper making or in building materials, such as particleboard. The seed is used for fish, bird or human consumption or for oil production. Growing regimes vary according to whether seed or fine fibre is required. Obviously, aside from the whole crop utilisation, multiple co-products will allow far greater income generation from the crop.

THE "HEMP FOR TEXTILES" PROJECT

In order to explore the value of UK grown hemp as a textile fibre BioRegional Development Group instigated a project "Hemp for Textiles" with funding from the UK Department of the Environment Local Projects Fund and the Konrad Zweig Trust. Hemp for Textiles aimed to:

- grow four hemp varieties (in Kent in Southeast England) to explore any differences in fibre quality and yield;
- extract by different methods a textile grade fibre and produce samples of UK hemp yarn and fabric;
- compare processing techniques and evaluate the best way to establish a UK hemp textile industry;
- make our results available to interested parties and the general public, to advance knowledge of hemp and its potential as a sustainable crop.

The "Hemp for Textiles" project started in April 1994 and is ongoing. It involves private, public and academic sectors.

Hemp textiles in context

As a starting point we investigated the centuries old method of hemp textile production (4) and (5). In principle it is similar to the method currently used to produce linen from flax. It involved:

1. Sowing the seed densely to produce tall, slender stems which contain a greater amount of finer fibre.
2. Harvesting after flowering but before the seeds set (the fibre content is reduced and becomes coarser toward seed formation);
3. "Retting" the crop - the process whereby bacteria and fungi break down the pectins that bind the fibres to the stem allowing fibre to be released. One of two alternative methods were generally used - water retting, which involves lying the stems in water in tanks, ponds or in streams for around 10 days is more effective if the water is warm and bacteria laden; and/or dew retting, which entails laying the crop on the ground for 10-30 days, turning as necessary to allow even retting;
4. Breaking the stems by passing through a "breaker" or fluted rollers.
5. "Scutching" -separating the fibre from the woody core by beating the broken stems with a beech stick or passing through rotary blades, and finally;
6. "Hackling" (combing) to remove any woody particles and to further align the fibres into a continuous "sliver" for spinning. Spinning was either carried out on a wet or dry basis. In the case of bast fibres generally, the best yarns are obtained by wet spinning (6), in which fibres are allowed to pass through a trough of hot water before being spun. This softens the pectin allowing a greater drawing out and separation of the fibres and producing a finer yarn (greater than 12Nm). Dry spinning is cheaper, producing yarns and fabrics with a different appearance and handle.

The hemp for textiles trial cultivation and processing.

The first stage of our project was to grow hemp on a trial basis specifically for textile fibre production. This we did in 1994 in Kent in partnership with a Kentish farm, Hemcore

(agricultural merchants) and Wye Agricultural College, University of London. The seed was sown at a rate of 55kg/hectare on 11th May (for fibre production 55-60kg/hectare is recommended (7)). Four different low narcotic varieties were grown, two French, F34 and F56 and two Hungarian, Kompolti and Uniko BF. We saw for ourselves hemp's remarkable weed smothering properties and the crop did not suffer from any pests. However, the crop did badly where soil was compacted by tractor wheels, with an reduction in plant height and increased competition from weeds along these "tram lines".

We harvested the crop when the male plants were in flower and shedding pollen and when the stems were whitening at tie base and the leaves were starting to drop as recommended in the literature (4) and (5). In our trial the French varieties were ready for harvest on 7 August and the Hungarian varieties on 13 August (Uniko) and 27 August (Kompolti). The crop reached 1-2 metres in height. We found that the Hungarian varieties yielded 70% greater biomass (as measured after retting) than the French varieties.

We also harvested 600 kg of Hemcore's 2 metre high commercial crop on 24 August using an Allen Scythe, which laid the crop in an even swath. The seed variety was F34, sown on 29 April.

Retting

We chose dew retting as our main test method to produce enough fibre for a spinning trial. After cutting, the hemp stems were laid Parallel in rows to dew ret. The stems needed turning at least once (sometimes twice) in order to allow for even retting. When turning, we observed that the stems closest to the ground remained green whilst the top was retting and turning brown. When retting was complete the crop was entirely brown/grey. The thicker stems took longer to ret, therefore uniform tall, fine stems would seem to be best for trouble free retting.

