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Hemp (*Cannabis sativa* L.) Cultivation in the Tai'an District of Shandong Province, Peoples Republic of China

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This paper summarizes the history of hemp (*Cannabis sativa* L.) cultivation and traditional use in the Tai'an District of Shandong Province in the People's Republic of China, and investigates the cultivation and processing techniques currently being employed to produce hemp ribbon and hemp seed. Recent production levels and market conditions are reviewed. Comparisons with Hungarian hemp cultivation and processing, being representative of Western hemp production, are provided where appropriate. Wild types and escaped plants are also described.

Introduction

Hemp is cultivated for its strong bast fiber throughout many of the numerous fertile inland valleys of Shandong Province, Peoples Republic of China. Hemp cultivation in China dates back more than 5,000 years and according to local legend, the peasant farmers of Shandong Province have grown hemp for more than a thousand years. Hemp is produced almost entirely by ancient traditional methods and local hemp farming practices have been influenced very little by modern Western techniques. However, a modern hemp degumming, spinning, and weaving mill was constructed in the village of Dong Ping in Tai'an District in 1987. In 1993, a Chinese-Dutch joint venture invested in the hemp mill and began to influence the local cultivation, market structure, and processing of hemp. This article documents the traditional hemp farming practices and current market situation, especially with reference to the sudden and rapid changes brought about through the influence of Western agricultural advisors, modern cultivation equipment and the introduction of improved hemp varieties.

Figure 1. Shandong hemp farmers use traditional methods to grow and process their crop.

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DEAR MEMBERSHIP

First, we owe our readers and authors an apology for all of the typographic errors and other mistakes apparent in our last issue. Because of editorial staff changes and scheduling pressures, proof-reading of that issue after its preliminary page set-up was sorely inadequate. We hope you will agree that this issue has returned the JIHA to its previous editorial standards.

The 1995 VIR/IHA *Cannabis* Germplasm Preservation Project was again successful and a preliminary report is presented in this issue. The IHA still owes the Vavilov Research Institute (VIR) of Russia US$ 5,000 for its work with the 1995 *Cannabis* seed reproductions. The 1996 project will require about US$ 20,000 and we must have funding organized by early Spring. We are extremely concerned about our ability to finance the VIR project in its fourth and final year. A grant support application for the VIR project has been made, but we are still interested to hear of any other such funding sources. Several of our members have made substantial donations, including: Don Wirtschafter of Ohio Hempery (US$ 500), John Roulac of Hemptech (US$ 250), Dr. J. P. Mathieu of FNPC (US$ 100) and Matthijs T. Huijgen (US$ 100). Generosity such as this, keeps the VIR project alive. Help us by renewing your membership for 1996 now and encourage your colleagues and libraries to join. We are planning to have our membership list ready in early 1996, so if you want to be included, please renew your membership soon. Remember, you must join at the Sustaining/Business level of US$ 100 to be included in the directory under your business or organization name.

We have continued our policy of active participation in both the hemp domain directly and at events that overlap these concerns. Examples of these efforts include the following.

---Textile Forum magazine, published by the European Textiles Network, devoted most of their June issue to hemp and derived much of their information from the IHA. If you haven't seen it, you can order a copy from the IHA bookstore. It's a beautifully done issue, with nice color plates.

---The IHA has been invited to join the FAO hemp/flax network and our journal received a favorable review in the June 1995 issue of its periodical, Euroflax Newsletter.

---The first two issues (1994) of the JIHA can now be found on the Internet at <www: http://www.calyx.com/~olsen/HEMP/IHA.iha.html>. An IHA member was kind enough to set us up on his web site, free of charge. We hope to establish our own site in 1996.

---We will soon be offering a *Cannabis* Information Kit for educators (see page 108). This was put together by our Projects Manager, Rob Clarke, and is a mixed media resource, including slides and actual examples of hemp products.

---The IHA was also pleased to contribute technical advice to the Colorado Industrial Hemp Act strategists on their efforts for 1996.

---In 1995, we supplied six varieties of seed, in small amounts, to IHA members for pilot research projects in Australia, Finland, and South Africa. We are expanding this archive for the 1996 season and hope to supply research quantities of seed for the majority of commercially available hemp varieties from France, Hungary, Poland and Romania. The IHA now has access to a refrigerated room (+3° C) for seed storage.

---The IHA appeared at a natural products exhibition held in September in Amsterdam and attracted significant interest, along with several new members.

---David Watson, Michael Rich, Xian Feng Jia and Rob Clarke gave a multifaceted presentation to the faculty of Detex Textile College in the Netherlands to help them incorporate hemp into their curriculum.

---Rob Clarke presented talks on two topics at the North American Industrial Hemp Forum, one a slide presentation about hemp cultivation strategies in Eastern Europe and China, and a second debate challenging the feasibility of genetically marking industrial hemp varieties (see page 104).

The passage of the last four years, and particularly this year, has seen more solid progress in establishing *Cannabis* as a major crop than the previous forty years combined. Let's keep up the good work!

Irene Bijl	Robert Clarke	David Pate	David Watson	Hayo van der Werf
Treasurer	Projects Manager	Secretary	Chairman	Editor-in-Chief

COLOFON

The Journal of the International Hemp Association is a bi-annual publication of the International Hemp Association (IHA), Postbus 75007, 1070 AA Amsterdam, The Netherlands. Tel./fax: +31 20 6188758, e-mail: iha@euronet.nl ISSN nr 1381-091X.

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The International Hemp Association is a non-profit organization established in 1992 to promote the beneficial uses of hemp products worldwide. The organization encourages and facilitates the accumulation and exchange of information on *Cannabis*, sponsors projects in several countries and publishes this journal for its members. The IHA is supported by memberships and by donations from foundations, corporations and individuals.

Although many IHA members may feel that in light of the great economic potential of *Cannabis*, the current legal restrictions hampering *Cannabis* research and hemp cultivation should be reconsidered, the IHA does not endorse a political stance on *Cannabis* legislation, nor will it serve as a forum for the *Cannabis* legalization debate.

LETTERS

Can THC occur in hemp seed oil ?

To the editors,

We have been approached by a firm which exports hemp seed oil from Hungary, who told us that foreign police or customs officials using dogs had stopped one of their consignments as it was suspected of containing THC. They sent us a small sample of the consignment, with the request that we investigate the validity of the suspicion, since literature data indicate that hemp seed oil should not contain THC.

Our working hypothesis was that the THC content could only be due to contamination of the oil with the seed tunic [bract].

1) The cannabinoid content of our own samples of 2 year old hemp seed oil was determined.
2) The THC content of 99 % pure Kompolti oil samples containing leaf and tunic debris and, as a control, that of oil from a hemp variety with a high THC content (of the hashish type) were also determined.
3) Determinations were made of the THC content of hemp seed oil from the Kompolti and high THC control varieties, purified to 99.9 % and further cleaned manually.
4) Finally, the THC content of the sample sent by the firm was determined.

Our own hemp seed oil had a THC content of 0.025 %, which even we did not know. Neither the Kompolti hemp seed oil purified mechanically to 99 %, nor the manually purified oil of Kompolti or of the control variety with high hashish content had a THC content which could be demonstrated chromatographically. The THC content of oil pressed by ourselves mechanically from the variety with high hashish content was 0.375 %.

It should be noted here that, due its extremely low THC content, the THC content of the oil sent by the firm can only be determined by thin-layer chromatography or gas chromatography after special preparation.

Since hemp seed oil and oils prepared from seeds not cleaned of leaf debris and tunics were found to have a cannabinoid content demonstrable by thin layer chromatography and gas chromatography (CBD was also identified), while oil prepared from seeds purified from the tepal (tunic) had none, it can be concluded that this cannabinoid content entered the oil in the course of the technological process of oil manufacturing. It can only originate from tunic and leaf debris. Consequently, hemp seed oil should only be pressed from seeds of eating quality, i.e. of at least 99.9 % purity, in which case there can be no possible occurrence of THC in the oil. It should be noted that even the 0.375 % THC content found in the variety with the highest THC content is completely innocuous, while that of oil pressed from purified and unpurified seeds of the other varieties was entirely negligible.

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4 Fleischmann Utca, Kompolt 3600, Hungary

Membership

The IHA has three types of membership: Student (US $25/NLG 40 per year), Individual (US $50/NLG 80 per year) and Sustaining/Business (US $100/NLG 160 or more! per year). In order to be listed by your business name you must join at the Sustaining/Business level. Members may order additional or previous issues for US $10 (postpaid), non-members pay US $ 15 (postpaid). Members joining after June may join for the next year and purchase the issues of the current year. Payments may be made by International Postal Money Order, American Express/Thomas Cook Money Order, or via AmEx credit card.

Authors who contribute an accepted article to the journal will receive a year's membership, including a subscription to this journal. Sustaining members can direct their contribution toward any specific project they prefer. A financial audit of income and expenditures is available to sustaining members.

Submission of manuscripts

The IHA Journal publishes original research, literature reviews and news items on hemp. Preferably, contributions should not exceed 10 double-spaced typed pages (ca. 4000 words). Longer contributions may be accepted if they can be serialized in two consecutive issues. Manuscripts can be submitted in triplicate to: IHA Journal, Editorial Office, Postbus 75007, 1070 AA Amsterdam, The Netherlands. Once a paper is accepted, the preferred medium of submission is on disk (Macintosh or MS-DOS format), preferably MS Word 5.0 or later, with accompanying manuscript. A guide for authors can be obtained from the IHA.

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Shandong Province

Shandong Province is located along the central coast of eastern China (see Fig. 2) and has a continental climate. Summers produce heavy rain and average 21^{o} C temperatures. Autumn weather is clear and sunny with an average temperature of 10^{o} C. Winters bring several snowfalls and average minus 4^{o} C. Spring is often foggy or rainy and the temperatures average 11^{o} C.

The city of Tai'an is located in west-central Shandong Province and is situated at the foot of Tai Shan, the most revered of the five sacred mountains of ancient China. Chinese mythology says that Tai Shan represents the head of Pan Gu, the mythological creator of China. His four limbs form the remaining four sacred mountains in North, South, West and Central China. The Chinese have made pilgrimages to Tai Shan for several millennia, believing that the mountain has power over Heaven and Earth, of which the summit is held to be a manifestation. Confucius ascended to the summit several times, over 2,000 years ago, as have many Chinese emperors. Millions of devout Buddhist and Taoist Chinese have climbed the more than 7,000 stone steps to the summit; lighting incense, leaving offerings and praying at the dozens of shrines, temples, and carved stone calligraphies along the way.

As one approaches the summit of Tai Shan, *Cannabis* can be seen growing spontaneously with increasing frequency along the sides of the paths. The mountain top is nearly covered in weedy hemp that has escaped cultivation and grows throughout the rocky outcrops. This perhaps results from the ancient Taoist tradition of offering grain to the Jade Emperor atop Tai Shan peak during the Double Nines Festival held on the ninth day of the ninth month of the Chinese calendar. Taoists consider the Jade Emperor to be the Supreme God of Heaven and spread offerings of grain so that the birds will carry their prayers and praises to the deity. New seeds are therefore brought to the mountain regularly. These escaped plants are of shorter stature (1-2 meters) than cultivated varieties and have brown seeds and medium sized leaves. Their reduced stature and seed size likely result from the harsh climate of Tai Shan, but in other respects they are very similar in appearance to the locally cultivated hemp varieties.

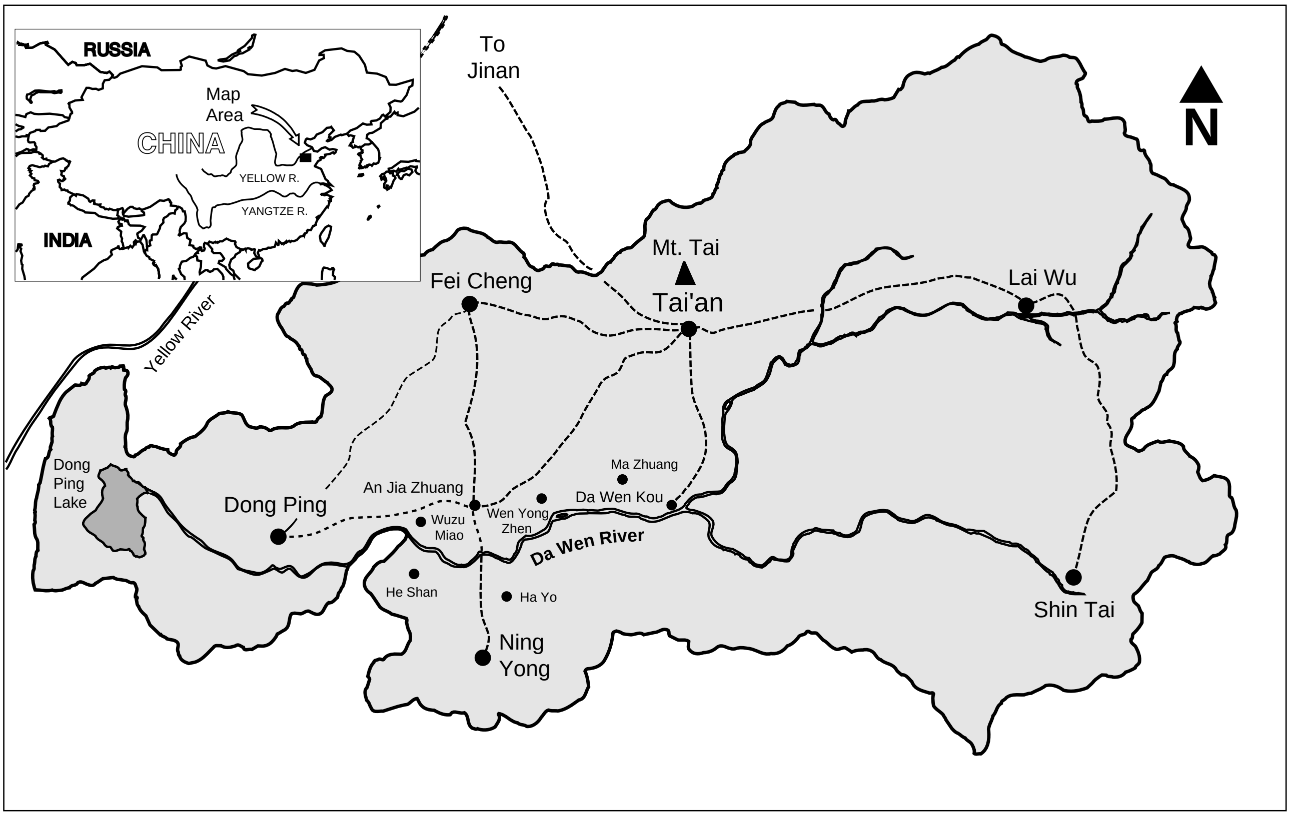

Figure 2. Tai'an District, Shandong Province, P. R. C.

A different spontaneously occurring variety of *Cannabis* is found on the north side of Tai Shan far from the influence of religious pilgrimage. This “wild” (naturally occurring without the influence of cultivation) variety is characterized by very short stature (less than one meter), reduced leaves with narrow leaflets, tiny dark seeds, and a very compact and highly branched growth form, even when crowded together. Some populations also have very red stems. Wild *Cannabis* flourishes on the rocky fringes of the highest terraced fields in the disturbed zone between cultivated lands and mountain slopes, along paths and roads, and in the shade of trees where no crops are planted. Spontaneously growing escaped and wild *Cannabis* does not survive as an intrusive weed in cultivated fields since it is removed by local farmers.

Phenotypic characteristics	Mt. Tai Shan 'wild'	Mt. Tai Shan 'escaped'	'Lai Wu' 'landrace'	'Fei Cheng' 'landrace'
Leaf shape and size	light green highly reduced leaves; 1-5 narrow leaflets w/ many fine serrations	light green small and narrow	medium green; 7-9 medium leaflets w/ more serrations	dark green; 7-9 large broad leaflets w/ fewer serrations
Stalk height	very short (0.2-1.0 m)	short (1.0-2.0 m)	medium (2.5-3.5 m)	tall (3.0-4.0 m)
Internode length	very short (1- 5 cm)	short (5-10 cm)	medium (10-15 cm)	long (15-20 cm)
Branch development	highly branched compact growth	sparsely branched	many long branches	few short branches
Flowering commences	very early (June)	early to late (July and August)	early (males = July 20-25) (females = August 10-15)	late (males = August 10-15) (females = August 25-30)
Stem diameter	very small (2-6 mm)	small (5-10 mm)	medium (10-30 mm)	large (15-40 mm)
Seed description	dark brown (nearly black) w/ abscission layer	brown or gray w/ or w/o pattern w/o abscission layer	light-colored seeds w/ dark longitudinal stripes w/o abscission layer	and large brown seeds w/ marbled patterns w/o abscission layer
Seed size	very small (1,000 seeds=4 gm)	small (1,000 seeds=10 gm)	small (1,000 seeds=12 gm)	largest (1,000 seeds=26 gm)
Seed maturation	very early (late July to early Aug.)	early (Aug. -Sept.)	medium early (September)	late (late Sept. - early Oct.)
Sexual type	dioecious	dioecious	generally dioecious *	dioecious

(*some male plants start out as female at first nodes, but change to purely male as flowering continues)

Table 1. Phenotypic differences between the spontaneously growing wild and escaped populations and the cultivated small-seed and large-seed landrace types of the Tai'an district.

In the Tai'an district, the landrace variety is referred to as either "Lai Wu" or "Fei Cheng" hemp, named after the famous eastern Lai Wu and central Fei Cheng hemp producing counties of the Tai'an District. Little if any intentional human selection has occurred and the evolution of the landrace has been directed almost entirely by unconscious selection by farmers and by natural factors. No special selection for crop improvement is exercised by farmers.

Cultivated Plant Description

The Shandong land race of *Cannabis* hemp is almost entirely dioecious. Plants are generally moderately branched and 2.5-4.0 meters in height. The foliage is medium to dark green and the leaves have 7-9 leaflets. The inflorescences are relatively sparse and seed yield is low compared to improved European varieties. Although some individuals elaborate resin glands, they apparently produce little if any of the primary psychoactive cannabinoid THC, and the local landrace cannot be considered a drug variety. There is no local tradition of its use as either medicine or inebriant. The physical characteristics of the seeds of the cultivated *Cannabis* of the Tai'an District fall into two groups; small light-colored seeds (1,000 seeds=12.0 gr.) with dark longitudinal stripes, and large brown seeds (1,000 seeds=26.0 gr.) with marbled patterns. Local agricultural officials report that the small-seeded variety is 'Lai Wu ' and the large-seeded variety is 'Fei Cheng'. Apparently the 'Lai Wu' and 'Fei Cheng' varieties have been traded back and forth throughout the Tai'an District for years.

Both of these seed types are derived from segregation of the local landrace. They originate from the same fields and both were found to be equal in bast content (8-15% d.w.). About 65% of the plants in any given population are large-seeded, about 20% are small-seeded, and (based on seed characteristics) only about 15% seem to be hybrids between the two, although the two varieties are cultivated in the same fields. Few hybrids are observed because the two varieties flower at very different times. The hybrids likely occur only between late flowering females of the small-seed variety and early flowering males of the large-seed variety. It would be very unlikely for males of the small-seed variety to hybridize with females of the large-seed variety since the small-seed males have ceased to shed pollen long before the large-seed females are receptive.

Several additional marked phenotypic differences are exhibited that must reflect underlying genotypic differences (see Table. 1).

The characteristics associated with the small-seed cultivated landrace could result from its breeding with a local wild variety, but this seems unlikely because the geographical ranges and flowering times of the wild populations do not coincide with the cultivated landraces. It is more likely that either the small-seed landrace is introduced from more northerly latitudes, since it matures early, or that the large-seed landrace is introduced from more southerly latitudes, since it matures late. Local hearsay has it that hemp varieties were introduced from southern China, but this could not be verified with agricultural officials. Introductions of small amounts of seed from Japan also may have been made many years ago for the local production of woven burial shrouds. Exchange of seed between counties within the Tai'an District is also common. Although the stalks of the small-seeded variety have a bast percentage equal to the large-seeded variety, they are shorter, so the overall yield is lower. Therefore, the farmers claim to prefer the large-seed variety. Despite this sentiment the small-seed variety is still present in the fields and consistently comprises approximately 20% of the population. This is one explanation for the lack of uniformity in local hemp crops that result in uneven competition within stands and for the production of many different height stalks. This difference in height is especially apparent in the Autumn harvest season since the upward growth of small-seed plants is slowed due to their earlier flowering.