Judging the degree and completeness of retting is currently a subjective exercise based upon experience. Retting is complete when the fibre bundles appear white, separate from the woody core and divide easily into individual finer fibres for their full length. Evenness of retting is as important as the degree of retting.

For the earliest harvested crop, retting took only 20 days. For the crop harvested 20 days later retting took 50 days and was incomplete (see table 1). This was due to a cold, wet spell of weather in September and confirmed our suspicion that dew retting would prove risky in the UK climate.

Table 1 Dew retting.

hemp variety	harvest date	retting time
F34 and F56	7/8/94	20 days
Uniko BF	13/8/94	22 days
F34	24/8/94	27 days
Kompolti	27/8/94	50 days (incomplete)

Water retting - 20 days at 4-5C

Once it is considered that retting has gone far enough, the crop needs to be dried to halt the retting process before it damages the fibre and to prevent further retting in storage. With flax a moisture content of less than 16% is recommended. We stood the crop in stooks in the field to dry, but turning and then baling on a dry day would have the same effect.

In our small-scale trials we harvested the crop by hand or with small machines, but if hemp is to be farmed commercially for textiles, special or adapted farm machinery will be needed to:

- cut the crop and lay it in swaths,
- turn the crop to allow even retting, and
- bale the dried stems.

Extracting the fibre from the retted stems

The next step in our project was to investigate the ways in which a fabric could be produced from the hemp we grew. With the resurgence of interest in hemp fabrics, manufacturers of fibre extraction equipment, research institutes, spinners and weavers have all been keen to run trial batches on their machines.

The amount of fibre contained within the stem is around 30% of which perhaps 20% is suitable for textiles. For comparison, yields of flax fibre from traditional scutching methods are 16-18% of long aligned fibre for textiles and 8-10% short fibres (tow) from a similar total of 30% fibre within the retted stem (8). Incidentally, the tow would be an excellent paper making material.

We attempted fibre extraction by two different methods using;

- conventional flax "scutching" machinery (producing aligned fibres) and
- the new "Fibrelin" machine (producing nonaligned fibres) developed in the UK to process flax.

We sent retted stems to Depoortere, a flax processing machinery manufacturer in Belgium for trial processing on a conventional flax scutch line. The hemp stalks needed to be cut from their full length to 1.5 metres and yields of only 8.5% fibre were achieved (given that unadapted flax machinery was used, with a scutch turbine adapted for hemp, we should be able to obtain greater yields). To be processed on conventional flax machinery, the stems have to be kept aligned throughout harvesting and fibre extraction. The long aligned "hanks" of fibre thus produced will need to be spun and woven on flax machinery. A flax scutch machine adapted to take hemp could be produced and indeed this is the method used in Eastern Europe to produce hempfibre. However, it is somewhat labour and energy intensive and requires that the stems be aligned at all times.

The remainder of the stems we sent to Silsoe Research Institute in the UK to be processed through their new "Fibrelin" machine. The hemp was successfully processed to produce nonaligned fibres, with a yield of 20-25% fibre. However, the hemp was very "heavy" on the machinery, which has been designed for flax, and a rather more robust version of the machine would need to be built to process hemp.

Processing the fibre produced into a yarn

Samples of the fibre extracted by the two different mechanical methods were sent to a number of different spinners for evaluation. A number of processes are involved in preparing fibre for spinning. First the fibres have to be combed, then processed into a sliver which is an assemblage of fibres in a continuous form, then into a rove (a finer sliver) ready for spinning. Preparing and spinning the traditionally produced linen fibre was fairly straightforward for conventional linen spinners. Although as hemp is coarser than flax, the pins on the board for drafting the combed fibre into a sliver needed to be set differently. The rove produced was then boiled in caustic soda to refine it and most of the yarn was bleached with hydrogen peroxide. The rove was successfully spun on a wet spinning system developed by the company Mackie International. Bleached and unbleached yarn of 9.6-10.8Nm were produced.

The non-aligned fibre presented spinners with difficulties, in particular in the preparation of a sliver and rove prior to spinning. The hemp fibres were passed through a breaker card and then a flax card to produce sliver, but losses of fibre were two to three times higher than when processing flax. The hemp sliver "behaved badly" on the roving machine, but eventually a rove was produced. It was boiled in caustic soda and bleached with hydrogen peroxide. Some dry spun yarn was produced, but it was not of very high quality, and was not even considered suitable for carpet backing. The majority of the rove was successfully wet spun to produce a slightly stubby and hairy 6-7Nm yarn.