Broadcast Sown			Sown in Rows (10-15 cm spacing)		
Quality level	**Avg. No. stalks/m^2**	**Percentage of each quality**	**Quality level**	**Avg. No. stalks/m^2**	**Percentage of each quality**
First (tall) (2.5+ m)	34	27	First (tall) (2.5+ m)	88	44
Second (med.) (1.5-2.5 m)	39	31	Second (med.) (1.5-2.5 m)	61	30
Third (short) (< 2.5 m)	53	42	Third (short) (< 2.5 m)	54	26
Total (No/m^2)	**126**	100	**Total** (No/m^2)	**203**	100

Table 2. Variations in stalk quality (length) between broadcast-sowing and row-sowing.

Extent of Hemp Cultivation

In the 1970s and early 1980s, Shandong Province produced more than 100,000 tons of hemp ribbon annually. (Hemp ribbons are strips of bark peeled from the outside of the stalks that contain bast fibers.) The author's estimates, based on interviews with local agriculture officials, indicate that the Tai'an District grew about 65,000 ha annually and produced about 60,000 tons of ribbon which accounted for about 60% of the production of Shandong Province. Hemp was widely grown throughout the Tai'an area in several counties where it is no longer cultivated today. During this time the region surrounding Lai Wu in eastern Tai'an District was considered to produce the tallest and finest hemp in Shandong Province. Very little hemp is grown in Lai Wu today and the vast majority of the hemp is grown in Fei Cheng and Ning Yong Counties. By 1992 no more than 10,000 tons of hemp ribbon were produced in Tai'an District on less than 10,000 ha. The decline in hemp production resulted from diminished markets for hemp products and the low prices for raw hemp ribbon in comparison to other crops. Farmers feel they can earn more money from food crops such as wheat, maize, soy beans, peanuts, fruits, and vegetables.

In Dong Ping County, approximately 1,600 tons of hemp ribbon were produced in 1992, and about 625 tons were bought by the Dong Ping Heavenly Hemp Textile Mill. The remaining 975 tons bought by the company came from the other hemp producing counties of Fei Cheng and Ning Yong and the Tai'an Urban District within Tai'an District.

In 1993, the Dong Ping Heavenly Hemp Textile Mill purchased 1,600 tons of hemp ribbon from farmers in the Tai'an District. This represents the production from about 1,500 ha. The total amount of land planted in hemp in Tai'an District in 1993 was estimated by local agricultural officials and hemp mill representatives to be approximately 5,300 ha. These estimates may be somewhat high. Estimates based on local data collected by interviewing village leaders and agricultural advisors, and the trends extrapolated from these data, lead to the conclusion that closer to 4,000 ha of land was used to grow hemp in 1993.

The remainder of this study concerns recent hemp production in Tai'an District along the Da Wen river south and west of Tai'an city. This area includes Dong Ping County (south and east of Dong Ping Lake), Tai'an Urban District (near the villages of Da Wen Kou and Ma Zhuang), Ning Yong County (near the villages of He Shan and Jiang Ji), and Fei Cheng County (near the villages of Wen Yong Zhen and Wuzu Miao).

Field Conditions

The growing season for Spring hemp extends for approximately 110-120 days from late March (Spring Equinox) through July (Seasons of Slight and Great Heat). The Spring crop reaches canopy stage at 1.0-1.5 meters by the middle of April. The Summer crop is planted in middle June (Season of Grain-in-Ear) and harvested in late August (Season of Limit of Heat) or early September (Season of White Dew). Spring hemp is regularly irrigated. Farmers of Summer hemp rely on Summer rains to irrigate their crop. Irrigation from numerous wells is often provided several times during the growing season. (This is in contrast to the single Hungarian hemp season that extends from May through August, during which the crop is never irrigated.) Much more land would be available for hemp cultivation if hemp was to rival maize or soy bean as the major Spring and Summer crop. Only significant economic incentives for farmers will revive hemp production in Tai'an District.

The soil type in this area is a coarse sandy clay with very few small rocks. It drains readily and most of the fields appear healthy and productive. The soil south of Dong Ping Lake is heavier than the soil in Fei Cheng and Ning Yong Counties, drains more slowly, and is subject to flooding. Hemp is grown primarily on the rich flat-bottom valley land along the Da Wen river and very little is grown in the terraced foothill fields.

Cultivation Techniques

Seeds of the local landrace are reproduced each year from remnant seed saved by the farmer. There is no intentional selection by the farmers, except possibly for the large-seed characteristic, and there are no imports of improved seed from other regions of China.

Seed is traditionally broadcast by hand at a seeding rate of 75 kg/ha for hemp fiber production and the resulting stand density ranges from 118-133 plants/m^2. (Hungarian hemp farmers usually sow from 70-85 kg/ha depending on the seed size and viability. Nearly 400 seeds are sown/m^2 resulting in 150 to 200 stalks/m^2 at harvest) In recent years, at the suggestion of local agricultural advisors in Wen Yang County, a few fields were sown by planting in rows approximately 10-15 cm apart rather than by broadcasting. In this case, the same sowing rate was used but the stand density ranged from 187-215 plants/m^2. (Average Hungarian hemp fields are planted in rows 12 cm apart.)

The average yield/m^2 of stalks was increased by 60% and the average percentage of first quality fiber was also increased by 60% by planting in rows. This results from the increase in surviving stalks when seeds are sown in rows, rather than broadcast (Table 2).

Fertilizers are applied before sowing and when the crop is about 50 cm tall. Various animal manures (15-60 tons/ha) and soy bean meal (up to 1,500 kg/ha) are spread on the fields and plowed or spaded under in the Spring well before sowing. Mixtures of chemical fertilizers are commonly used at a total application rate of up to 1,000 kg/ha.

The hemp crop is harvested in its entirety before the plants begin to flower, approximately 100-120 days from sowing. Plants range in height from 1.5 to 3.5 meters. The average height of healthy stands of hemp is 2.5 meters. The majority of plants have ceased rapid stalk elongation as they approach flowering. Upon close observation a few of the plants can be sexed at harvest in middle July (Season of Slight Heat), but none have begun to flower.

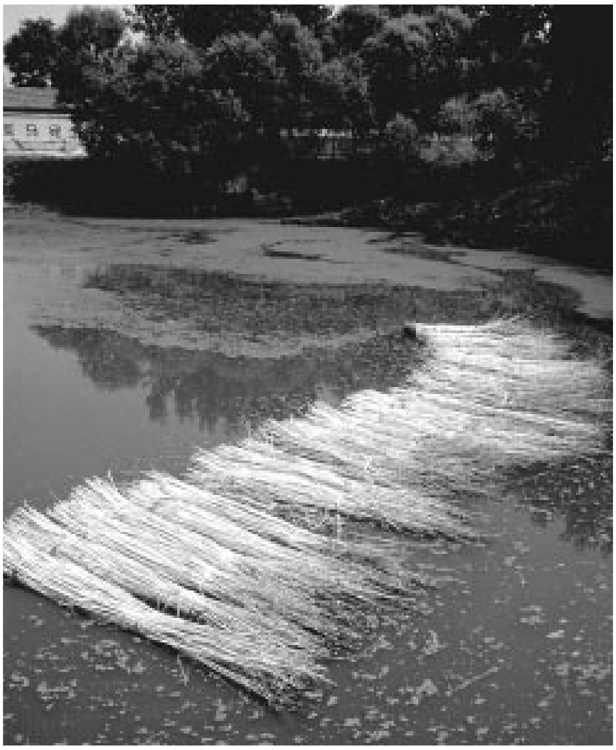

Figure 2. Bundles of hemp stalks retting in a pond.

(Hungarian hemp is harvested when it begins to flower and the male plants shed pollen, but very few viable seeds form before the hemp is harvested in late August.)

Since hemp is harvested before it flowers, no seed is produced. Seed is produced either in fields intentionally sown for seed, or from plants growing along the margins of fields, on the banks of irrigation ditches or along roadsides. Seed crops are planted in late May (Season of Full Grain) or early June (Season of Grain-in-Ear) with the rows spaced approximately 50 cm apart. Seed plants are harvested in the middle of October (Season of Cold Dew).

Only one insect pest seems to cause economic damage to the Spring hemp crop. A small shiny black jumping flea-beetle infested all of the fields to varying degrees. Few fields were uninfected. In fields where less fertilizer was used, and crop growth was not quite so vigorous, the beetle infestations reached tremendous levels, and they skeletonized all of the leaves on every plant. The beetles must certainly lower yield, but it was difficult to determine by how much, since the only fields to be seriously attacked were those where little fertilizer was applied, low nutrient levels also decreasing yields dramatically. Farmers report that the flea beetles only cause damage late in the crop cycle during the last month before harvest, and that the fields harvested last have the worst infestations of flea beetles. Seed crops maturing in the Autumn are plagued by leafhoppers, caterpillars, aphids, and many other common agricultural pests.

Hemp fields are planted so thickly that weeds are shaded by the dense canopy and crowded out. Weeding is only necessary in widely spaced seed gardens. No herbicides or insecticides are used on hemp in Tai'an District since they are expensive and few pests threaten to cause serious economic damage.

Hemp Processing

The hemp crop is harvested by cutting all of the stalks at the soil line with a short-bladed sickle, taking care not to pull up any roots. Bits of root attached to the ends of the ribbons lower their quality and must be removed later by hand at the mill. Dry soil is more convenient for harvesting because the shallow roots stay in the ground rather than pulling out. Branched plants at the margins of the fields are usually discarded or occasionally saved for seed production.

The plants are graded by pulling out the longest stems of highest quality first. The top projecting leaves of the bundles are pulled to first select the longest stalks and then the medium length stalks of second quality are removed. The short and twisted stalks of third quality are taken back to the village for domestic use, such as laying crude twine and rope, and do not normally enter into commerce. The leaves are stripped from the graded stalks with a long field knife before drying.

The three grades of stalks are separated and laid out in the sun in a single layer across the empty harvested field for 2-4 days until they are partially dried. (The Hungarians dry the stalks completely and ret either in the Autumn or the following Spring and Summer after the weather warms.)

The partially dried stalks are then bundled together approximately 200 at a time and immersed in a pond, stream, or brick tank for 1 to 3 days of retting. The bundles are turned twice a day in ponds or streams, or weighted down with stones and timbers in retting tanks, to keep them wet. Since the stalks are still somewhat moist, and do not float as buoyantly as completely dried stalks, they need not be weighted so heavily. The retting water is from 23° to 30° C. depending on the depth of the water and its exposure to direct sunlight. (Hungarian retting takes a week or ten days in much cooler water, or only a few days in warm geothermal water.) After the brief retting the stalks are again laid out on the field in a single layer and partially dried in the sun for 2 to 3 days. If the initial retting was insufficient to free the fibers the stalks are sometimes retted a second time and partially dried again.

At this point, the stalks can be processed by two different methods. The most common is the wet-method in which the stalks are partially dried and then stripped of their fibers by hand. Small bundles of these bast fiber ribbons are then tied together near the basal end and dried on lines in the sun. After they are thoroughly dried for several days, the smaller bundles are tied together, ten at a time, and bundled tightly for market. This wet-method allows the farmer to market his hemp very quickly.

However, a very few farmers dry the stalks completely and store the dried stalks until later in the Summer or Autumn. They then break the dried stems and comb the ribbons to remove the woody hurds by the typical Western dry-method. The yield of salable ribbon by the dry-method is approximately 10% of total dry stalks, while the yield of salable ribbon by the wet-method is approximately 8% of total dry stalks. Dry-method hemp is of slightly higher average quality than wet-method hemp, and as there is far less dry-method hemp, it commands a slightly higher price at market. Bast fiber content of plants of the local landrace saved for seed production ranged from 5-22% and averaged 12%. (Improved Hungarian varieties yield from 30-35% bast.)

Apparently the dry-method was initiated in 1986 by request of the Dong Ping Hemp Mill, but it has not gained much popularity, as it requires specialized equipment. The mill uses mostly wet-method ribbon but prefers to use the less common dry-method ribbon. By 1995 almost all of the hemp ribbon was produced by hand stripping of partially dried stalks. Any technique that will make the farmer's work easier and free up their fields earlier, so they can sow another crop, is always favored and becomes the most common.

A good crop produces approximately 8-12 tons of dry stalks and 0.7-1.0 tons/ha of first and second quality (long and medium length) salable ribbon. (Hungarian hemp fields produce 7-10 tons/ha of dry stalks or approximately 2.5-3.5 tons/ha of ribbon.)

Hemp Marketing

The quality and price of hemp ribbon are determined by its method of preparation, length, and moisture content. Long strands of well retted and dried hemp ribbon command the highest prices. The price of hemp ribbon is lowest in July and August when hemp fills the markets following the Summer harvest.

In July of 199, the farmers were being paid up to US$ 0.60/kg for first-quality wet-method ribbon and US$ 0.40-0.50/kg for second-quality wet-method hemp ribbon. By July 1994 it was reported that the farmer was being paid US$ 0.75/kg for first-quality ribbon. The July 1994 harvest was delayed slightly by heavy rains during early July, but this also raised the total yield of hemp. In July of 1995 the market price of first-quality hemp ribbon had risen to nearly US$ 1.00/kg.

Seed Production and Marketing

Seed for the following year's sowing is obtained from two sources. The largest portion of the seed comes from fields that were planted for hemp seed production. The second source of seed is from spontaneously growing escaped roadside ditch plants that the farmers call "wild". Cultivated seed fields are usually sown in late May or early June (Seasons of Grain and Grain-in-ear) in clusters of 4-5 seeds at approximately 15-50 cm intervals in rows approximately one meter apart in order to allow sufficient branch development and increased seed yield.

All of the seed plants have sparse inflorescences and even the most fecund have a fairly low average yield of seed (400-500 kg/ha) when compared to improved hemp varieties from eastern Europe (800-1,200 kg/ha). Roadside plants have very sparse flowers and even lower seed yield, due mainly to a lack of nutrients. The seed crop is traditionally harvested during the Season of Cold Dew and before the Season of Frost's Descent. This time falls approximately between October 8 and October 23.

The inflorescence is absolutely non-shattering and the seeds must be threshed from the plants during collection. This indicates that the Shandong landrace is fully domesticated. The seeds are very resistant to threshing unless the plants are fully dried. The seed is threshed from the plants in three stages. After the seed plants are harvested, they are stacked in pyramids and allowed to partially dry for 2-3 days before the first threshing. The plants are still fairly moist and supple at the time of the first threshing. Only the most mature seeds fall from the inflorescences as the whole plants are flailed against the ground. The first threshing produces the highest yield of the most mature and highest quality seed. The second threshing of the whole plants is done after the plants have had a few more days to dry and the less mature seeds can be freed more easily. The third and final threshing is performed a few days later when the plants have had time to thoroughly dry. The last of the seed is squeezed from the inflorescences by rolling them between the palms or by children walking barefooted on top of the plants. In each case the seed is dried in the sun for 2-3 days to ensure that it is sufficiently dry to be stored in rice sacks without spoiling.

The farmers keep a constant daytime watch and hang brightly colored cloth above the stacks of drying seed plants to prevent small sparrows from feeding on the seeds. Firecrackers are commonly used to scare flocks of feeding birds away from the seed fields. Seed plants are often transported to the farmer's home immediately after they are harvested to prevent further destruction of the seed by birds and rodents.

Some special cultivation techniques are used in hemp seed fields to increase yield. The tops of female plants are often removed as they begin to flower so they will grow more branches and consequently yield more seed. Sometimes up to 90% of the male plants are thinned at the time of early flowering to allow the female plants more room to branch and yield more seeds. The fiber of the highly branched male plants and seed plants is too coarse for textiles and is used by the peasants to make rope, binding twine, and other domestic products.

The majority of seed is bought by other local hemp farmers who require additional seed to grow their hemp fiber crop. The remainder is sold in Tai'an city for bird seed. Hemp seed usually sells for US$ 0.75-1.00/kg. Maize seed costs US$ 0.75-1.00/kg, soy bean seed costs US$ 0.25/kg, and peanut seed costs US$ 0.30/kg. Densely planted stands of fiber hemp are sown at a rate of 75 kg/ha, while maize fields are sown at a rate of 10 - 15 kg/ha, so hemp is by far the most costly agricultural seed.

Traditional uses

Shandong Province has a long history of folk uses for hemp. In today's open market most of the first and second quality hemp ribbon is sold for cash to suppliers and only the third quality hemp ribbon from short and twisted stalks is commonly used domestically. Sometimes the fibers are stripped from the stalks without retting or entire small stalks are twisted or braided together to make crude rope. The local peasants traditionally made twine, rope, sacking, burial cloths and other domestic items from the small stalks, ribbon and fiber. The small stalks are used directly for binding without any further processing, the hemp ribbon is twisted into twine, or the fiber is extracted and laid into rope. Hemp stalks are tied together to make crude walls for field shacks and are also lashed together in the garden for bean trellises and light fences.

Neither hemp seed, nor hemp seed oil, is commonly eaten in Tai'an district. This is in direct contrast to much of China where whole hemp seeds are eaten uncooked or roasted as snacks and oil is also sometimes pressed from the seed. The peasants around Tai'an say that if you eat too many hemp seeds (about 250 gr.) you will faint. The resin-covered bracts adhere tightly to the outside of the seed, and this may be the reason for this legend, even though the local landrace is only slightly psychoactive. Pigs and other farm animals eat the fresh leaves that are cut from the hemp stalks and seed plants before they dry completely.

Crude paper is occasionally made from the hurds or wood. Local paper factories include hemp hurds and hemp fiber to strengthen wheat straw paper. The hurds are most commonly used to start coal fires for cooking and heating.

A small specialty market also exists based on direct export of unprocessed hemp products to Japan. Raw fiber is used there for the hand spinning of fine textiles and specialty paper production. Japanese traders also buy a limited number of long straight hemp stalks for fireworks manufacture or for use as funerary offerings. Long straight clean stalks, peeled of their fiber are used in Japanese funerary rituals to show respect for the spirit of the deceased. In 1993 the farmers received (0.3 US$/kg) for cleaned stalks.

Conclusions

A comparative study of the historical and current techniques of hemp cultivation in the Tai'an District provides insights into the relatively unchanged practices of peasant farmers. More importantly, an understanding of these ingrained hemp farming and processing methods will allow advisers to make more appropriate suggestions concerning the modernization of local hemp production. Rapid changes in hemp farming and processing will follow in the wake of Western investment in local hemp production. Advisers must make educated decisions concerning the timely implementation of these changes.

Fibre hemp cultivars: A survey of origin, ancestry, availability and brief agronomic characteristics

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Due to renewed interest in hemp, many experiments in Western Europe, Australia and Canada have been initiated which are aimed at (resumed) domestic hemp production. Obtaining sufficient seed quantities from a range of different cultivars is a practical difficulty often met by researchers. The present paper surveys the more or less currently available cultivars with respect to breeding history and provides addresses of seed suppliers. Agronomic characteristics assessed in standardized variety trials in the Netherlands are treated briefly.

Introduction

There is a renewed interest in hemp as a source of cellulose fibre and seed oil in Western European countries, Australia, the US and Canada as these countries share a need for profitable arable non-food crops. Many experiments which are aimed at the feasibility of domestic hemp production have recently been initiated. All Western countries, except France, have either never had a hemp industry, or have interrupted it for decades. A substantial hemp industry has survived only in Eastern Europe, the former Soviet-Union and China.

Presently, legal measures against *Cannabis* drug use in Western countries may improperly discourage any hemp activities, including research. Other obstacles generally faced by individuals wanting to resume a fibre hemp industry are more practical: local cultivars are extinct, there is no adequate harvesting machinery and fibre extraction technology is antiquated.

At least for the short term, the new initiatives must rely on cultivars imported from countries which currently breed hemp. As far as the author knows, the breeding of new domestic cultivars has only been pursued in a recent program the Netherlands (van Berlo, 1993) which focused on hemp grown as a raw material for pulp. This paper surveys national registration and registration in European Union member states, as far as could be traced, by country of origin the current cultivars, with regard to commercial availability. Further, it briefly presents some agronomic characteristics. The commercial availability of cultivars can rapidly change, and the assessment of the present situation, based on personal experience, hearsay and assumptions, may hence contain mis-information. Prices recently charged for seed for sowing are given when available.

The status with regard to registration in the European Union is relevant as within the EU cultivation of fibre crops including registered hemp cultivars is supported by an equivalent of ca US$ 1,050 per hectare. The reasons for this support are that fibre production in the EU does not meet the demand, and, that the yearly fluctuations in both production and prices are considered too strong. Out of the twelve presently registered EU cultivars only the seven French cultivars are readily available. In order to be less dependent on the French hemp seed distributor several cultivars originating outside the EU were submitted for EU registration in 1995, eight in Austria and three in the Netherlands. For 1996, other submissions probably concerning newly bred cultivars from within the EU are expected in the Netherlands. The procedure for registration takes two to three years and comprises research aimed at morphological distinctness and practical agronomic value of the submitted material in relation to reference cultivars. Once a cultivar is registered in a member state it will automatically be placed on the general EU register. This implies that its cultivation should be admitted by any member and that it should be eligible for EU subsidy. However, a member state may obstruct admittance on the ground of lack of quality or distinctness in relation to domestic cultivars and of course national drug legislation may hamper actual application.

Fibre hemp in the *Cannabis* genepool

All strains within the genus *Cannabis* intercross readily (Small, 1972) and the pattern of variation for all morphological and agronomic traits is continuous (Small *et al.*, 1976). Hence there is little reason to distinguish other species than the single *C. sativa* L. Morphologically discriminated subspecies and varieties are not very suitable to indicate plant groups of various economic interest. Non-biosystematic classifications, for example based on purpose and status of domestication, are more appropriate to circumscribe such groups. Accordingly, one can distinguish truly wild and naturalized populations, fibre landraces and fibre cultivars, drug strains and even ornamentals. Such pre-defined 'plant-use groups' (de Meijer, 1994) can be recognized quite well on the basis of experimental observations of agronomic traits. Contents of bark fibre and cannabinoids, the major goals of domestication, are fairly discriminative between groups.

From the breeding histories it is evident that a considerable mutual genetic relatedness exists among the modern European and West Asian cultivars. Landraces belonging to the Mediterranean and Central Russian fibre hemp ecotype groups and cross-progenies of these two groups have directly been the basis of, or have been used

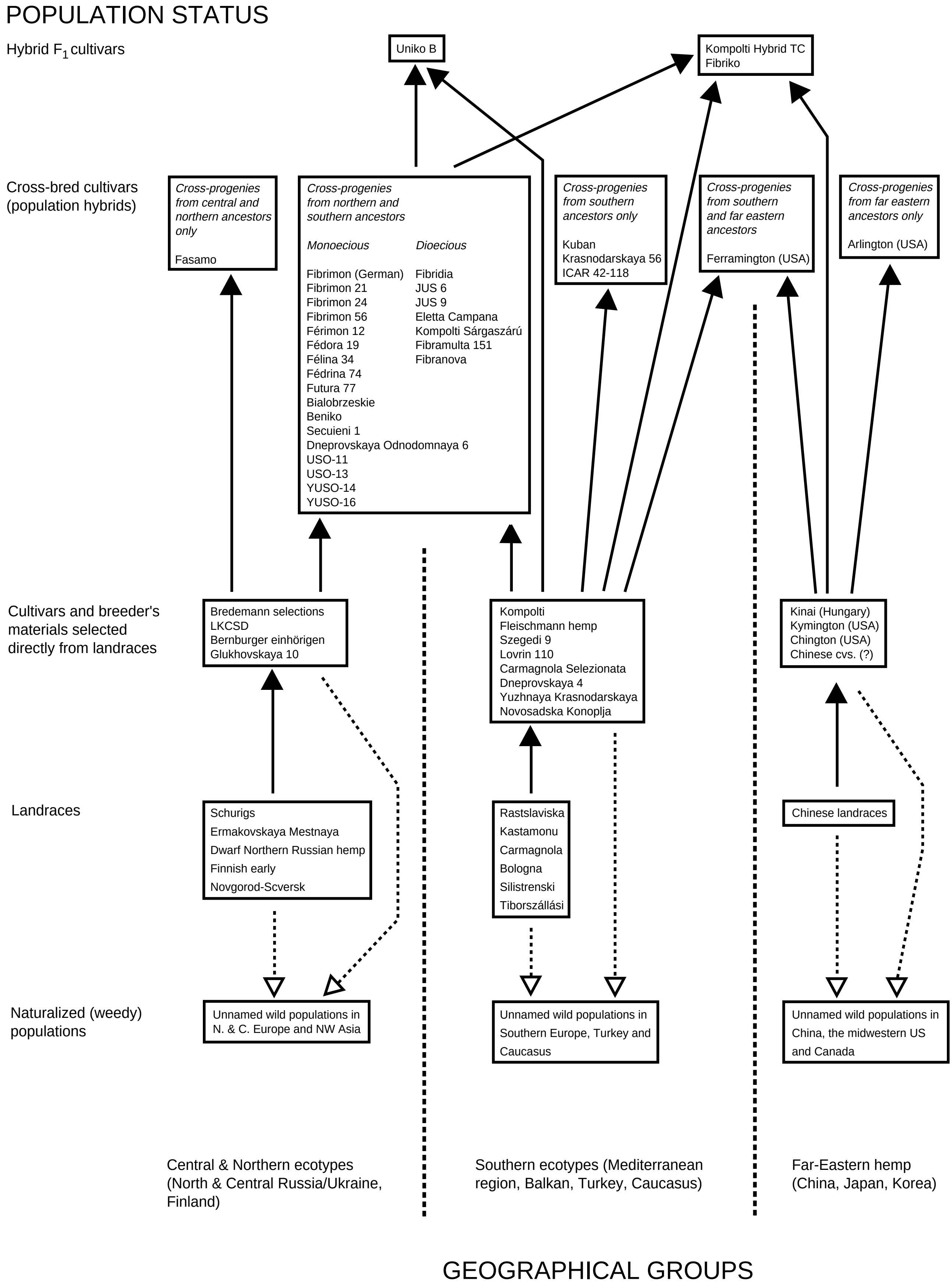

Figure 1. The hemp strains mentioned in the text classified roughly according to population status and geographical group. Solid arrows indicate the descent of the groups due to breeding activities. Dashed arrows indicate spontaneous naturalization. Boxes enclose open-ended groups of strains.

as breeding parent for, each of the present European and West Asian cultivars (Fig. 1). Fibre strains from China (Far Eastern hemp) may be somewhat distinct from the previous ones. References on Chinese fibre strains are hardly available, indicating that landraces are still primarily cultivated. At the beginning of the 20th century Chinese landraces were used to select the now extinct Kentucky hemp cultivars that were cultivated until the mid-1950s in the United States. The first improved selection from Chinese origin was called ‘Minnesota No. 8’ (Dewey, 1913). Dewey (1927) gives the ancestries of the later developed Kentucky cultivars: ‘Kymington’ was selected from the progeny of a free-pollinated single female plant of ‘Minnesota No. 8’. ‘Chington’ was obtained by successive individual selection in the progeny of a single female plant from a different introduction from China. ‘Arlington’ was selected from the progeny of the crossing (‘Kymington’ x ‘Chington’). ‘Ferramington’ was selected from the progeny of a cross between the Northern Italian landrace ‘Ferrara’ and ‘Kymington’. A Chinese strain is presently used in Hungary as a heterosis breeding parent which is relatively unrelated to the crossing partners of European origin (Bócsa 1954).

Naturalized (weedy) *Cannabis* populations (sometimes indicated as *C. ruderalis* Janischevsky; *C. sativa* ssp. *ruderalis* or *C. sativa* var. *spontanea*) which persist in many continental areas descend from previously cultivated fibre hemp crops and can hence be considered related to fibre strains once grown at a certain location. They are, however, completely different in appearance. Close relatedness between drug and fibre strains seems unlikely due to geographic isolation and the long-lasting distinct human utilizations of the two groups.

Origin, breeding history, registration and availability

The cultivars below are presented by country. Each current cultivar name, unlike those of its ancestors, is printed once in boldface. The sexual type (monoecious, dioecious, unisexual), being a trait closely linked to breeding strategy, is usually given. Other agronomic characteristics are treated in the next section. It should be realized that the preservation of any desired agronomic trait in hemp cultivars, especially the monoecious character, requires continuous selection during seed multiplication.

French cultivars

Cultivars from France are bred and commercialized by the Fédération Nationale des Producteurs de Chanvre (FNPC), 20, rue Paul Ligneul, F-72000, Le Mans, France; Fax: +33 4377 0916. French cultivars are monoecious. In France they are grown for pulp. Their cultivation within the EU is eligible for the subsidy on fibre crops. Current breeding in France is mainly aimed at maintenance of the present cultivars (conservative breeding) and at further reduction of their THC content. Seed for sowing is readily available in two qualities. Crops grown from first quality seed (elite seed) consist almost exclusively of monoecious plants. Those from second quality seed (harvested from free-pollinated crops raised from elite seed) comprise, due to natural genetic drift, 15 to 30% males as well as a substantial amount of true-female plants. In 1995 prices were 19.30 FF/kg (ca US$ 4.00) for first quality seeds and 14.80 FF/kg (ca US$ 3.00) for second class seed. Within France, for FNCP members, seed is cheaper (O. Beherec, pers. comm., 1995).

All French cultivars are either selected directly from 'Fibrimon' (truly-monoecious cultivars), or from cross-progenies of 'Fibrimon' and several dioecious exotic fibre strains (pseudo-monoecious cvs.). 'Fibrimon' is a monoecious cross-bred cultivar with high fibre content. It was bred at the German Max-Planck-Institut Hamburg-Volksdorf by von Sengbusch between 1951 and 1955 (Bredemann *et al.*, 1961). The parental populations were: inbred material obtained from monoecious plants spontaneously occurring in 'Havelländische' or 'Schurigs' hemp which was again a selection from Central-Russian origin (Hoffmann, 1961); dioecious selections with very high fibre content from Germany (also retained from Central-Russian populations) and dioecious late-flowering landraces from Italy and Turkey. 'Fibrimon' was transferred to France, among other countries, in the late 1950s. The crossing of selected exotic populations with 'Fibrimon' was carried out in the 1960s.

Most details on the breeding of French cvs. are based on J.P. Mathieu (pers. comm., 1992). The current cultivars **'Fibrimon 21'**, **'Fibrimon 24'** and **'Fibrimon 56'**, were selected directly from 'Fibrimon' for diverging dates of maturity. **'Férimon 12'** is an early maturing selection from 'Fibrimon 21', especially intended for seed production. The higher the numbers added to the names of French cultivars, the later they are supposed to flower and mature.

'Fédora 19' is the result of a cross between female plants of the Russian dioecious cv. JUS 9 and monoecious individuals from 'Fibrimon 21', followed by back-crossing of the unisexual female F_1 with 'Fibrimon 21' intersex plants. The parent 'JUS 9' is an offspring from a crossing between 'Yuzhnaya Krasnodarskaya' (originally selected from Italian hemp) and dwarf northern Russian hemp.

Likewise, **'Félina 34'** results from a cross between the dioecious parent 'Kompolti', and 'Fibrimon 24', followed by back-crossing with 'Fibrimon 24'.

'Fédrina 74' and **'Futura 77'** both result from a cross between the dioecious parent 'Fibridia' and 'Fibrimon 24' followed by back-crossing with 'Fibrimon 24'. 'Fibridia' is described by Bredemann *et al.* (1961). It originates from the same German program as 'Fibrimon' and has the same ancestors, except the monoecious 'Schurigs' inbreds.

A new completely THC-free cultivar, with name and pedigree unknown to the author has been registered in 1995 (O. Beherec, pers. comm., 1995).

Hungarian cultivars

Present Hungarian fibre hemp cultivars originate from the GATE-"Rudolf Fleischmann" Agricultural

Research Institute, H-3356 Kompolt (Heves), Hungary; Fax: +36 36 489 000. Current activities at GATE with respect to fibre hemp are mainly restricted to maintenance of the existing cultivars. However, in the context of an agreement with HempFlax b.v. (Netherlands), creative breeding has been resumed to create an early maturing dioecious cultivar for Western-Europe. Hungarian cultivars are generally dioecious and used for production of rope and technical fabrics. Seeds from the cultivars listed below, except 'Kompolti Sárgászarú', are readily commercially available from the company Fibroseed (which can be reached through the GATE institute). Recent (1995) prices were ca US$ 3.50/kg.

Details on the breeding of Hungarian cvs. are based on I. Bócsa (pers. comm., 1995) and Bócsa (1995). **'Kompolti'** has been selected for high fibre content from 'Fleischmann hemp' or 'F-hemp' which is from Italian origin. It was registered in 1954. To make it eligible for EU subsidy it was submitted in 1995 for registration in the Netherlands, by Hemcore Ltd., as well as in Austria, by Raiffaisen Waren Austria (RWA).

The chlorophyll-deficient yellow-stemmed **'Kompolti Sárgaszárú'** was registered in 1974, but is however not currently cultivated. It was obtained from a cross between a spontaneous yellow-stemmed mutant from Germany (Helle Stengel-Hoffmann, found in the offspring of a cross between Finnish early and Italian late hemp) and 'Kompolti', which was repeatedly back-crossed with 'Kompolti' (Bócsa, 1969). Small seed quantities of 'Kompolti Sárgaszárú' are available for research purposes.

Hungary is the only country where heterosis breeding of hemp became implemented. This resulted in several F_1 hybrid cultivars. A single cross hybrid cultivar is **'Uniko-B'** (registered in 1969). It is a hybrid progeny of ('Kompolti' x 'Fibrimon 21') where the monoecious 'Fibrimon 21' acts as pollen spender. The F_1, being almost unisexual female, is used to produce an F_2, containing ca 30% males, which is cultivated for fibre. 'Uniko-B' was recently submitted for registration in Austria by RWA.

'Kompolti Hybrid TC' (registered in 1983) is a three-way-cross hybrid in which two selections from Chinese origin, 'Kinai Kétlaki' (dioecious) and 'Kinai Egylaki' (monoecious), and 'Kompolti' are combined. The first step of the crossing ('Kinai dioecious' x 'Kinai monoecious'), where the monoecious parent acts as pollen spender, gives a unisexual, almost pure female F_1, called 'Kinai Uniszex'. This unisexual progeny can be considered as an analogue for male sterile breeding lines. It is subsequently used as female parent in the crossing ('Kinai Uniszex' x 'Kompolti') which produces the commercial three-way-cross hybrid 'Kompolti Hybrid TC', which has again a 50/50 sex ratio.

'Fibriko' (registered 1989) is the most recent Hungarian hybrid. It results from a three-way cross for which 'Kinai dioecious' and 'Kinai monoecious' are first crossed to produce the unisexual female progeny 'Kinai Uniszex', which is subsequently crossed with the yellow-stemmed pollen spender 'Kompolti Sárgaszárú'. However, 'Fibriko' is not yellow-stemmed, as the normal green stem (from 'Kinai Uniszex') dominates over yellow.

Polish cultivars

The Institute of Natural Fibres (INF), Wojska Polskiego 71B, 60-630 Poznan, Poland; Fax: +4861 417 830, is responsible for the breeding and supply of sowing material of Polish hemp. The current Polish cultivars 'Bialobrzeskie' and 'Beniko' are monoecious. They are mainly intended for production of cordage, military fabrics, blended yarns (hemp with wool and cotton), fibre board and technical oil products. Seeds of both 'Bialobrzeskie' and 'Beniko' are readily available, recently (1995) charged prices by INF were US$ 3.00/kg.

Creative hemp breeding has continued at INF and recently resulted in monoecious cultivars with the tentative names 'W-1', 'Dolnoslaskie' and 'D/83' (R. Kozlowski, pers. comm., 1995). The author is not familiar with the ancestry of these potential cultivars. They are low in THC and have better (finer) fibre quality for textiles than 'Bialobrzeskie' and 'Beniko'. 'W-1' and 'Dolnoslaskie' have been submitted to national registration tests but now seem to have been withdrawn again, and 'D-83' is still in the breeding process.

Details on the breeding of Polish cvs. are based on B. Jaranowska (pers. comm. 1992). **'Bialobrzeskie'**, registered in 1968, is the result of a multiple crossing of dioecious and monoecious strains: ((('LKCSD' x 'Kompolti') x 'Bredemann 18') x 'Fibrimon 24'), followed by long term plant selection for fibre content. The dioecious parent 'LKCSD' was selected from 'Havelländische' or 'Schurigs' hemp from Central-Russian origin. The dioecious 'Bredemann 18' is a selection from Germany (originally also Central Russian) and is very rich in fibre. 'Bialobrzeskie' is submitted for registration in Austria by Saatbau Linz (I. Bócsa, pers. comm., 1995).

The most recent cultivar **Beniko** is a progeny, obtained by individual selection, from the crossing ('Fibrimon 24' x 'Fibrimon 21'). It was registered in Poland in 1985. To make it eligible for EU subsidy, 'Beniko' was submitted for registration in 1995 in the Netherlands by HempFlax B.V., as well as in Austria by Saatbau Linz (I. Bócsa, pers. comm., 1995).

Romanian cultivars

The current Romanian hemp cultivars originate from three different breeding institutes. At least the Agricultural Research Station in Secuieni is still involved in creative hemp breeding. Romania produces hemp fabrics and yarns in fine qualities.

'Fibramulta 151' originates from the Research Institute of Crops and Industry Plants in Fundulea and was registered in 1965. It is a dioecious selection from the single cross ('ICAR 42-118' x 'Fibridia'). The parent 'ICAR 42-118' is a cross progeny of Italian ('Carmagnola' and Bologna hemp) and Turkish ('Kastamonu') strains (Hoffmann, 1961). Details on the availability of seed are not known.

The dioecious **'Lovrin 110'** originates from the Agricultural Research Station, Lovrin, Jud. Timisoara. It was registered in 1981, as a replacement for 'Fibramulta 151'. It was bred by selection among family groups from the Bulgarian Silistra landrace ('Silistrenski'). Details on its availability are unknown.

The monoecious **'Secuieni 1'** originates from the Agricultural Research Station, Secuieni (Neamt county) and is presently commercialized by Rohemp S.A., Str. Limpejoarci nr. 8 sector 1, Bucharest, Romania; Fax: +40 1 210 1261. Rohemp is represented in Austria by J. Hofer, Tendlergasse 12/003, A-1090 Wien; Phone/Fax: +43 222 4036039. It was state registered in 1984. To make it eligible for EU subsidy it was submitted for registration in 1995 in the Netherlands by Hemcore Ltd., as well as in Austria by Rohemp S.A. 'Secuieni 1' results from the crossing ('Dneprovskaya 4' x 'Fibrimon') followed by two back-crosses with 'Fibrimon 21' and 'Fibrimon 24', respectively. The Russian dioecious parent 'Dneprovskaya 4' was selected from 'Yuzhnaya Krasnodarskaya' which, again, was obtained from Italian hemp.

Besides 'Secuieni 1', the recently released cv. **Irene** is also commercially available through Rohemp and was submitted by this company for registration in Austria in 1995. The breeding history of this cv. is unknown to the author.

In 1995, Rohemp charged 5 DM/kg (ca US$ 3.50) for the seed of both 'Secuieni 1' and 'Irene'.