We observed that the line fibre yarn was smoother, finer and stronger than the non-aligned fibre yarn.

Weaving

Having produced the yarn, weaving is comparatively straightforward, but not without its problems! In order to carry out a machine weaving trial 100kg of yarn was needed. High losses of fibre due to the experimental nature of our work meant that we only had 12kg of yarn in total, but fortunately two textile colleges, Chelsea School of Art and Design and Huddersfield University were keen to hand weave small amounts. We concentrated on producing 100% hemp fabrics for our experiment, but hemp would be suitable to use in blends with wool, cotton or flax.

Generally weavers found the hemp was rather like linen to work with but stiffer and coarser. The line fibre hemp produced was easier to work with and produced better results than the non-aligned fibre yarn. We discovered that in Eastern Europe and historically in the UK hemp fibres were subjected to a softening process prior to spinning. This involves passing the scutched fibres through crushing rollers. If we were to repeat our experiment we would include this step.

Shrinkage was around 7%. We found that the hemp fabrics softened and improved with washing, rather like linen does. Simple industrial or handwashing improved the fabric, softening it, filling out gaps and adding smoothness and lustre.

A British grown and designed hemp garment

Top British designer Katherine Hamnett, well known for her strong commitment to environmental issues, was very impressed with the fabric produced from the line fibre and offered to design and make a garment from it. A lightweight summer blazer was produced, a picture of which is shown here.

What niche will hemp find in the textile market?

The fabrics and garment produced from our Hemp for Textiles trial are impressive, the bleached line fibre hemp fabric in particular. The line fibre hemp could be produced in the same manner as flax linen and for a similar cost. Hemp fabrics are in fact very similar in appearance, handle and other properties to flax and industry wisdom would say that there would be little to be gained in producing hemp unless it had some advantage - unique selling point - over flax. In certain respects hemp has some disadvantages when compared to flax. Its spinning limit (fineness) seems to be lower; about 12-14 Nm compared to 35 Nm or more for flax - though extremely fine hemp yarn at 30 Nm is apparently produced in China. A textile consultant has estimated that bearing in mind hemp's similarity to flax and it's likely lower spinning limit it would seem that hemp would only be successful as a textile fibre for the international markets if its price came somewhere below flax and above cotton. At the same price as flax there would of course, still be a market, but it would be small. However, the potential to grow hemp organically, which is difficult in the case of flax, would assist hemp gain a place in the small, but growing, market for eco-friendly products.

Tests were carried out at Huddersfield University this year to ascertain hemp's suitability as a furnishing fabric. Chinese hemp fabric, usually used for waistcoats, was compared with 100% cotton and a flax/synthetic blend. The hemp fabric had superior tear and break. The hemp was slightly less resistant to abrasion than the other fabrics, being most suitable for heavy domestic use.

Bearing in mind hemp's particular properties, the types of fabric and uses that hemp would seem to be most suited to are:

- the furnishing fabric area, especially drapes
- "bottom weights" in clothing; perhaps jeans and sportswear in both 100% hemp fabric and blends with cotton, linen or wool and with synthetics.

At the moment it is difficult to estimate the size of the potential market except to say that it is somewhere, depending on price, between cottons 50% of total fibre consumption and flax's 3%.

Technical problems to be overcome

We are pleased with the results of our experiment, as we succeeded in producing the first machine processed, UK grown 100% hemp apparel fabric probably this century. In the short term we feel that it would be possible to establish hemp textile production in Southern England to produce high quality hemp yarn and fabrics at a similar cost to linen. However, if hemp is to be grown and processed in cooler climates or at a more competitive price there are two technical problems which would need to be overcome.

Firstly, as hemp is harvested late in the season (a month later than flax) dew retting of hemp is unreliable. Therefore we must develop retting technologies that are suitable for our temperate climate, or bypass the need to depend on the weather. A lot of work has been done on retting flax, particularly by the French. In the UK we are also trying various techniques but it is too early to assess their probability of success. A great deal of work still needs to be done. What is certain is that unless the problem of retting is overcome we will not be able to produce textiles from hemp in countries where the climate is unsuitable for reliable dew retting.