Cultivars from the former USSR

Eight cultivars are presently cultivated in the central and southern parts of the Ukraine and Russia. They are used for the production of shipping cordage, ropes, core for steel cables, twines and, technical fabrics. Hemp cultivars in the former USSR are classified into maturity groups or geographical types. Current cultivars belong either to the southern, late maturing group, bred at the Agricultural Research Institute of Krasnodar or to a group of hybrid progenies from central and southern hemp. Cultivars of the latter group are intended for cultivation at higher latitudes than to which they are ecologically adapted. They were generally bred at, and are commercialized by the (former) Federal Research Institute of Fibre Plants, today called: Ukrainian Institute of Bast Crops, Lenina street 45, 245130 Sumy Region, Glukhov, Ukraine; Fax: +380 54 4422643. At least two of the latter group of cultivars, USO-11 and USO-13, are also commercially available through the Krasnohirska company, located near Zolotonosha, Ukraine; Fax + 380 472 450808. Recently (1995) charged prices by Krasnohirska were US$ 2/kg.

Data on the ancestries of former USSR cvs. are partly based on unpublished notes of K. Hillig (Indiana University). The dioecious southern type cultivar **Kuban** was registered in 1984. It was obtained by ten cycles of family group selection in the hybrid progeny from ('Szegedi 9' x 'Krasnodarskaya 56'). The breeding parent 'Szegedi 9' was selected in Hungary from the Tiborszállási landrace. 'Krasnodarskaya 56' is probably a selected cross progeny from local Caucasian and Italian strains (Hoffmann, 1961).

The dioecious southern cv. **Zenica** (synonym **'Shenitsa'**) was registered in 1990. The ancestry is unknown to the author.

The monoecious southern cv. **Dneprovskaya Odnodomnaya 6** is obtained by family group selection in the progeny from ('Szegedi 9' x 'Fibrimon 56'). It was registered in 1980.

The remaining current cultivars have a southern phenological pattern but are cultivated at higher latitudes. They are all monoecious. Their names generally provide specifications with respect to ecotype (yuzhnaya = southern) and the monoecious character (odnodomnaya). Identical cultivar names, only differing in the added numbers, do not necessarily indicate common ancestry.

'Zolotonoshskaya Yuzhnosozrevayushchaya Odnodomnaya 11' (synonyms: **'Zolotonoshskaja 11'** and **'Zolotonosha 11'**; abbreviated **'USO-11'** or **'YUSO-11'**) was registered in 1984. Parental populations used for the breeding of this cultivar are 'Dneprovskaya 4', 'YUSO-21' and 'Dneprovskaya Odnodomnaya 6' (N.M. Orlov, pers. comm. via J. Masura, 1995). The dioecious parent 'Dneprovskaya 4' was selected from 'Yuzhnaya Krasnodarskaya' which again was obtained from Italian hemp. The ancestry of parent 'YUSO-21' is not known.

'Zolotonoshskaya 13' (synonym: **'Zolotonosha 13'**; abbreviated **'USO-13'** or **'YUSO-13'**) was registered in 1986. It is a selected progeny from ('YUSO-16' x 'Dneprovskaya Odnodomnaya 6') (Orlov *et al.*, 1987). 'USO-13' is submitted for registration in Austria, probably by Saatbau Linz (I. Bócsa, pers. comm., 1995).

'Yuzhnosozrevayushchaya Odnodomnaya 14' (abbreviated: **'YUSO-14'** or **'JSO-14'**) was registered in 1980. It is a further selection from 'YUSO-1', which again is a cross progeny from ('JUS-6' x 'Odnodomnaya Bernburga'). The dioecious parent 'JUS-6' was selected from ('Yuzhnaya Krasnodarskaya' x 'dwarf Northern Russian hemp'). 'Yuzhnaya Krasnodarskaya' is originally selected from Italian hemp. 'Odnodomnaja Bernburga' is a monoecious cultivar which was originally produced in Germany in the 1940s at the Akademie der Landwirtschaftwissenschaften in Bernburg under the name 'Bernburger einhäusigen' (Hoffmann, 1961).

'YUSO-16' or **'JSO-16'** was registered in 1980, it is selected from the French cv. Fibrimon 56.

'YUSO-31' or **'JSO-31'** was registered in 1987. It was selected from the crossing ('Glukhovskaja 10' x 'YUSO-1'). The parental population 'Glukhovskaja 10' is a selection from the central Ukrainian Novgorod-Seversk landrace. The ancestry of 'YUSO-1' is described above under 'YUSO-14'.

Apart from the previous cultivars, the landrace **'Ermakovskaya Mestnaya'** seems to be cultivated at a significant scale in Siberia. It belongs to the Central-Russian maturity group. It is not clear whether it really is a landrace in the strict sense that it is maintained only through mass-selection by local farmers, but its fibre content is indeed low (Bócsa, pers. comm., 1995).

Creative hemp breeding is still continued in the Ukraine and Russia. For example the cv. **Zolotonosha 15** (**'USO-15'**) was developed this year by family group selection among the cross-progeny from ('USO-11 x 'USO-13') (J. Masura, pers. comm., 1995).

Italian cultivars

The EU list of cultivars of agricultural crops includes three Italian hemp cultivars: 'Carmagnola', 'CS' and 'Fibranova' which are commercially represented by the Istituto Sperimentale per le Colture Industriali, Via di Corticella 133, 40129 Bologna; Fax: +39 51 374857. These cultivars have been practically unavailable for a few decades. Recently the Instituto Sperimentale per le Colture Industriali has started to multiply again ‘Carmagnola’ and ‘Fibranova’ (G. Grassi, pers. comm., 1995). Legal obstacles, however, seem to obstruct the commercial distribution of seed. So far, small samples of these cultivars are available for research purposes only. Two additional Italian cvs., 'Eletta Campana' and 'Superfibra', are listed by the OECD (Organisation for Economic Co-operation and Development) on the schemes for the varietal certification of seed moving in international trade. They are said to be distributed by the Istituto di Agronomia Generale e Coltivazione Erbacee Universita degli Studi, 80055 Porticci-Napoli, but they are not really available. The general unavailability of Italian cultivars is probably due to legal reasons. Hemp cultivation is prohibited in Italy as long as there isn't a cultivar with a morphological marker which is genetically linked to low THC-content (pers. comm., Ranalli, 1994, via I. Bócsa). A research program aiming at such a solution seems to have been activated in 1994 (G. Grassi, pers. comm., 1995).

'Carmagnola' is a Northern Italian landrace (Allavena, 1967). **'CS'** or **'Carmagnola Selezionata'** is dioecious and selected in the early 1960s from 'Carmagnola' (Allavena, 1967).

'Fibranova' is a dioecious cultivar, selected in the 1950s from the progeny of ‘Bredemann Eletta’ x ‘Carmagnola’ (Allavena, 1961). The parent ‘Bredemann Eletta’ (or ‘Bredemann Elite’) which was received from the German Max-Planck-Institut, is one of Bredemann’s high fibre selections obtained from Northern and/or Central Russian hemp strains, as were used in the breeding of ‘Fibrimon’ and ‘Bialobrzeskie’.

'Eletta Campana' (dioecious) resulted from a cross between the Carmagnola landrace and high fibre strains from German origin, most likely 'Fibridia' or again one of the Bredemann selections.

No information was found on the pedigree of **'Superfibra'**.

Cultivars from ex-Yugoslavia

Seven dioecious hemp cultivars were registered in the former Federal Republic of Yugoslavia. Among them were five of foreign origin: ‘Kompolti’, ‘Kompolti Sárgaszárú’, ‘Kompolti Hybrid TC’ and ‘Uniko B’ (Hungarian), and ‘Fibranova’ (Italian) which are treated elsewhere in this article. Two registered domestic cultivars were ‘Flajšmanova’ and ‘Novosadska konoplja’ (J. Spanring, pers, comm., 1995).

Presently hemp production is organized mostly in the present Yugoslavia (Serbia). Also in Croatia there may be some cultivation, the other republics have no significant hemp production. The crop is mainly grown for textile production. In the last decade, for this purpose, the imported hybrids ‘Kompolti Hybrid TC’ and ‘Uniko B’ were used. Until 5 to 10 years ago the improved cultivar Fibranova especially was used for small scale birdseed production (J. Berenji, pers. comm., 1995).

In the present Yugoslavia there is a tendency to replace gradually the imported cultivars by domestic ones. ‘Novosadska konoplja’ is the only available registered domestic cultivar. Large scale seed production has been resumed in 1995. The yield of certified seed is intended to cover 40% of the textile hemp area (1,000 ha) which is planned for 1996. Breeding activities at the Institute of Field Crops and Vegetables (Novi Sad) are aimed at new domestic cultivars for the future (J. Berenji, pers. comm., 1995)

‘**Novosadska konoplja**’ is an improved selection from ‘Flajšmanova’ which is the same as ‘Fleischmann hemp’ (from Italian origin, see under Hungarian cultivars). It was bred in the 1950s, but included in the former Federal cultivar register only since 1989. ‘Novosadska konoplja’ is maintained and commercialized by Dr. Berenji, Institute of Field and Vegetable Crops, Novi Sad, 21470 Bački Petrovac, Yugoslavia; Fax: +381 21 780 198. Seed prices charged to the (almost) single customer, the domestic hemp industry who distributes to contracted farmers, are 3.5-3.7 DM/kg (ca US $2.50/kg). Small amounts of seed are sold to individual farmers at 4-5 DM/kg (ca US $ 2.80-3.50) for birdseed production (only 1-2% of the total hemp area).

In Slovenia the seven cultivars from the Federal register are proposed for registration in 1996. Some selections from indigenous landraces are presently under study at the Biotechnical Faculty of the University of Ljubljana (Slovenia). They were selected for seed as well as fibre production and received tentative names as ‘Rudnik’ and ‘Pesnica’. Some of these materials may be released as cultivars in the future (J. Spanring, pers. comm., 1995).

Spanish cultivars

The EU hemp cultivar list includes **'Delta-405'** and **'Delta-Llosa'** from Spain. Breeder and owner is the specialty pulp manufacturer Celulosa de Levante SA, C/Tuset 8-10, 08006 Barcelona, Spain; Fax: +34 93 2906126. 'Delta-405' and 'Delta Llosa' have been grown for pulp production by Celulosa de Levante until 1992, nowadays they use French cultivars for this purpose (R. Ripol, pers. comm., 1995). References on the two Spanish cultivars could not be traced. In spite of enquiries addressed to 'Celulosa' the breeding histories have not been elucidated. Evidently, 'Delta-405' and 'Delta Llosa' are not commercially available.

Former Czechoslovakian cultivars

The OECD schemes for the varietal certification of seed moving in international trade include the former Czechoslovakian cultivar **Rastslaviska** (synonym **'Rastislavicke'**). It is said to be represented by Slovosivo, Zahradnicka 21, 881 26 Bratislava, (the present) Slovakia. References to this cultivar were not found. According to Bócsa however (pers. comm., 1995) it is (was) rather a landrace (of southern European type) than a cultivar. The former Czechoslovakia has never had its own hemp breeding. Until 1980 Hungarian cultivars were grown. Seed of 'Rastslaviska' is unavailable.

Future German cultivars

At the end of 1995 a newly bred early-maturing German monoecious fibre and seed cultivar, called **'Fasamo'**, was submitted to the Bundessortenamt in Hannover for research aimed at registration and admittance in Germany (L. Loch, pers. comm., 1995). The 40 years of breeding work was the private enterprise of Dr. Lothar Loch, Berlin. The commercial representative will be Norddeutsche Pflanzenzücht Hans-Georg Lembke KG, Hohenlieth, 24363 Holtsee, Germany. 'Fasamo' was obtained from a cross-progeny of 'Schurigs' hemp and 'Bernburger einhäusigen', monoecious hemp bred in Bernburg in the 1940s (Hoffman 1961).

Agronomic characteristics

Numerous references on agronomic performance, under various cultural treatments in various locations, are available for most of the above mentioned cultivars. However, as the expression of quantitative agronomic traits depends more or less strongly on the environment, such data cannot simply be pooled in one table.

Twenty-four of the described fibre cultivars have been tested simultaneously in standardized trials in the context of the evaluation of the CPRO *Cannabis* germplasm collection in Wageningen, the Netherlands. Some of the traits involved were: the pattern of phenological development (being related to potential stem and seed production); stem quality (characterized by the fractions of woody core, secondary bark fibre and primary bark fibre as well as by the length of woody core fibres); contents of the cannabinoids THC and CBD, and resistance to soil pathogens (root-knot nematodes). Brief results of this evaluation are summarized in Table 1 (for methods see: de Meijer, 1994). Due to the extreme plasticity of some of the tested traits, especially phenological patterns and cannabinoid contents, the reported absolute values apply for the Netherlands only. However, assuming little interaction between cultivars and latitudes, one can expect that ranking orders of cultivars for most traits are fairly stable.

Statements on the practical suitability of cultivars are omitted as, e.g. in the case of phenological pattern, stem and seed yield potential and stem quality, such judgements depend on the purpose for which cultivars are cultivated. However, low THC content and a poor host-suitability to *Meloidogyne* (low values for GAL and EGG in Table 1), are unambiguously favourable.

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Corrections

B. De Groot 1995. Hemp pulp and paper production: Paper from hemp woody core. *Journal of the International Hemp Association* 2(1): 31-34

“In my paper, the last sentence of the third column on page 33 should have been printed as: ‘Alkaline pulping, with sodium hydroxide only (without sulphide) is a potential pulping process for hemp woody core, and a basis for alkaline-oxygen and alkaline peroxide processes’. I do not wish to imply the mentioned process is the only potential pulping process for hemp woody core!”

F. Höppner and U. Menge-Hartmann 1995. Cultivation experiments with two fibre hemp varieties. *Journal of the International Hemp Association* 2(1): 18-22

“In our paper, predominantly in the part dealing with the results, we used the abbreviation ‘Kompolti’ to signify the variety ‘Kompolti Hibrid TC’. This could mislead the reader as there exists a separate variety called ‘Kompolti’. At this point we would like to emphasize that our results, especially the statements regarding THC content, refer to the Hungarian variety ‘Kompolti Hibrid TC’.”

The authors

Cultivar CPRO no.	THC	CBD	ANT	MAT	HEI	LEN	WOO	SEC	PRI	TOT	GAL	EGG
Férimon 12												
880827	0.17	1.16	172	253	269	534	57.1	3.9	21.1	25.0	142.4	87.5
Fédora 19												
883065	0.26	1.40	168	250	221	538	63.7	3.3	16.2	19.5	159.9	94.3
Fibrimon 24												
880824	0.26	1.34	203	250	285	526	57.8	4.9	19.3	24.2	149.6	85.3
Felina 34												
880826	0.15	1.59	187	253	236	515	60.6	5.2	20.1	25.3	144.1	94.6
Fibrimon 56												
880828	0.30	1.18	183	255	224	487	59.6	2.3	20.9	23.2	147.7	74.8
883041	0.25	1.02	204	258	265	570	60.7	4.0	19.8	23.8	172.4	99.9
883067	0.54	1.69	198	250	238	551	67.5	3.3	14.1	17.5	169.7	95.8
891158	0.21	1.07	213	260	273	526	62.7	3.6	18.9	22.5	143.3	83.6
Fédrina 74												
880825	0.25	1.67	176	263	261	546	60.0	3.6	18.9	22.6	155.9	89.6
Futura 77												
880823	0.15	1.20	212	260	360	538	59.5	5.7	17.1	22.8	191.8	113.2
883066	0.32	1.76	215	262	292	536	62.3	6.7	17.0	23.7	158.9	65.2
Kompolti												
883048	0.10	1.51	234	275	330	538	50.3	6.7	22.4	29.1	130.0	63.8
891069	0.15	1.38	233	274	247	549	53.5	9.9	18.1	28.0	148.3	78.5
Kompolti Sárgaszárú												
883049	0.25	1.08	198	275	257	531	52.2	12.6	19.6	32.2	79.1	27.1
Kompolti Hybrid TC												
883047	0.63	1.01	223	273	278	548	56.6	6.6	19.3	25.9	131.3	64.2
891071	0.69	0.92	213	271	272	556	57.1	7.4	18.5	25.9	113.4	63.3
891343	0.55	0.78	229	266	263	556	55.2	8.2	18.8	26.9	109.5	54.1
Uniko-B												
883045	0.35	0.92	213	263	285	538	52.5	8.6	22.1	30.8	160.0	89.2
891070	0.22	1.21	219	264	258	537	54.3	10.3	18.4	28.8	142.8	80.6
Bialobrzeskie												
891223	0.26	0.58	176	238	292	489	52.9	6.6	22.9	29.5	143.7	85.8
921019	0.13	1.33	181	240	263	536	53.7	6.1	23.0	29.1	*	*
Beniko												
921040	0.34	1.15	178	240	259	526	53.9	7.8	24.9	32.7	*	*
Fibramulta 151												
883174	0.24	1.53	192	262	282	554	70.4	2.2	14.1	16.3	145.1	48.5
Lovrin 110												
883173	0.66	1.29	184	263	282	493	60.7	5.7	16.1	21.8	148.6	70.3
Secuieni 1												
883172	0.75	1.13	206	253	308	544	59.4	6.0	20.5	26.5	153.8	88.5
Dneprovskaya Odnodomnaya 6												
891326	0.06	0.64	186	244	263	522	59.8	6.0	16.3	22.3	154.6	78.0
USO-11												
891186	0.12	0.96	193	246	247	541	57.4	5.6	19.1	24.7	161.5	102.1
USO-13												
891187	0.05	1.12	189	248	240	538	59.0	6.9	19.2	26.1	176.3	110.6
YUSO-14												
891228	0.03	0.92	140	234	261	533	56.6	4.1	22.6	26.7	141.4	66.0
YUSO-16												
891229	0.05	0.66	154	205	232	528	57.3	3.4	22.3	25.7	157.4	79.0
Eletta Campana												
883038	0.63	0.86	230	277	286	507	59.6	2.2	22.1	24.3	122.9	55.1
Superfibra												
883040	0.37	1.36	229	284	268	554	59.8	2.6	20.6	23.2	150.1	79.0
Rastslaviska												
880816	0.22	1.83	212	268	256	556	67.8	4.2	13.4	17.6	110.1	50.5

Table 1. Agronomic evaluation data for twenty-four fibre cultivars (source: de Meijer, 1994). Column abbreviations: THC = THC content (%); CBD = CBD content (%); ANT = date of flowering (day number); MAT = date of seed maturity (day number); HEI = height of mature female plants (cm); LEN = wood fibre length (μm); WOO = woody core mass fraction in stem (%); SEC = secondary bark fibre mass fraction in stem (%); PRI = primary bark fibre mass fraction in stem (%); TOT = total bark fibre mass fraction in stem (%); GAL = number of *Meloidogyne* root-galls per g root fresh weight; EGG = number of *Meloidogyne* egg masses per g root fresh weight.

Guide to the scientific literature on potential medical uses of *Cannabis* and the cannabinoids

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Marijuana and its component cannabinoids have been demonstrated to affect many medical conditions. However, original sources on this topic are often difficult to access, as they are diffusely distributed across a voluminous scientific literature. This bibliography gathers most of the primary (and some of the secondary) citations available, categorized according to medical indication.

Introduction

Widespread reports of self-medication with *Cannabis* have aroused medical and scientific interest in the potential application of cannabinoids for the treatment of a variety of diseases. Some limited human trials or case studies have revealed the safety and efficacy of this class of compounds for the symptomatic treatment of a broad number of ailments. The results of tests on other animals or *in vitro* experiments imply new paths of clinical investigation. The references below represent a starting point for further inquiry. Included are papers regardless of their experimental outcome. Not included are citations related to the presently approved uses of THC (i.e., cancer chemotherapy nausea amelioration, AIDS patient appetite stimulation).

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An efficient new cannabinoid antiemetic in pediatric oncology

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Δ-8-tetrahydrocannabinol (Δ-8-THC), a cannabinoid with lower psychotropic potency than the main *Cannabis* constituent, Δ-9-tetrahydrocannabinol (Δ-9-THC), was administered (18 mg/m2 in edible oil, p.o.) to eight children, aged 3-13 years with various hematologic cancers, treated with different antineoplastic drugs for up to 8 months. The total number of treatments with Δ-8-THC so far is 480. The THC treatment started two hours before each antineoplastic treatment and was continued every. 6 hrs for 24 hours. Vomiting was completely prevented. The side effects observed were negligible.

Introduction

Cannabis preparations have been used for millenia as antiemetic drugs [1]. With the identification of Δ-9-tetrahydrocannabinol (Δ-9-THC) (Fig 1) as the psychoactive *Cannabis* constituent [2] its evaluation as an antivomiting agent was also made possible. It was indeed found that Δ-9-THC prevents or reduces vomiting induced by anticancer chemotherapy [3-5]. Δ-9-THC is marketed under the generic name Dronabinol [5]. Depending on the clinical protocol used, Δ-9-THC (5-10 mg/m2 p.o.) prevents vomiting and nausea in some patients and reduces these symptoms in others. The side effects are those noted in marijuana users, in particular elderly ones: drowsiness, dizziness and in rare cases anxiety. Mood changes usually predominate in younger patients.

DeIta-8-THC (Fig 1) is a double bond isomer of Δ-9-THC. It is less psychotropic than Δ9-THC [6], but its antiemetic potential has not been investigated so far. In preclinical antiemetic studies in pigeons (to be reported separately), using the methodology previously described by us for Δ-9-THC [7], we found that Δ-8-THC is at least as potent as Δ-9-THC. It is much more stable than Δ-9-THC to various chemical treatments, including oxidation. and is considerably less expensive to produce than Δ-9-THC. Hence. it seemed of potential therapeutic interest to investigate the antiemetic effect of Δ-8-THC in patients. We chose to administer Δ-8-THC to children, who were expected to vomit on anticancer chemotherapy. The reason for the age limitation was the general (but not documented) belief that most side effects of Δ-9-THC, in particular anxiety, are more prevalant in an adult population than in a younger one. Hence Δ-8-THC could possibly be administered to children in higher doses than those given to adult patients.

We report now that Δ-8-THC in an open label evaluation was found to be an excellent pediatric antiemetic with nonsignificant side effects. We chose an open label trial for ethical reasons. A clinical trial based on placebo versus Δ-8 THC as an antiemetic agent during anticancer treatment is unacceptable. Our original protocol envisaged a comparison between metoclopramide (0.3 mg/kg) and Δ-8-THC (18 mg/m2). However preliminary results indicated complete block of emesis with Δ-8-THC, while metoclopramide showed variable results. Most of the children (5 out of 8) vomited with this dose of metoclopramide. In higher doses (0.5

mg/kg dose or above) metoclopramide caused extrapyramidal effects. Hence for ethical reasons the protocol was modified to an open trial design. However, we would like to point out that over a period of about 10 years, when most of the antineoplastic protocols followed in the present study were used in our clinic, emesis was observed in about 60% of all pediatric cases even though metoclopramide (0.3 mg/kg) was used as antiemetic agent.

Ondansetrone and other HT3-receptor blockers are today the drugs of choice for chemotherapy-induced vomiting and nausea [8]. While such therapy is superior to previously used treatments (dopamine antagonists, corticosteroids) adverse effects such as headache are troublesome [8] and its efficiency in delayed vomiting is questionable. Ondansetrone is also a very expensive drug and less expensive alternatives should be made available. Hence additional therapeutic protocols are required.

Materials, patients and clinical protocol

Δ-8-THC was prepared from natural cannabidiol by cyclization (Figure 1) and purified by chromatography as previously described [9]. It was analyzed by gas chromatography and was found to be 98% pure.

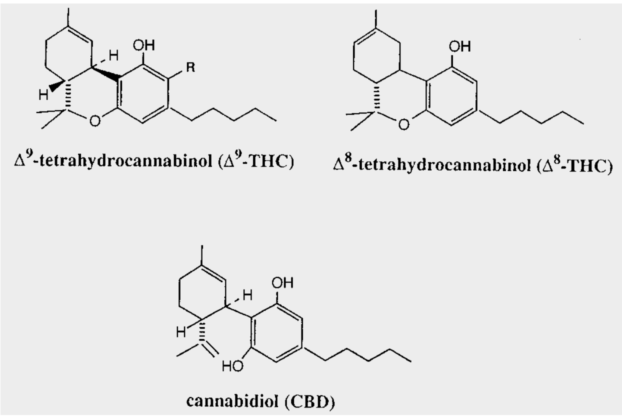

Figure 1. Chemical structures of cannabinoid compounds

Eight children with various blood cancers (see Table) were administered Δ-8-THC (18 mg/m2 p.o.) two hours before the start of the anticancer treatment. The drug was dissolved in corn or olive oil (6 mg/ml), and was administered directly as oil drops on the tongue, or on a bite of bread. The same dose was repeated every 6 hrs for 24 hrs. The treatment tor each child is presented in the Table. Whenever additional cycles of antineoplastic therapy were required, Δ-8-THC was administered following the same time procedure described above. Children received Δ-8-THC only during days when emetogenic drugs were administered. Established anticancer drug protocols were followed with all patients. These are indicated below and in Table 1:

High-dose Cytarabine and Asparaginase [10] (Patient 1) MOPP-ABV protocol [11] (Patient 2). This protocol is a standard combination of Mechlorethamine hydrochloride, Vincristine, Procarbazine, Prednisone, Doxorubicin, Bleomycin and Vinblastine. BFM protocol [12].(patients 3 and 8) This protocol is a complicated standard protocol consisting of numerous antineoplastic drugs (Vincristine, Daunorubicine, L-Asparaginase, Cyclophosphamide, Cytarabine, Mercaptopurine, Etoposide, Methotrexate, Thioguanine) and 3 types of corticosteroids (Prednisone, Hydrocortisone, Dexamethasone) in p.o., i.v. and intratecal administrations. National Wilm’s tumor study protocol (NWTS-4) [13] (Patient 4) This protocol is a standard combination of Vincristine, Doxorubicin, Dactinomycin. Amsacrine-high dose Cytarabine protocol [14] (Patient 5). This is a standard protocol consisting of Cytarabine and Amsacrine. Burkitt's lymphona protocol [15] (Patient 6. This is a standard protocol consisting of Vinscristine, Doxorubicin Cyclophosphamide, Methotrexate and Prednisone. Rezidive study. A.L.L. - Rez BFM 87 protocol [16] (Patient 7). This is a standard complicated protocol consisting of numerous antineoplastic drugs. In addition to drugs mentioned above it includes Ifosfamide and Vindesine.

Results

The present study on prevention of vomiting due to antineoplastic therapy took place over a 2 year period with 8 patients. Details of their antineoplastic treatment and side effects of the antiemetic therapy are presented in Table 1. The mild side effects observed were reported by the physician and nurse in charge. Chemotherapy protocols of the types indicated almost invariably cause intense vomiting, which starts about 2 hrs after the initiation of chemotherapy and gradually ends over a 24 hr period. In prelimary trials we tried to end the antiemetic therapy after the first or second dose of the cannabinoid, i.e. after 6 or 12 hrs. Vomiting started in most cases. Hence, in the recorded trial, all children were given 4 doses (every 6 hours) for 24 hrs. When the antiemetic protocol described in the "Methods, patients and clinical protocol" section was strictIy followed, no emesis was noted during the 24 hrs of treatment or over the next two days. In one case (patient D.E.), Δ-8-THC therapy initially was refused. The patient experienced debilitating vomiting for 24 hrs after the antineoplastic treatment. During the second treatment cycle (which took place after 8 days), at the patient's family request, Δ-8-THC treatment was initiated. No vomiting occurred. In a second case (A.M.), the patient refused antiemetic treatment during a relapse of his disease as it was based on an "illicit drug" (*Cannabis*). Repeated vomiting took place. Renewal of the THC treatment, before the next administration of antineoplastic drugs, prevented additional vomiting. As indicated in Table 1 the side effects were observed in only 2 of the the 8 patients: some irritability and slight euphoria which in children is difficult to quantify. No anxiety or hallucinogenlc effects were noted in spite of the high doses administered.

Discussion

Δ-8-THC is an isomer of Δ-9-THC, the major natural constituent of *Cannabis* from which it differs only in the position of the double bond. The stereochemistry of the two isomers is identical; their chemical behavior is in most cases very similar [17]; their metabolism in vivo and in vitro follow the same pathways [18]. The major chemical difference between them is that Δ-9-THC is easily oxidized to the biologically inactive cannabinol; Δ-8-THC is stable, does not oxidize to cannabinol and has a very long shelf life. Due to their close structural similarity, Δ9-THC and Δ-8-THC present essentially identical pharmacological profiles [19-21]. Quantitatively, however, Δ-8-THC differs from Δ-9-THC in being about twice less potent in most, but not all pharmacological tests.

In monkeys Δ-8-THC causes a general behavior depression in doses reported to be higher than the doses ofΔ-9-THC required to produce similar effects [22, 23].

A direct comparison of the effects of Δ-8-THC (20 and 40 mg total dose) and of Δ-9-THC (20 mg total dose) orally administered to human volunteers has been published [24]. The spectrum of clinical effects was similar with both isomers, but Δ-8-THC was considered to be only 3/4 as psychotropically potent as Δ-9-THC. The same ratio of activity was observed on i.v. administration.

Δ-9-THC (4 mg/kg i.m.) blocked the emetic response in cats caused by cisplatin (7.5 mg/kg i.v.) [25]. The metabolite 11-hydroxy-Δ-9-THC, which is considerably more psychotropic than Δ-9-THC, was less antiemetic than Δ-9-THC showing that, in cats at least, there is no parallelism between the psychotropic effects and the antiemetic ones. Indeed, we have recently shown that a non-psychotropic cannabinoid (HU-211) is more potent than Δ-9-THC as an antiemetic [7].

The LD50 values for Fischer rats treated orally with single doses of Δ-9-THC and Δ-8THC, and observed for 7 days, are 1910 mg/kg and 1980 mg/kg (for males) respectively and 860 mg/kg (for females) [26]. The histopathological changes caused by these extremely high doses were essentially the same for both Δ-8-and Δ-9-THC. LD50 could not be determined in either rhesus monkeys or dogs as single oral doses of up to 9000 mg/kg of either Δ-8- or Δ-9-THC in dogs or monkeys were non-lethal. Histopathological alterations did not occur in either dogs or monkeys. A chronic oral toxicity study in rats with both isomers has been reported. Δ-8-THC was found to be slightly less toxic than the Δ-9 isomer [27]. With Δ-8-THC, after 119 days of consecutive administration, no deaths were observed in males with daily doses of up to 400 mg/kg; 1/10 deaths occurred at 500 mg/kg. With females, no deaths were caused by doses of up to 250 mg/kg; 5/13 deaths were recorded at 400 mg/kg and 12/67 were recorded at 500 mg/kg. The above described animal and human data indicated that Δ-8-THC can be safely administered to human patients.

We found, as expected, that young children with different hematologic cancers. who were treated with a variety of anticancer drug protocols, could be administerd doses of Δ-8-IHC considerably higher than the doses of Δ-9-THC generally administered to adult cancer patients without the occurrence of major side effects, (5-10 mg/m2 of Δ-9-THC generally recommended for adult patients

No.	Name sex	Age (years)	Diagnosis treatment[c]	Antineoplastic	Number and effect of antiemetic treatments
1.	A.M. m	10	A.L.L.[b] pre B, in relapse	Cytarabine-L-Asparaginase	(32), no side effects
2.	C.O. m	3.5	Hodgkin's disease	MOPP-ABV protocol	(64), slight irritability dudng first 2 cycles
3.	L.H. f	4	A.L.L., T type	BFM protocol	(76), slight irritability and euphoria [1]
4.	M.H. f	3	Wilm's tumor, stage 1II	NWTS-4 protocol	(30), no side effects
5.	R.M. f	13	A.L.L. T type in second relapse	Cytarabine, Amsacrine protocol	(24), no side effects
6.	DE. m	7	Burkitt's lymphoma	Burkitt's lymphoma protocol	(114), no side effects [2]
7.	K.K. f	6	A.L.L.	Rez BFM 87 protocol	(64), no side effects [3]
8.	A.A. m	5	A.L.L.	BFM protocol	(76), no side effects

[a] Delta-8 THC, 18 mg/m2. For details see text. In all cases complete prevention of vomiting was noted.
[b] Acute Lymphoblastic Leukemia (A.L.L.). [c] see Methods, patients and clinical protocol.

[1] Metoclopramide (0.3 mg/kg) p.o. or i.v. in previous treatment failed to prevent vomiting.
[2] During first cycle, refusal to take THC caused profuse vomiting.
[3] Treatment during remission after 2nd relapse and during 3rd relapse.

Table l. Delta-8-THC Administered to Children Treated for Various Hematologic Cancers.[a]

[28] versus 18 mg/m2 of Δ-8-THC used by us in children). As mentioned above, the prevention of vomiting was complete, regardless of the antineoplastic protocol followed. We observed no delayed nausea or vomiting. Although the number of pediatric cancer patients treated so far is small, the total number of treatments is considerable (480 times) as most patients underwent several treatment cycles. Without the cannabinoid therapy we would have expected the patients to vomit in most treatments.

In summary, the complete success in preventing vomiting due to antineoplastic treatment in children, and the essential lack of side effects, leads us to believe that Δ-8-THC at a dose considerably higher than the doses of Δ-9-THC usually administered to adults, can serve as a new, inexpensive antiemetic agent in pediatric cancer chemotherapy.

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Changes in yield characteristics among various seed generations of hemp variety USO-14

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Yield parameters of the non-drug hemp variety USO-14 were studied. Reproductions of various seed lots and the same seeds from different years, obtained as a result of a new method of seed selection, were tested. Seed yield was not altered up to the second generation while stem and fibre yield were not altered up to the fourth generation. It was found that a variety's potential productivity remains the same during this period of its industrial use.

Introduction

The expression of the yield potential of a variety depends on the quality of the seed material, which is affected amongst others by agro-technical measures. All agricultural crops, including hemp, are characterised by biological variability when reproduced and used industrially (Remeslo 1972, Gulyaev and Guksov 1978, Demkin 1971). It has been previously reported that stem and fibre yield of monoecious and dioecious hemp varieties decrease with the number of propagations of elite seeed (Virovets 1971, Demkin and Bondarenko 1971). In the 1990's, to solve the problem of drug use, the Institute of Bast Crops and affiliated scientific and research institutions obtained the highly productive and non-drug hemp varieties USO-14, USO-16, USO-31, Zolotonoshskaya-13, Dneprovskaya monoecious-6, and Zenitsa. To maintain all the valuable biological and economic characteristics of these new monoecious hemp varieties at all phases of their cultivation, a system of seed multiplication was elaborated (Senchenko, Sitnik et al. 1988). It included a group of nurseries and seed lots, wherein selection and propagation of improved hemp varieties took place. We studied the influence of this new system of seed multiplication on seed characteristics.

Materials and Methods

We investigated seeds of different reproductions of the monoecious hemp variety USO-14. The seeds of the plant nursery of the family testing of hemp variety USO-14 (harvest of 1986, 1987, 1988 and 1989) were propagated according to a new method of seed-growing up to the second and third reproductions. The propagation was carried out in the following succession: plant nursery of the families (the seeds of the best families selected for their economic and biological characteristics), superelite (the seeds destined for growing elite), elite (the seeds grown in research establishments and destined for propagation in production), first reproduction, second reproduction and third reproduction (the seeds following elite in the link of seed growing propagation). Thus by 1992 we had received five lots of superelite seeds of the harvests of 1987, 1988, 1989, 1990 and 1991, respectively, four lots of elite seeds (1988, 1989, 1990 and 1991), three of the first reproduction (1989, 1990 and 1991), two of the second reproduction (1990 and 1991) and one of the third reproduction (1991). To maintain the viability of seeds which had been accumulated since 1987, they were stored at the critical moisture without oxygen in polyethylene bags.

In 1992-1993, all seed lots of superelite, elite, first, second and third reproduction were sown in field conditions to determine their biological and productive characteristics. Experiments were carried out in four randomised repetitions. The area of the plots was 25 m^2. The seeds were sown at a density of 60/m^2 and at 45 cm row width. The change in yield and biological characteristics was determined by comparing the reproductions of each initial seed lot and by comparing different seed lots of the same reproduction.

Table 1. Yields (tons/ha) of hemp crops grown from seed of different seed generations (Variety USO-14) average for 1992-1993.

Years of seed production	Seed generation: Super-elite	Elite	First reproduction	Second reproduction	Third reproduction
			Seeds (moisture 13 %)		
1987	0.74				
1988	0.74	0.80			
1989	0.76	0.82	0.83		
1990	0.80	0.76	0.84	0.66	
1991	0.76	0.76	0.76	0.79	0.60
				LSD* -0.12	0.05
			Stems (moisture 19 %)		
1987	4.16				
1988	4.14	5.24			
1989	5.20	5.30	5.32		
1990	5.06	4.95	5.26	4.83	
1991	5.70	5.60	5.66	5.70	5.83
				LSD* -0.41	0.05
			Fibre (moisture 19%)		
1987	1.22				
1988	1.23	1.59			
1989	1.57	1.61	1.60		
1990	1.51	1.52	1.56	1.43	
1991	1.77	1.70	1.78	1.75	1.79

* LSD-least significant difference at 0.05 level of significance

Results and Discussions

The yields of fifteen seed lots of different reproductions and years are given in Table 1. It shows that seed reproductions, including the first one, do not differ much for seed productivity. Some seed yield decrease was found in the second and third reproductions. This could result either from the deterioration of the varietal purity of these reproductions or from the change of their sex

Table 2. Sexual structure of hemp grown from seeds of different generations. Content of Sexual Types* (%)

		1992			1993		
Seed generation	Years of seed production	Monoecious pistillate hemp	Monoecious feminised staminate hemp	Staminates of monoecious hemp	Monoecious pistillate hemp	Monoecious feminised staminate hemp	Staminates of monoecious hemp
Super-Elite	1987	82.2	14.3	2.1	85.2	13.5	0.2
	1988	80.1	14.1	2.8	80.4	16.6	0.6
	1989	82.6	15.2	1.2	78.6	18.3	2.0
	1990	83.8	13.2	1.2	84.4	13.9	0.9
	1991	82.9	15.6	0.7	79.3	19.1	0.5
	1992				82.1	16.0	1.1
Elite	1988	88.3	9.3	0.5	73.6	23.8	0.7
	1989	84.9	13.7	0.9	76.9	20.6	1.1
	1990	86.6	11.9	0.5	73.5	21.3	2.5
	1991	85.6	12.6	0.7	80.1	17.6	1.4
	1992				80.9	14.6	0.7
First reproduction	1989	82.3	13.5	2.3	82.4	11.2	4.6
	1990	86.9	10.2	2.4	78.5	19.2	0.9
	1991	81.8	11.1	5.4	77.6	17.7	2.8
	1992				81.1	14.1	3.2
Second reproduction	1990	80.9	12.1	5.6	71.8	20.7	3.2
	1991	75.7	17.2	6.9	77.8	13.3	8.5
	1992				75.9	13.8	8.5
Third reproduction	1991	66.8	10.4	21.4	61.8	14.8	21.4
	1992				56.1	8.2	35.1

* A new classification of sexual types of monoecious hemp, worked out in the 1990s (by N. D. Migal). It suppliments the classification by Grishko, von Sengbusch, Bredemann. The genotypes of sexual types of monoecious hemp are not identical to the genotypes of the same sexual types of dioecious hemp.

structure (Table 2). In the third reproduction, the proportion of male plants was 21-35 %. In preceding reproductions, the proportion of male plants was lower. According to the new system of seed-growing, hemp seeds of the third reproduction were not sown for industrial use. A different result was found regarding the effect of seed reproduction on stem and fibre yield. The yield of dry stem and fibre did not depend on seed generation. The stem yield from elite seed (1988) was 5.24 ton/ha, its progeny in the third reproduction yielded 5.83 ton/ha. Elite yield of 1989 was 5.30 ton/ha correspondingly. According to data presented in Table 1, there were no differences in the stem productivity among superelite, elite, first, second and third reproduction seeds produced in 1989, 1990 and 1991. Exceptions are the yields of superelite seed lots produced in 1987 and 1988. Long seed

Table 3. Results of phenological observation on superelite sowings of the variety USO-14.