The second problem is technically easier to overcome, but still needs substantial research and development. After retting the hemp stems, the fibre needs to be removed from the rest of the plant. Adapted flax machinery can be used, but it is not entirely suited to hemp which requires a more robust machine, and unless cutting the stems in half as we did for our trial, a much larger machine. The problem could be rapidly solved if the market demands the final product.

Concerning the further processing of hemp to produce the finished textile, we know that wet and dry flax spinners can adapt their machinery to handle hemp without too much difficulty, particularly the line fibre hemp. There is some practical experience in spinning hemp fibre in blends with cotton but as far as we know, no experience of blends with polyester or acrylics. As environmentalists we would prefer not to blend oil based synthetics with hemp but have been told that the addition of 10% of synthetic material greatly improves abrasion resistance and extends the range of end uses for hemp. For blends, it would probably be necessary to cut the hemp fibre to required lengths, but this will not prove to be a problem if the market is as substantial as expected. We foresee no particular problems in commercial weaving, dyeing and finishing.

Potential Yields

From the information that we have gathered we can calculate the amount of fabric that could be produced from each tonne of hemp if it were produced on a commercial scale (see table 2).

One tonne of hemp could comfortably be grown on 0.2 hectare (approximately 0.5 acre). A tonne of hemp would produce at conservative yields of 15%, 150 kg of line or high quality fibre. We should expect losses of 35% in hackling or carding, 5% in yarn production and a further 20% in boiling and bleaching the yarn to accept dye. This would leave us with 73 kg of fine hemp yarn producing 182 square metres of 400 gsm (jeans weight) fabric.

In addition, 100kg (10%) of shorter tow fibres would be generated which could be used for paper making or geotextiles and 500 kg (50%) of hemp hurds which would make excellent building materials or paper or can be sold as animal bedding. Whole crop utilisation is obviously beneficial from both an economic and an environmental point of view.

Table 2 : Predicted conservative yields of fabric.

0.2 hectares, (1 tonne) hemp
150kg textile fibre
97.5kg sliver
73kg yarn
182 square metres of 400 gsm fabric

In conclusion - Opportunities and challenges

BioRegional have learnt an enormous amount from our Hemp for Textiles trial. We have written up the results along with details of hemp for textiles in UK history and around the world in our report "Hemp for Textiles" ([9](#)). The major conclusions of our trial are that:

- hemp can be grown and dew retted in our bioregion South-East England, to produce textiles;
- the Hungarian hemp varieties we trialled have a higher yield than the two French varieties;
- flax processing machinery can be adapted easily to process hemp;
- line fibre hemp (from a 'scutch' mill) produces yarn and fabric which are noticeably superior in quality and strength to the nonaligned fibre hemp yarn and fabric;
- boiling with caustic soda, bleaching with hydrogen peroxide and wet spinning on flax machinery produced the best results.

We are greatly encouraged by the results of our experiment. Hemp, as a crop suited to organic cultivation has considerable potential as a new eco-textile, but the achievement of this potential is not certain and will require both hard work and investment. However, we believe that the revival of hemp industries world-wide would have many environmental, social and economic benefits - not if it is another internationally traded commodity, but if it takes place in the context of local production for local needs and whole crop utilisation.

REFERENCES

1. Bosticco, Miss Mary, personal communication 1995
2. Haraszyta A & Jakoby I, Effects of trace elements on the harl formation of hemp. 1968 Acta Biol. Debrcina 6:53-64 Field Crop abstracts, 23 3915
3. Jakobey I, Effects of micro-elements and fertilisers on the fineness of hemp. Rustnovenyek Kompolt 1968, 13-20 In; Field Crop abstracts,22.
4. Rowlandson T, On Hemp, Journal of the Royal Agricultural Society 1849, v10, pp172-182.
5. Eyre J.V., Some Minor Farm Crops, Hemp, Journal of the Royal Agricultural Society 1913, V74, pp 141-149.
6. Carter H.R., Modern flax, hemp and jute spinning and twisting (2nd edition) Scott, Greenwood and Son, London,1925.
7. Cultivation of hemp Fiches Techno-Economiques, Institut Agricole et Horticole Genech 1992 (French).
8. Sultana C, La culture du lin fibre. 1991 Institut Technique Agricole du Lin, France.
9. Riddlestone S, Hemp for Textiles, growing our own clothes, 1995 BioRegional Development Group, Sutton, Surrey UK.

Last updated 24th January 2008