Years of Super-Elite seed production	Date of sowing	Dates of the beginning of development phases: Beginning of germination	Three pairs of leaves	Beginning of budding	Beginning of seed ripening	Mass ripening of seeds
				1992		
1987	28-04	9-05	31-05	22-06	1-07	7-08
1988	28-04	8-05	31-05	22-06	1-07	7-08
1989	28-04	6-05	28-05	19-06	1-07	7-08
1990	28-04	6-05	28-05	19-06	1-07	7-08
1991	28-04	6-05	28-05	19-06	1-07	7-08
				1993		
1987	7-05	15-05	9-06	20-06	4-07	14-08
1988	7-05	15-05	8-06	20-06	4-07	14-08
1989	7-05	13-05	4-06	18-06	4-07	14-08
1990	7-05	13-05	4-06	18-06	4-07	14-08
1991	7-05	13-05	4-06	18-06	4-07	14-08

storage influenced vigour, simultaneity of germination and yield of those seeds. In the plots with seed produced in 1987 and 1988, seedlings appeared 2-3 days later and plant development until the phase of budding was delayed for 3-5 days (Table 3), which could negatively influence the yield.

The response of fibre yield was similar to that of stem yield (Table 1), fibre content of the stems was not affected. Having compared biological and yielding characteristics of superelite seed propagations harvested in 1987, 1988, 1989, 1990 and 1991, we observed that over five years, varietal characteristics of the hemp variety USO-14 did not deteriorate, sometimes they even improved, except for the distribution of sexual types.

While studying these fifteen different hemp seed lots it is notable that seed, stem and fibre yields are very similar. Conditions of cultivation did not significantly influence seed yielding ability in spite of the fact that the seeds were produced in different years and under different environmental conditions.

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Tasmanian hemp research

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A cultivar trial conducted during the 1994/95 season at Cambridge (147°30'E 42°50'S) incorporating Unico B, Fedrina 74, USO 11 and Kompolti showed that the later flowering Unico B and Kompolti cultivars gave significantly higher dry stem yields of 1357g/m² and 1174g/m² respectively. It is apparent from the flowering times that the relatively long, dry summer season in Tasmania could accommodate later flowering and potentially higher yielding genotypes.

Separate sowing date trials involving Kompolti and Fedrina 74 established at Cambridge and Devonport (146o40'E 41o10'S) demonstrated significant stem yield loss associated with delays in sowing date from mid September to early November, particularly with late flowering Kompolti. Stem yields from autumn sown Kompolti were restricted by waterlogging during the winter months and early flowering in September. The success of early sowings in Tasmania clearly depends on finding later flowering genotypes and cultivation on well drained sites.

Preliminary harvesting trials highlighted problems associated with dual purpose cultivation of hemp. A 'dry' harvest system in which the straw is either baled or cut using a modified forage harvester seems appropriate for Tasmanian conditions and the intended end use of the fiber as a reinforcing agent in newsprint manufacture.

Introduction

A cooperative research effort involving the Department of Agricultural Science, University of Tasmania and Australian Newsprint Mills Ltd. (ANM) commenced in early 1994. The primary objective of this study is a broad feasibility assessment of using locally produced hemp (*Cannabis sativa*) and flax (*Linum usitatissimum*) fibre as a reinforcing agent in newsprint manufacture. This involves an *integrated analysis* of the whole potential industry, with consideration of key crop management issues, industrial utilisation of crop products, and economic potential from both the farmers and manufacturers perspective. The second aim of the research programme is to develop a crop growth model for hemp cultivation.

This paper outlines results from preliminary trials conducted during the 1994/95 season and gives an overview of future and ongoing research.

Method and design

Hemp cultivar trial

The purpose of this trial was to rank the performance of a number of selected imported cultivars. Any shortcomings in these genotypes and the potential for future improvement through local breeding was to be identified.

Cultivars were selected on the basis of THC level, bark percentage and potential for late flowering. With these criteria in mind, a range of cultivars have been selected for importation and assessment. These included three from the Ukraine (USO-11, USO-14 and USO-13), four from France (Futura 77, Felina 34, Fedrina 74 and Ferimon 12) and two from Hungary (Kompolti and Unico B). Four of these cultivars were assessed during the 1994/95 season. The remaining cultivars will be screened in a second trial planned for the 1995/96 season.

The trial was sown on the University of Tasmania farm at Cambridge on the 13th of October.

Variety	Unico B	Kompolti	Fedrina 74	USO 11
Germination (%)	49	63	77	71
Plant count (/m²)	63 a	126 b	140 b	144 b
O.D. Stem yld. (g/m²)	1357 a	1174 a	893 b	868 b
Stem diameter (mm)	12 a	9 b	7 b	8 b
Stem length (cm)	227 a	191 b	179 c	140 d
% Bark	35 ab	37 a	33 b	35 b
Date flowering.	23rd Jan	26th Jan	8th Jan	5th Dec
Date seed maturity	16th Mar	18th Mar	24th Feb	11th Feb
Seed yield (g/m²)	135 a	43 b	84 c	100 c
% THC	0.03	< 0.01	0.11	0.01

Note: Mean values followed by the same letter in each row are not significantly different (ie p> 0.05)

Table 1. Stem and component yield, seed yield, dates of flowering and seed harvest, %THC and plant density for hemp cultivar trial.

Sowing date trial

Separate sowing date trials were established in the north of the state near Devonport and in the southeast at Cambridge. Two cultivars were trialled, namely Kompolti and Fedrina 74. Four separate sowing dates were selected over spring and at Cambridge, an additional late autumn sowing (May 30) of Kompolti was included for the purpose of comparison and assessment of the potential of hemp as a winter crop.

Harvesting trial

A licence was also granted for a one hectare plot of hemp to conduct harvesting trials. This larger area enabled preliminary evaluation of potential harvesting methods suited to the Tasmanian environment and the need for new machinery or modifications to existing equipment.

It is believed that the relatively long, dry nature of our growing season and existing equipment is best suited to a 'dry' harvest system where the straw is dried naturally in the field prior to collection. The crop was allowed to proceed through to seed maturity to assess dual purpose potential. A range of equipment was trialled including a combine harvester, finger mower, draper style windrower, ground driven rake, round baler and chaff cutter.

All trials were established with a sowing rate of 80kg/ha and a row spacing of 15 cm. Fertilizer rates were based on literature recommendations modified according to soil nutrient status. Crops were irrigated when soil moisture deficit exceeded about 35mm using overhead sprinklers.

The date of flowering was taken as the time when 50% of the plants had one or more pedicillate male flowers or female flowers with styles clearly evident (Van der Werf *et al* 1994). Seed maturity was taken as the time when 50% of the plants had seed that was dark brown in color and resistant to applied pressure.

Determination of bark percentage of whole stem was based on a method used by De Meijer *et al* (1994). Starting from about 15 cm above ground level, stem sections approximately 30 cm long were taken from 15 individual plants per plot. Care was taken to select plants with a uniform diameter of approximately 7-10 mm measured at a height of 30 cm. In the case of dioecious cultivars, only the females were selected. The sections were then dried at 70 degrees Celsius for at least 24 hours prior to manual separation.

Small losses from infection with *Sclerotinia sclerotiorum* and *Alternaria sp.* were observed during the growing season. Losses were minimal and control was felt unnecessary. The rapid growth rate and high plant densities afforded strong competiton with weed species thus negating the need for chemical weed control. Substantial losses from bird damage were apparent just after emergence. Bird control tape and hawk effigies were employed to minimise further losses.

THC content was measured at State Government

analytical laboratories using gas chromatography. Readings were based on a composite subsample of the upper 25 cm of the main stem inflorescence of six individual plants. In the case of dioecious cultivars, female plants only were sampled.
Randomised complete block and split plot designs were used for cultivar and sowing date trials respectively. Analysis of variance tests were performed using *Systat 5.2* software. Means were compared using the Fisher LSD test with significance for p values less than 0.05.

Sowing date trial

Results from the sowing date trial (Table 2) at Devonport indicate significant stem yield loss associated with delays in sowing date from mid September to early November, particularly with late flowering Kompolti. A similar trend was apparent for spring sowings at Cambridge.

The May 30 sowing of Kompolti at Cambridge suffered losses from waterlogging during the winter months and flowered in the latter half of September at a height of 0.5m with oven dry stem yields of approximately 230 g/m². A further sowing of Kompolti at the same site on August 30 showed an apparent dual flowering response with evidence of partial flowering in early November and the majority of flowering ocurring in late January. The success of early sowings in Tasmania clearly depends on finding later flowering genotypes and cultivation on well drained sites.

Kompolti seed used in the sowing date trial was from a different source to that used in the cultivar trial and had a higher germination percentage (89%). This is reflected in the significantly larger harvest plant counts relative to Fedrina in the sowing date trial. Furthermore, establishment on the clay loam soils at Devonport was superior to that on the duplex sandy loams at Cambridge, as shown by the relative plant densities for Fedrina at each site.

Differences in bark percentage with delayed sowing were not significant. Similarly, differences in seed yield for Kompolti were not significant. However, an increasing trend in seed yield with delayed sowing was apparent with Fedrina.

Sowing date.	Cultivar	Density (per m^2)	Height (cm)	Stem Yld. (OD g/m²)	Seed Yld (g/m²)	Flower date.	Seed maturity	Bark (%)
21 Sept	Kompolti	306a	206a	1282a	77a	29 Jan	27 Feb	42a
10 Oct	Kompolti	253a	203a	1271a	73a	31 Jan	29 Feb	41a
24 Oct	Kompolti	308a	183b	1054b	83a	31 Jan	29 Feb	37a
8 Nov	Kompolti	254a	182b	962b	76a	3 Feb	1 Mar	38a
21 Sept	Fedrina 74	225a	158a	945a	65a	25 Dec	31 Jan	34a
10 Oct	Fedrina 74	182a	178b	972a	83b	3 Jan	7 Feb	33a
24 Oct	Fedrina 74	212a	157a	909b	98b	13 Jan	15 Feb	32a
8 Nov	Fedrina 74	215a	165a	849b	102b	16 Jan	19 Feb	30a

Note: Means values for each cultivar followed by the same letter in each column are not significantly different (p>0.05).

Table 2. Stem and component yields, plant density, seed yield, flowering and seed maturity dates and bark percentage for sowing date trial, Devonport.

Results & Discussion

Cultivar trial

The influence of flowering time on stem yield is clearly evident in Table 1 with the later flowering Hungarian cultivars, Unico B and Kompolti having significantly greater stem yields than Fedrina and USO 11. The larger stem yield of Unico B was achieved with significantly fewer plants per unit area. The low plant density was attributed to a poorer germination rate. The plants have apparently compensated for this lower plant density by developing taller, thicker and branched stems.

It is apparent from the flowering times that the relatively long, dry summer season in Tasmania could accommodate later flowering and potentially higher yielding genotypes. Genotypic variability in flowering time and yield components exists within this species (De Meijer, 1994) and offers the potential for future breeding work to generate varieties more suited to cultivation in Australia.

The seed yield of Unico B was significantly greater than all other cultivars and was attributable at least in part to a lower plant density. Conversely, Kompolti had the lowest seed yield.

Kompolti had a significantly greater percentage of bark in the stem than both USO11 and Fedrina.
Content of both THC and CBD in collected samples is substantially less than that noted by other researchers (de Meijer S. pers. comm.). Possible reasons for this include sampling at flowering rather than initial seed maturity (De Meijer *et al* 1992), the small sample size and differences in chemical analysis methods.

Harvesting trial

The conventional combine harvester was able to take seed off, but only by raising the cutter bar to the maximum allowable height of approximately 180 cm. At this cutting height, more than the seed bearing portion of the stem was removed resulting in fibre yield losses. In order to optimise the efficiency of the seed harvesting operation, timing is vital and even with good timing the efficiency is expected to be low due to the nonuniform nature of seed maturity. Other potential problems with a dual purpose hemp crop include contamination from leaf and residual seed in the papermaking process, losses of stem yield in the wheel tracks, prolonged security risk and some potential risk associated with inadequate drying of the stem late in the season. A more appropriate system might involve separate seed and fibre crops, managed in such a way as to optimise the yield and quality of each crop product.

Having removed the seed, the remaining stem was then mown near ground level with a finger mower. The narrow draper style windrower was clearly unsatisfactory for handling tall hemp crops. Existing wide draper or augur type windrowing equipment designed for other crops may prove satisfactory for hemp harvesting.

No major problems were encountered with the round baling of the stem. Minor pickup blockages can be overcome by careful selection of groundspeed and a reduction in windrow volume.

In order to overcome problems with fibre tangling in the pulping of hemp, the stem or bark fibre will need to be cut into lengths of 5-10 mm. With this in mind, it was felt that another possible harvesting option might be to pass the stem through a modified forage harvester and feed the cut straw into a hopper bin. To assess this, retted and unretted stem material was passed through a stationary five-bladed chaff cutter. A more uniform cutting length could be achieved by ensuring the stem is fed end on to the cutter, by minimising the gap between blade and cutting face, having sharp blades and employing a sieving table with feedback of over-long pieces. The action of cutting seemed to separate the bark and core fractions quite effectively. Further separation of the two components for pulping trials was afforded by floatation in water.

Ongoing and future research

Pulp and papermaking trials

The Tasmanian operation of ANM produces approximately 40% of Australia's newsprint requirements from a blend of eucalypt chemo-mechanical pulp (CMP), radiata pine thermo-mechanical pulp (TMP) and a small amount (3%) of imported long-fibre kraft pulp. The purpose of the kraft supplement is to provide additional strength to the newsprint. Interest from ANM in this current study lies in assessing the potential of replacing the kraft component with locally grown hemp and flax, pulped with existing mechanical processes. Potentially, ANM would benefit from being able to source and process the required long fibre supplement locally, thus freeing them from fluctuations in the world price and availability of kraft pulp. The key processing questions are whether or not it is possible to produce a mechanical pulp with properties at least equivalent to kraft and for a price somewhat less than the imported option. Laboratory pulping trials and an economic assessment will be directed toward answering these questions. Emphasis will be given to evaluating and optimising the existing chemo-mechical (CMP) and thermo-mechanical (TMP) processes with hemp and flax as raw materials. Pulp evaluations will be made of the whole stem as well as the core and bast fractions of hemp and flax.

Economic feasibility assessment

Work has recently commenced on an economic feasibility assessment of a hemp and flax based industry. This will investigate development potential and strategies and issues to develop the industry. Preliminary budgets have emphasised the need for utilising the whole stem in order for a future industry to be economically viable. Application of the core fraction in the newsprint as well as non-paper end uses is currently being investigated.

Crop growth model

The legal status of hemp requires that trial and commercial cropping activities be conducted under strict licencing arrangements. This coupled with the high cost of traditional agronomic trials suggests a potential role for a crop growth model. Such a model would aid decision makers in the assessment of production potential at a given site. It is intended that the model will be based on a similar model developed for kenaf (Carberry *et al* 1992) and predict key phenological events and potential stem and bast fibre yield from crop management and local environment inputs.

Forthcoming trials will investigate key aspects such as leaf area development, pre-emergent growth responses to temperature and flowering responses to daylength.

Irrigation trials

It is apparent that irrigation is one of the major variable costs associated with hemp cultivation in Tasmania. Irrigation is necessary to overcome deficiencies in both the distribution and total amount of rainfall over the summer months in Tasmania. It was next decided to conduct an irrigation trial with hemp in order to gain an understanding of its effect on yield and growth responses, according to different irrigation schedules based on a range of refill points.

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Interview

'SOMETIMES WE HAVE THE WIND AT OUR BACKS, AND SOMETIMES IN OUR FACES

Interview with Prof. Ryszard Kozlowski,
Director of the Institute of Natural Fibres (INF) in Poznan, Poland

How did your career develop?

I graduated in Applied Chemistry at the University of Poznan in 1961. Subsequently I went to INF, where I worked up to now with only short breaks. My Ph.D. work, from 1970 to 1972, was aimed at the biochemistry of retting of flax and hemp, and the effects of added nutrients, like urea, on the processes. As head of the INF department for waste and by-products, partly during a fellowship in Finland, I focused on the development of fire-, fungi- and water resistant particle board made from flax residues and hemp woody core. In 1987, I was promoted to be General Director of INF and in 1990 awarded the degree of Professor of Technical Science at Poznan University.

What are your international functions on the fibre scene?

I am Coordinator of the FAO flax network. This network consists of five subgroups focusing on the subjects: breeding and agriculture; harvesting and processing; quality; non-textile applications and marketing. We try to connect people from all over the world working with flax, linseed and also hemp by organizing symposia and by publishing proceedings and a newsletter. The next general meeting is in 1996 in Rouen, France. Maybe we could arrange the one after that in the Netherlands in collaboration with IHA. Further, I am a country member of the council of the World Textile Institute in Manchester, UK.

When was INF established, what is its size and some of its research interests?

The INF was founded under a different name in 1930 in Vilna, the present Vilnius, in Lithuania. After the war, the institute continued in Poznan. Besides flax and hemp, we do research on the protein fibres, silk and wool. At present, sixty-three employees work in seven laboratories, on seven experimental farms in different climatic regions and in an experimental retting mill. We have activities in the field of biotechnology, breeding, agronomy, spinning technology, environmental protection, marketing, technical information and normalization and standardization.

Due to strongly reduced funding levels by the government, we were also forced to start commercial activities to keep the INF running. That's why we have a marketing group of six persons to promote our products. We really need to earn money to invest in new equipment.

This year, we are testing an improved hemp harvester which was developed at the INF. We expect it to be better than the Russian machinery which is standard at the moment.

In the retting mill, we investigate alternatives to the traditional dew retting system, such as enzymatic

degumming and mechanical green straw processing. An important project, ordered by the Polish government, is to find out if non-food crops like hemp and flax can be applied for the cleaning of soils contaminated with cadmium and copper. Up to 1000 ha of hemp is presently grown for this purpose in S.W. Poland (Silesia) in an area with copper mines.

Don't you only spread the pollution more diffusely with such an approach?

No, the metals are specificly accumulated in the seed flour fraction. The cellulose of the stems can safely be used for pulping. The seed oil is also clean, it's mainly applied in paint production. The metals can be extracted by leaching the seed cake with hydrochloric or other acid solutions.

How is the situation of the Polish hemp industry?

Until the 1960s, there was quite a large Polish hemp industry, with four retting mills. Hemp fibres were mainly used for manufacturing ropes and fabrics for military use. Hemp was even of strategic importance. We had yearly 20,000 to 30,000 ha.growing. A factory had an annual production of 18000 m^3 of particle board, partly made from hemp woody core. Unfortunately, this factory was closed in 1975. After the changes in Russia, our export of military textiles completely collapsed. At present, there are two hemp processing factories left. They make fibre board and still some military fabrics (tents, shoes). Hemp is a marginal crop at the moment. Besides the area in polluted regions, there is another 2000 ha in S.E. Poland.

Are there, apart from the INF, other Polish institutes or companies involved in any aspect of *Cannabis* research?

No, no, no. In some botanic gardens and at universities they may have some plants, but they have obtained the seeds from us and it's only for demonstration, not research.

What is the goal of present hemp breeding at the INF? Can new cultivars be expected in the near future?

Ever since the institute was established, hemp breeding has never been interrupted, although we have had pressure to abandon this work entirely. I remember a congress in the 1960s where representatives of the industry said that there was no longer need for hemp with a fine textile quality. They wanted high yielding crops with coarse fibres for rope and technical fabrics. We changed our breeding completely to this direction, which resulted in the present two monoecious cultivars, Bialobrzeskie and Beniko. Current breeding is aimed at fine textile quality again, in combination with an acceptable productivity and a very low THC content. Within two or three years, we expect to release a new textile cultivar which is partly based on a Silezian landrace. For better textile quality, however, cultivation methods should also be altered, using higher plant densities and less fertilizer.

At the last World Textile Congress in Yokohama, there was an idea presented to modify the biosynthesis of cellulose in order to improve its molecular structure for textile application. Our biotechnology group is interested in such ideas.

Are you already working on it?

We have plans.

Are old Polish hemp landraces preserved? Is there a *Cannabis* germplasm collection in Poland?

Unfortunately, our old local hemp strains are not preserved in any genebank. There is only a breeding collection maintained at the INF.

Is the history of the Polish hemp industry archived or documented in a museum?

There is not a special museum dedicated to hemp, but the agricultural museum in Poznan exhibits some hemp related objects.

How is the legal situation with regard to *Cannabis* in Poland?

One needs a permit, a special agreement with the government, to grow it.

Is there significant production and trade of *Cannabis* drugs in Poland?

No, there's little interest in these matters.

How do you regard the future of the INF and the Polish hemp industry?

I expect that the present difficult period, which is due to reduced funding by the government, will last for at least ten more years. Sometimes we have the wind at our backs, and sometimes in our faces. Still, I belong to the optimists. A personal experience: when I started working at the INF in 1961, my boss sent me to a village to harvest hemp and flax, and collect raw materials for particle board experiments. I was used to workiing in clean laboratories, and now I found myself in dirt and dust. That time was also the beginning of nylon-era. Everybody wanted synthetic polymers instead of plant fibres. Even farmers preferred polypropylene above hemp rope. I remember from a visit to the library that Svenska Dagbladen reported: 'last retting mill is closing in Sweden'. Nails in my coffin, as it were. I was then convinced that natural fibres had no future, that I was employed at the wrong place and that I had to escape as soon as possible. Still, I am here and I see a future for our hemp industry. I expect that after 2000, the worlds' forests will be better protected and that hemp, or crops like kenaf and *Miscanthus*, will become important alternative sources of cellulose. At our high latitude (52_ to 60_) the yield potential of hemp, being up to 17 tonnes of dry mass consisting of 35% high quality fibre, exceeds that of any tree species. Especially since the Frankfurt hemp symposium, we get frequent requests from abroad for hemp seed for sowing and for fine fabrics. At present only China and Rumania can meet such demands. But these countries still use warm water retting. Although this method gives fibres of high and stable quality, it is very expensive and polluting. Per tonne of fibre, one needs ca. 50 tonnes of water for retting and washing. I tend to optimism for the future of textile hemp in Poland, provided that we develop finer cutivars than the current ones, and introduce more advanced techniques for fibre extraction.

How do you consider recent innovations for fibre extraction, for example, steam explosion?

We are testing fibres extracted by a newly developed machine of the Claes company (Germany) for simultaneous harvesting and fibre extraction in the field. I see, however, problems with quality and costs. After the steam explosion of flax, the fibre doesn't look like flax anymore. Due to such treatment, the product looses its authentic character.

Is the INF interested in international cooperation and business?

Yes, certainly we are. But although a lot of people show commercial interest in hemp, they generally do not want to support the necessary research work, and that is what we need first. Most peoples' largest concern is how to earn money with hemp, they do not seem to realize that they first have to put money into it. We have agreed to export ca 20 tonnes of hemp sowing material this year to Canada and Australia. We are however always somewhat afraid that the seed will be used not only for cultivation but also for multiplication and further breeding. Further, we sell hemp products to Germany.

We have had a long and regular exchange of researchers with the Ukrainian Research Institute of Bast Crops in Glukhov. In collaboration with the Institut Lna, Torzhok, Russia, we try to accelerate hemp breeding through the implementation of biotechnological techniques.

Is there anything else that you would like to mention?

I hope that the IHA will develop into a prosperous organization and that its activities will help to promote fibre hemp. And the IHA should join the FAO fibre crops network!

1995 ICRS Symposium on *Cannabis* and the Cannabinoids

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The 1995 Symposium on *Cannabis* and the Cannabinoids sponsored by the International *Cannabis* Research Society (ICRS) was held at the Regal McCormick Ranch at Scottsdale, Arizona, USA from June 8-10. Nearly 80 *Cannabis* researchers from around the world convened to share primary research papers covering a wide range of topics including the chemistry, biochemistry, and metabolism of cannabinoids; the characterization of the cannabinoid receptors and associated G-proteins; the endogenous ligands and antagonists associated with the cannabinoid receptors; investigations of the immunological, pharmacological, and physiological actions of cannabinoids; the effects of chronic exposure to cannabinoids; and the effects of cannabinoids on human behavior.

The research presented at the 1995 ICRS symposium represents international cooperation between 45 universities and private companies from Australia, Canada, Finland, France, Hungary, Israel, Italy, Japan, Korea, The Netherlands, Scotland, Spain, and the United States. Twenty-five of the 64 papers presented (nearly 40%) were collaborative efforts between two or more laboratories. Basic cannabinoid research has been largely sponsored by government agencies such as the United States National Institute on Drug Abuse. Since there has been little interest shown in the cannabinoids by the highly competitive pharmaceutical industry, there have been fewer of the limitations on collaborative effort so often imposed by proprietary considerations.

Cannabis and its cannabinoid compounds have been under study by researchers worldwide since the 1960s when the recreational use of *Cannabis* drugs began to gain popularity in the West. The basic structures and activities of the naturally occurring cannabinoids and synthetic cannabinoids created in chemistry laboratories were elucidated during the 1970s. The physiological and psychological effects of cannabinoids on animal and human subjects were extensively studied during the 1970s and 1980s. However, few new insights into the mechanisms of cannabinoid actions on the body and the brain were being realized. By the early 1990s the field of cannabinoid research lacked momentum and direction. Then three key discoveries radically changed the face of cannabinoid research. The discovery of the cannabinoid receptor (1992), the isolation and synthesis of anandamide, the naturally occurring ligand (receptor binding molecule) produced in the brain (1993), and the synthesis of an antagonist (receptor blocking molecule) to the cannabinoid ligands (1994), providing tools making it possible to study the effects of cannabinoids from the inside out. Without these basic tools no viable models could be proposed by which to measure new theories.

The vibrant field of cannabinoid research is now advancing rapidly on many new fronts. As researchers probe deeper into the mechanisms of the interaction between the cannabinoid receptor and its various ligands, they move ever closer to understanding the relationship between humans and *Cannabis*.

The specific topics of the papers presented at the 1995 ICRS symposium reflect the underlying research interests of the majority of ICRS members in developing a deeper understanding of the complex relationship between *Cannabis* and humans. Brief summaries of the presentations most likely to be of interest to IHA members are given below. Many presentations have been omitted from this brief review in the interest of conserving space.

June 8 Chemistry

Marcus Tius (University of Hawaii) opened the Chemistry Session with his research on the synthesis of hybrid cannabinoid molecules incorporating features of both the classical cannabinoids (naturally occurring cannabinoids and synthetic molecules modeled on their structure) such as THC and non-classical cannabinoids (non-natural cannabinoid molecules derived from other chemical structures that induce cannabinoid effects) such as CP 55,940. Many of these hybrid cannabinoids were found to bind with the brain cannabinoid receptor CB1. New hybrid cannabinoids can be used as probes to elucidate the structures and functions of the cannabinoid receptors and may also prove to have medical applications.

Alexandros Makriyannis (University of Connecticut) began the report of his findings concerning the synthesis of hexahydrocannabinol analogs and their binding behavior with receptors by explaining how new cannabinoid probes are being used to investigate the structure of the cannabinoid receptors. The probes that he and his colleagues have developed bind irreversibly to the receptor and allow the receptor proteins to be cleaved into discrete subunits. These protein subunits can then be subjected to further analysis in order to determine their detailed structure and the way in which they function in forming the receptor.

John Huffman and Julia Lainton (Clemson University) gave two papers on the synthesis of several methyl and dimethyl-heptyl substituted side chain analogs of Δ-8-THC. Pharmacologically the analogs were of equal or greater potency than the natural cannabinoid Δ-8-THC.

Raj Razdan (Organix Inc.) presented a synthesis of the cannabinoid antagonist SR 141716A. The SR 141716A antagonist binds with the cannabinoid receptor and significantly limits the effects of Δ-9-THC the primary psycho-active compound in *Cannabis*. Chemists at Sanofi Recherche first described SR 141716A at the 1994 ICRS symposium in Montreal, Canada. Their discovery met with great enthusiasm and now two syntheses have been presented.

Biochemistry and Metabolism

Herbert Seltzman (Research Triangle Institute) presented a second synthesis of SR 141716A, as well as the tritium labeled molecule, and an elucidation of the antagonist's structure. The cannabinoid antagonist SR 141716A and its radio labeled analog will be used in studies of the cannabinoid receptors.

Dale Deutsch (State University of New York at Stony Brook) reported on a new assay technique for anandamide amidase activity. Anandamide is a compound produced in brain tissue that binds to the cannabinoid receptors and may modulate such psychologically and physiologically related functions as control of mood and the sensations of contentment and euphoria. Anandamide amidase is the enzyme at the site of the cannabinoid receptors that breaks down (hydrolyzes) the anandamide molecule into its precursor molecule arachadonic acid and thereby clears the cannabinoid receptors so they can be stimulated again. The new assay technique allows much faster determination of the location of the cannabinoid receptors in brain tissue as indicated by the hydrolysis of anandamide.

Sumner Burstein (University of Massachusetts Medical School) presented his theory that categorizes anandamide, and other endogenous cannabinoid ligands (compounds that bind to receptors) yet to be discovered, as members of a novel group of eicosanoid compounds. In this light he presented a theoretical model for the biosynthesis and mode of action of anandamide involving a positive feedback mechanism where anandamide synthesis triggers additional anandamide synthesis. This model can be used as a framework within which to explore the evolution of the anandamide pathway in humans.

Cecelia Hillard (Medical College of Wisconsin) reported on research using brain cell cultures to study the uptake of anandamide and its breakdown by cells. Anandamide is absorbed rapidly by cells, is only broken down within the cell, and breaks down quite slowly. The assay technique developed using these cell lines is being used to identify the specific locations of anandamide's actions amongst the myriad cellular components. Initial results indicate that cell fractions containing myelin or microsomal membranes exhibit the greatest breakdown of anandamide.

Aidan Hampson (University of California at San Francisco) offered strong data indicating that anandamide is broken down in the brain through the action of a lipoxygenase. The lipoxygenase pathway is suggested as a third pathway, in addition to the previously elucidated anandamide amidase and cytochrome P450 pathways, that brain cells use to break down anandamide. The structures of various anandamide lipoxygenase metabolites were shown, and some of these compounds were found to have a very high affinity for the cannabinoid receptor.

Receptors and G-Proteins

Patty Reggio and Daniel Bramblett (Kennesaw State College) gave two papers and a poster showing the results of detailed studies into the mechanism of action of the cannabinoid receptors. Through the determination of amino acid sequences in the receptor proteins and advanced computer assisted modeling techniques, the cannabinoid receptors can now be visualized as a membrane-bound docking site encircled by 7 nearly parallel helical protein subunits. The cannabinoid ligand molecules enter the circular opening between the protein helices and bind temporarily to several of the amino acid bases that form the long protein chains. When a ligand binds to the receptor it causes the proteins to bend, and this change in shape triggers a chemical change that activates the G-protein attached to the inner side of the membrane. The G-protein then detaches from the receptor and is transported to wherever in the organ the message from the receptor is intended to have its effect.

Brian Thomas (Research Triangle Institute) showed computer generated structural models for the eicosanoid, classical cannabinoid, and non-classical cannabinoid classes of molecules and compared the structural requirements of these molecules in terms of their having cannabimimetic (*Cannabis*-like) activity. Structural studies allow pharmaceutical chemists to design molecules with a high likelihood of having cannabimimetic activity that mimics one of the beneficial actions of a natural cannabinoid.

Abby Parrill (University of Arizona) also showed a computerized structural analysis of apparently dissimilar cannabinoids looking for hidden structural similarities that may be required for the molecular to be active.

Denise Pettit (Medical College of Virginia) presented an assay of CB1 receptor activity using melanophore cells that change color dramatically in the presence of compounds that activate the CB1 cannabinoid receptor. This technique could prove useful for mapping the sites of active receptors and as an assay of activity for novel ligands and antagonists.

Steven Childers (Bowman Gray School of Medicine) presented a comparison of the opioid and cannabinoid receptors in terms of receptor density and the activity of their associated G-protein effectors. The activity of G-protein coupled receptors does not correspond to the number of receptors available. Data also indicate that cannabinoid receptors are not as efficiently coupled to their associated G-proteins as are the opioid receptors.

June 9 Receptors

Roger Pertwee (University of Aberdeen, Scotland) presented further evidence that CB1 receptors, usually characterized as the brain cannabinoid receptors, are also found in the mouse vas deferens. The presence of the CB1 receptor in tissues other than the brain could indicate that cannabinoid receptors are somehow involved in basic physiological functions.

David Shire (Sanofi Recherche, France) reported on Sanofi's continuing research to characterize the CB1 and CB2 receptors, and a new variant receptor CB1A discovered during the cloning of the CB1 receptor using their cannabinoid antagonist SR 141716A. Data indicate that the amino-terminal region of the CB1 receptor may play a part in the receptor's recognition of the antagonist.

David Compton (Medical College of Virginia) presented additional characterization of the CB2 receptor in terms of its affinity for various ligands. Cannabinoid ligands can be divided into three groups: CB1 selective ligands; CB2 selective ligands; and ligands with low selectivity.

Pharmacology and Nociception

William Martin (Brown University) presented research showing that anandamide plays a role in antinociception (analgesia and sedation) and Jennelle Durnett-Richardson (University of Minnesota) showed that anandamide has its effect in the spinal chord. Sandra Welch (Medical College of Virginia) demonstrated that anandamide and THC have different mechanisms by which they induce antinociception and tolerance. Aron Lichtman (Medical College of Virginia) presented evidence that SR 141716A antagonizes the antinociceptive effects of cannabinoids.

Physiology and Pharmacology

Sam Deadwyler (Wake Forest University) brought us up to date on his investigations of the mode of action of cannabinoids through their regulation of the potassium A-currents. Potassium currents are pathways through which electrical signals are transmitted through cells and form a link in the communication system within the body.

David Compton (Medical College of Virginia) showed that the structures of certain active indole derivatives of non-classical cannabinoids can suggest templates for the development of new cannabinoids with specific pharmacological activities.

Ken Mackie (University of Washington and Panlabs) showed evidence that the CB1 receptor is phosphorylated by protein kinase C and that this mechanism may be involved in the receptor's action.

June 10 Chronic Exposure

Stacie Cook (Medical College of Virginia) reported that rats develop a pharmacological tolerance to extremely high doses of THC, that the tolerance to THC was not as great as tolerance to CP 55,940, and that no tolerance developed to anandamide.

Wensheng Lang (University of Connecticut) presented a model for the transport of cannabimimetic agents across the blood brain barrier involving (i) an "on" step from the blood into the membranes (ii) a "flip-flop" step within the membrane where the orientation of the polar ends of the cannabinoid molecules are reversed, and (iii) an "off" step from the membrane into the brain tissues.

Dave Pate (HortaPharm, Amsterdam) presented research performed during development of a cyclodextrin delivery system for administering cannabinoids to the eyes, lowering the high intraocular pressure associated with glaucoma. Several novel anandamide analogs were found to cause a minimal initial hypertensive effect (increased ocular pressure) followed by a significant hypotensive phase (lowered ocular pressure). This paper illustrated that the recently discovered anandamides may have promising medical uses.

Julian Romero (Complutense University, Spain) presented evidence that chronic exposure to anandamide causes down-regulation of the CB1 receptor and that the rapid breakdown of anandamide counteracts the desensitization. Investigations along these lines are leading to a better understanding of the tolerance to cannabinoid compounds.

Endogenous Ligands and Antagonists

Ester Fride (Hebrew University, Israel) presented the results of research into the effects of very low doses of anandamide on the behavior of rats. The effects produced by very low doses of anandamide are opposite from the effects of high doses. Also, the effects of very low doses of anandamide are easier to detect than the effects of very low doses of Δ-9-THC. The hypothesis that low doses of anandamide activate the G-protein signaling pathway is currently being tested.

Amruthesh Shivachar, Jenny Wiley and Mario Aceto (Medical College of Virginia) and Mike Walker (Brown University) all gave papers on research using the cannabinoid antagonist SR 141716A to block the effects of anandamide, Δ-9-THC, CP 55,940 or WIN 55,212-2 either to investigate the actions of the antagonist itself or to precipitate withdrawal in investigations of tolerance to cannabinoids.

Human Behavior

Mario Peres-Reyes (University of North Carolina) reviewed his earlier clinical research confirming that there is no significant correlation between the condition of red eyes and the amount of THC a person has been exposed to. He also cautioned that the use of red eyes as a criterion for deciding if a person is under the influence of THC is not reliable.

Rik Musty (University of Vermont) pointed out that the data from a study of light and heavy marijuana users with either above average or below average self esteem suggest that marijuana smokers are well adjusted to life as measured by the Sense of Coherence Scale (SOC). This research also shows that regardless of the amount of marijuana consumed both groups with low self esteem had lower SOC scores. It is unlikely that marijuana use alone leads to the poor adjustment to life experienced in marijuana users seeking treatment, and that their poor adjustment to life is more likely a result of depression.

Poster Session

Fourteen posters covered many of the same fields of study represented by the oral presentations. Nancy Buckley and Eva Mezey (National Institutes of Neurological Diseases and Stroke) presented a poster on the cellular location of the non-brain cannabinoid receptor CB2 found in spleen tissue. The discovery that the CB2 receptor is localized to the lymphocytes, but is not found in the macrophages, may help to explain the immunosuppressive effects of THC and suggests that certain CB2 receptor agonists (receptor stimulating compounds) might be used to stimulate certain immune responses. Amy Herring et. al. (Michigan State University) also presented evidence that the CB2 receptor is active in splenocytes which suggests that the CB2 receptor is involved in the modulation of the immune system by cannabinoid compounds. The possible effects of cannabinoids on the immune system is currently being actively explored by several research teams.

Helen McIntosh and Allyn Howlett (Saint Louis University School of Medicine) presented investigations into the turnover time of the CB1 receptor. Since the rate of turnover or synthesis of new receptors to replace exhausted and no longer active receptors is known to influence drug tolerance, this line of research may prove useful in understanding the mechanism of cannabinoid tolerance.

Alexandros Makriyannis *et al.* presented research with potent inhibitors of anandamide hydrolysis that showed antinociceptive (analgesic and calmative) activity. When anandamide breakdown by amidase is inhibited, and an antagonist is also administered, antinociception is attenuated, indicating that the antinociceptive effects of the cannabinoids are mediated by the cannabinoid receptor.

Murielle Rinaldi-Carmona *et al*. (Sanofi Recherche, France) presented the newest stage in Sanofi's development of their orally active cannabinoid antagonist molecule SR 141716A. Data indicate that SR 141716A competitively displaces the CP 55,940 and WIN 55,212-2 non-classical cannabinoids and Δ-9-THC while it non-competitively displaces anandamide. Tritiated radio-labeled SR 141716A was shown to be an effective tool for labeling the brain cannabinoid receptors both in vitro and in vivo.

Kang Tsou *et al*. (Brown University) reported that their research with CP55,940 provides evidence that cannabinoids suppress pain by affecting the processing of pain signals in the spine.

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The International *Cannabis* Research Society is an organization of *Cannabis* researchers established in 1990 whose main focus is on cannabinoid chemistry and pharmacology. ICRS members and their research teams have made the key discoveries that now fuel the resurgent interest in *Cannabis* and cannabinoid research. If you are interested in learning more about the ICRS contact Dr. Rik Musty, 31121 Lakeview Avenue, Red Wing, MN, USA 55066, <Mrik @aol.com>

The Colorado Hemp Production Act of 1995: Farms and forests without marijuana

Thomas J. Ballanco

"Make the most of the hemp seed, sow it everywhere."
George Washington, 1794 [1]

Why does America continue to discourage hemp research and cultivation? This review clearly shows that the United States federal government never intended to interfere with or prevent industrial hemp cultivation. This authority has been usurped by the Drug Enforcement Administration under their mandate to control drug *Cannabis*. A clear perspective of how we have arrived at this situation will permit the examination of the situation and provide a basis for change in the future. The importance of allowing hemp research and cultivation in the United States, the West's largest market for hemp products, should not be under estimated. The Act has been rewritten and will be reintroduced in Colorado in early 1996 by Senator Lloyd Casey. - JIHA Editors

Introduction

Colorado became the first state in the United States of America to take legislative action aimed at re-establishing a commercial hemp industry, when Colorado State Senator Lloyd Casey introduced the Colorado Hemp Production Act of 1995 ("Colorado Act") [2] on January 25, 1995. Earlier, in November, 1994, Kentucky Governor Brereton Jones established a commission to decide how to re-create the industry in that state.[3] The commission has been studying the prospect informally for eighteen months and intends to allow Kentucky farmers to begin planting hemp as soon as possible.[4] As of this writing, at least six other states are taking action to revive the dormant commercial hemp industry.[5] This Comment explores the Colorado Act in light of current federal law and explains how domestic hemp production can proceed while maintaining existing prohibitions against marijuana.

The differences between hemp and marijuana

Hemp is an ancient fiber and seed crop that is often described as "marijuana's misunderstood cousin."[6] The once prosperous American hemp industry was dealt a fatal blow when it was made the inadvertent victim of the Marihuana Tax Act of 1937 ("1937 Act").[7] While hemp and marijuana are both products derived from the same plant species, *Cannabis sativa* L., they are produced independently by different *Cannabis* strains.[8] "Hemp" generally refers to the high fiber *Cannabis* varieties that have extremely low tetrahydrocannabinol ("THC") content.[9] THC is a chemical compound that is found in the resin secreted by the plant.[10] It is this ingredient that gives marijuana its psychoactive properties.[11] "Marijuana" refers to the leaves and flowers of certain *Cannabis* species containing high THC concentrations.[12] High fiber hemp strains are usually incapable of producing marijuana and high-THC marijuana strains produce only relatively small amounts of low quality fiber.[13]

In order for *Cannabis* plants to be classified as hemp under the European Union standards, which have been proposed in Kentucky and Colorado, they must contain no more than 0.3% THC.[14] Marijuana on the other hand, usually ranges from 3% to 12% THC.[15] THC was only identified as the active ingredient in marijuana in 1964, so classification based on psychoactive content was not possible when *Cannabis* was first regulated in the 1930s.[16] In 1995, however, a simple chemical analysis can accurately differentiate between *Cannabis*-hemp and *Cannabis*-marijuana.[17] The European Union certifies twelve *Cannabis* seed varieties that produce only high-fiber, low-THC hemp.[18]

[1] Note to Mt. Vernon's gardener, *reported in* CHRIS CONRAD, HEMP: LIFELINE TO THE FUTURE 305 (1993).
[2] S.B. 95-132, 60th Leg., 1995 Colorado.
[3] "Kentucky to Study Hemp," Lexington Register, Nov. 25, 1994 A1.
[4] Telephone interview with com-mission member Jake Graves on January 25, 1995.
[5] Oregon, California and Hawaii are considering legislation similar to S.B. 95-132, while the state Departments of Agriculture in Wisconsin, Minnesota and Georgia are negotiating with the U.S. Drug Enforcement Administration. Telephone interview with David Martin and Laura Kriho, *Colorado Hemp Initiative Project*, (Apr. 3, 1995).
[6] "Clothing Industry Going to Pot," CHICAGO TRIBUNE, Jan. 24, 1995 A12.
[7] Marijuana Tax Act, 26 U.S.C. § 2590 (1937). *See also, Taxation of Marihuana: Hearing on H.R. 6906 Before the Subcomm. of the Senate Comm. on Finance*, 75th Cong., 1st Sess., 7, 17 (1937)(statement of Clinton M. Hester, Assistant General Counsel, Treasury Dept.)("The production and sale of hemp and its products for industrial purposes will not be adversely affected by this bill.") and (statement of Harry J. Anslinger, Commissioner, Federal Bureau of Narcotics)(Sen. Brown: "What dangers, if any, does this bill have for the persons engaged in the legitimate uses of the hemp plant?" Mr. Anslinger: "I would say they are not only amply protected under this act, but they can go ahead and raise hemp just as they have always done it.").
[8] Ed Rosenthal, Hemp Today 305 (1994).
[9] Id. at 304
[10] Mel Frank & Ed Rosenthal, Marijuana Grower's Guide 21 (1990)
[11] Id.
[12] Rosenthal, supra note 8.
[13] Id.
[14] Commission Regulation 1164/89 of 28 April 1989 laying down detailed rules concerning the aid for fibre flax and hemp, Annex C(9), 1989 O.J. (L121), 32.
[15] Rosenthal, supra note 8 at 21-22. The strongest marijuana on record, seized by the United States Drug Enforcement Administration in Alaska, contained 37% THC. (Telephone interview with Special Agent Ron Wilson, U.S.D.E.A. on Nov. 22, 1994.).
[16] Rosenthal, supra note 8, at xiv.
[17] Commission Regulation, supra note 14, at Annex C.
[18] Id. at Annex B.

Benefits of hemp production

Hemp is touted by activists and environmentalists as a possible solution to deforestation.[19] Activists claim that hemp, the source of the world's longest and strongest natural fiber, is a far more efficient source of industrial fiber and paper pulp.[20] According to industry estimates, up to 70% of the annual commercial U.S. timber harvest is chipped for use in industrial fiber products, such as particle board, and as pulp for paper mills.[21] Less than 30% of the harvest is used as raw lumber for planks and beams.[22] A dated United States Department of Agriculture ("U.S.D.A.") report claims that an acre of hemp can produce four times as much pulp and fiber as an acre of trees.[23] However, recent reports from Europe, Australia and Canada indicate that the pulp and fiber return from hemp may be even greater than the old U.S.D.A. estimates.[24] Additionally, unlike kenaf and other alternative paper crops, hemp can grow in a variety of climates.[25] Farmers claim that it has no known insect predators nor plant competition, and thus can grow without pesticide or herbicide application.[26] It has water and fertilizer requirements similar to corn and wheat.[27]

In addition to the long bast fiber, hemp produces short fiber hurds from the stalk pith, as well as a valuable seed. The hurds are used to make lower quality paper and a variety of other cellulose-based products ranging from insulation to degradable plastics.[28] Hemp seeds are a rich source of oil and, like soy beans, are very high in protein.[29] Hemp seed oil contains the two essential fatty acids which some researchers claim strengthen the human immune system.[30] Hemp hurds can also be pyrolyzed into methanol or the seed oil burned like diesel fuel.[31] While some of these applications are yet to be fully established, strong plentiful textile fibers and edible seeds are presently hemp's most attractive economic qualities.[32] Industrial hemp's economic potential interests many Colorado farmers who are eager to begin production.[33]

The Colorado Hemp Production Act

The Colorado Act attempts to clarify the language in the 1937 Act, by defining "Hemp" as "all parts of the plant *Cannabis sativa* containing less than 1% THC."[34] It amends the definition of "Marijuana" and "Marijuana Products" to include only those *Cannabis* plants that contain more than 1% THC.[35] As a safety provision, it also includes a requirement that hemp plants contain cannabidol ("CBD") in concentrations equal to or greater than the THC concentration.[36] The high CBD content of such plants tends to counteract the psychoactive effects associated with any THC present.[37] The Colorado Act requires the Commissioner of the State Department of Agriculture ("Commissioner") to license all hemp farmers and handlers in the state.[38] The Commissioner must also certify authorized sources of industrial hemp seed.[39] Farmers may only plant certified hemp cultivars. Under the Colorado Act, hemp fields must be inspected at least once during the growth cycle and samples taken for THC analysis.[40] Crops that exceed the THC limits must be destroyed at the farmer's expense. The Colorado Act incorporates a 0.4% buffer between hemp and marijuana, requiring criminal prosecution only when crops test greater than 1.4% THC.[41] Few commercial hemp strains produce THC concentrations greater than 1%.[42]

Hemp production under federal law

As of this writing, the United States Drug Enforcement Administration ("D.E.A.") fails to acknowledge the difference between hemp and marijuana.[43] A letter faxed by the Special Agent in Charge of the D.E.A.'s Rocky Mountain Division to the members of the Colorado State Senate Committee on Agriculture just two hours before the final Committee hearing on S.B. 95-132 caused the Committee to postpone the measure indefinitely.[44] The letter characterized the Bill as a subterfuge,

[19] Jack Herer, The Emperor Wears No Clothes, (1985) and Chris Conrad, Hemp: Lifeline to the Future, (1992).
[20] Herer, supra note 19, at 2,7.
[21] Organization for Economic Cooperation and Development, The State of the Environment, (1991) p 117.
[22] Id.
[23] Lester Dewey, "Hemp" in Yearbook of the U.S. Dept. of Agriculture (1913).
[24] Rosenthal, supra note 8.
[25] Id, at 41-42.
[26] Hemptech, Industrial Hemp (1995), 18-19.
[27] Id. at 19.
[28] Id. at 24-30.
[29] Rosenthal, supra note 8, at 171.
[30] Lynn Osburn, Hempseed Nutrition, (1990).
[31] Rosenthal, supra note 8, at 139, 141.
[32] Id. at 143.
[33] Interview with Bob Winter, President, Weld County Farm Bureau (Apr. 5, 1995).
[34] S.B. 95-132, supra note 2, at § 103(4).
[35] Id. at § 103 (6-7).
[36] Id. at § 106 (1)(b). CBD is another chemical compound found in Cannabis resin, but it has no psychoactive properties. Rather, when smoked, CBD produces feelings of drowsiness and a headache in the user. Frank & Rosenthal, supra note 10, at 36.
[37] Frank & Rosenthal, supra note 10, at 22, 36; Rosenthal, supra note 8, at 43.
[38] S.B. 95-132, supra note 2, at § 105.
[39] Id.
[40] Id. at § 106(1).
[41] Id. at § 106(1)(b).
[42] Hemptech, supra note 26, at 4, 20, 47.
[43] Letter from Philip W. Perry, Special Agent in Charge, *U.S.D.E.A. Rocky Mountain Division Field Headquarters*, to Members, *Colorado State Senate Committee on Agriculture, Natural Resources and Energy* 1-2 (Feb. 16, 1995)(on file with the *University of Colorado Law Review*).
[44] Telephone interview with Lloyd Casey, *Colorado State Senator*, (Feb. 17, 1995).
[45] Perry, *supra* note 43, at 3.
[46] *Id.* at 2.

charging that S.B. 95-132 was "no more than a shallow ruse being advanced by those who seek to legalize marijuana."[45] It expressed concern that, if passed, S.B. 95-132, "would add the force of a Colorado statute to the perception that marijuana is 'OK'."[46]

The letter also pointed out that in the D.E.A.'s opinion, the Colorado Act would conflict with standing federal law.[47] The federal law cited by the D.E.A. defines "marihuana" as:

> all parts of the plant *Cannabis sativa* L., whether growing or not; the seeds thereof; the resin extracted from any part of such plant; and every compound, manufacture, salt, derivative, mixture, or preparation of such plant, its seeds or resin. Such term does not include the mature stalks of such plant, fiber produced from such stalks, oil or cake made from the seeds of such plant, any other compound, manufacture, salt, derivative, mixture, or preparation of such mature stalks (except the resin extracted therefrom), fiber, oil, or cake, or the sterilized seed of such plant which is incapable of germination.[48]

This statutory language is identical to that in the 1937 Act.[49] Before passage of the 1937 Act, proponents of marijuana regulation had assured Congress that this language would not interfere with the legitimate commercial hemp industry.[50] In 1937 and again in 1945, Congress made clear that it was not delegating to the Federal Bureau of Narcotics ("F.B.N.")[51] the authority to destroy the legitimate commercial hemp industry.[52]

After the 1937 Act began to impede the domestic hemp industry in the late 1930s, the United States Army and Navy, large consumers of fiber for rope and canvas, relied on imports from the Philippines to meet their needs.[53] When the Philippines fell to the Japanese in early 1942, the United States was left without a source of fiber.[54] The government responded by launching the "Hemp for Victory" campaign that encouraged American farmers to grow hemp.[55] Between 1942 and 1945, without any change in the federal law, the United States cultivated over four hundred thousand acres of hemp.[56]

After the end of World War II, the commercial hemp industry began to decline, due, in part, to the F.B.N. registration requirements.[57] In 1945, at the request of commercial hemp farmers, the United States Senate conducted hearings regarding the coverage of certain drugs under the federal narcotics laws.[58] During testimony before the Senate Finance Committee, William S. Wood, Deputy Commissioner of the F.B.N., commenting on the definition of "marihuana" guaranteed that it would not have a negative impact on the commercial hemp industry.[59] In fact, the Rens Hemp Company raised industrial hemp in Wisconsin under the federal definition of "marihuana" until 1957, when the owner retired and moved to Arizona.[60] By 1958, there were no longer any commercial hemp producers in the United States.[61]

In 1970, Congress repealed the 1937 Act[62] and replaced it with the current federal narcotics law, the Comprehensive Drug Abuse Prevention and Control Act of 1970 ("1970 Act").[63] During passage of the 1970 Act, Congress did not amend the federal statutory definition of "marihuana,"[64] nor did it express such an intent.[65] The House commission explicitly recommended exempting "the emergency production of hemp" from prohibition.[66] The 1970 Act expresses an intent[67] to bring the United States into compliance with the United Nations Single Convention on Narcotic Drugs of 1961.[68] The Convention recognizes that there is a difference between *Cannabis* grown for its resin (marijuana) and *Cannabis* that is grown "exclusively for industrial purposes."[69] The Convention exempts industrial *Cannabis* from coverage and only requires the parties to "adopt such measures as may be necessary to prevent the misuse of, and all traffic in, the leaves of the *Cannabis* plant."[70] The Colorado Act attempts to do exactly that.

In 1973, President Nixon

47 *Id.* at 1. D.E.A. headquarters confirmed that SAC Perry's letter reflected the official position of the D.E.A. Letter from Catherine H. Shaw, Chief, *Office of Congressional and Public Affairs, U.S.D.E.A.*, to Thomas J. Ballanco 1 (Mar. 23, 1995)(on file with the *University of Colorado Law Review*).

48 Comprehensive Drug Abuse Prevention and Control Act of 1970, 21 U.S.C. § 802(16) (1970).

49 26 U.S.C. § 2590, *supra* note 7, at § 1(b).

50 Hearings, *supra* note 7 and *infra* notes 58 and 59.

51 Treasury Department agency created to enforce federal narcotics laws, forerunner of the D.E.A.

52 *Id*.

53 *Hemp Being Grown in U.S. as War Cuts Off Imports*, SCI. NEWSL., May 30, 1942 at 140.

54 *Id.*

55 HEMP FOR VICTORY (U.S. Dept. of Agriculture 1942).

56 CONRAD, *supra* note 19, at 56-58; ROSENTHAL, *supra* note 8 at 37.

57 Richard L. Miller, Hemp as a Crop for Missouri Farmers: Report to the Agricultural Task Force, Missouri House of Representatives 38-41 (Summer 1991)(on file with the *University of Colorado Law Review*). *See also, supra* note 8, at 39-46 (discussion about the demise of commercial hemp production after World War II).

58 *Hemp and Marijuana: Hearings on H.R. 2348 Before the Senate Comm. on Finance*, 79th Cong., 1st Sess. 1 (1945)(statement of Hon. Joseph P. O'Hara, Rep., 2d Cong. Dist. of Minn.).

59 *Id.*, at 18(statement of William S. Wood, Deputy Commissioner of the F.B.N.)(Sen. La Follette: "Because it is perfectly clear if you read those Senate committee hearings that the Senate committee was very much concerned to be certain that in enacting this drastic piece of legislation they weren't putting the Bureau (F.B.N.) in a position to wipe out this legitimate hemp industry." Mr. Wood: "Which, of course, the Bureau doesn't want to do.")

60 ROSENTHAL, *supra* note 8, at 41-42.

61 *Id.*

62 Pub. L. No. 91-513, 84 Stat. 1292 (1970).

63 21 U.S.C. § 801 et. seq. (1970).

64 *Id.* at § 802(16), *supra* note 49.

65 H.R. Rep. No. 91-1444, 91st Cong., 2d Sess. 12 (1970), *reprinted in* 1970 U.S.C.C.A.N. 4566, 4569 (The drugs with respect to which these

transferred drug enforcement authority from the Treasury Department to the Justice Department, abolishing the F.B.N. and creating the D.E.A.[71] The Reorganization Plan mentions narcotics and "marihuana" but neither limits nor expands the D.E.A.'s authority beyond that of the F.B.N.[72] This transfer was the last federal executive or legislative action that could have affected the federal statutory definition of "marihuana." Moreover, when attempting to discern the meaning of the federal definition of "marihuana," courts have consistently gone back to the intent of the 1937 Congress.[73] However, these cases all involved questions about *Cannabis* in the drug context. No federal or state court has ever extended the federal statutory definition of "marihuana" to include the legitimate commercial hemp industry.[74]

The Colorado Act was the first legislative attempt by a state to revive its commercial hemp industry. The D.E.A.'s position on that legislation reflects an intent to "wipe out the legitimate hemp industry."[75] Such an intent seems to exceed that agency's delegated authority under the ultra vires doctrine.[76] If Congress did somehow delegate the authority to include commercial hemp crops in the definition of "marihuana" to the D.E.A., then that agency's 1995 position represents a reversal of policy since 1957 (when the F.B.N. knew that Willard Rens was growing hemp in Wisconsin)[77] and, in effect, creates law.[78] This reversal should impose the notice and comment requirements of section 553 of the Administrative Procedures Act,[79] with which the D.E.A. did not comply.[80]

In short, there does not seem to be any federal law or authority that should prevent farmers in Colorado or any other state from raising legitimate industrial hemp crops. To quote Harry Anslinger, "they can go ahead and raise hemp just as they have always done it."[81]

Conclusion

Other federal regulations reflect an ambiguity that, at least implicitly, notes a difference between hemp and marijuana. As recently as June 3, 1994, President Clinton issued an Executive Order that lists hemp as one of several "strategic crops" that are essential to national security in times of crisis.[82] The U.S.D.A. retained ten bags of hemp seed from the Hemp for Victory program at the National Seed Laboratory in Ft. Collins, Colorado, for future emergencies. When those seeds were tested in 1994, however, they were not viable, leaving the United States without the means to produce one of its designated "strategic crops."[83] In this era of thermonuclear war, it is unlikely that hemp, or any other crop, is essential to the national defense. Yet hemp's environmental and economic promise have spurred research efforts in several countries and may contribute to our future economic security.

As of 1994, the governments of Canada, Australia, Great Britain, Austria and the Netherlands all permitted their farmers to grow hemp crops for research and limited industrial applications.[84] In 1995, South Africa and Finland grew for the first time in decades and Germany declared hemp legal to grow for the Spring 1996 season. France, Spain, Poland, Romania, Hungary, Slovenia, Ukraine, Japan, Korea, China and Russia, among others, continue to produce industrial hemp as they have for hundreds, and in some cases, thousands of years.[85]

Cannabis-hemp strains are distinct from psychoactive *Cannabis*-marijuana strains and this distinction is identifiable and predictable. There is a cognitive difference, a phytochemical difference and a legal difference. If the federal government adopted the Colorado Act's new definition, it would clarify the existing law, thus allowing for the strict regulation of marijuana while keeping the D.E.A. from continuing the inadvertent suppression of this legitimate industry through its misinterpretation of federal law.

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controls are enforced initially are those listed in the bill. These drugs are those which by law or regulation have been placed under control, *under existing law*.)(emphasis added).

66 *Id*. at 4584.

67 21 U.S.C. § 801(7) (1970).

68 Single Convention on Narcotic Drugs, March 30, 1961, 18 U.S.T. 1408.

69 *Id.* at 1421 Art. 28, § 2.

70 *Id.* at § 3.

71 Reorg. Plan No. 2 of 1973, 38 F.R. 15,932 (1973), *reprinted in* 5 U.S.C. app. at 141 (1995).

72 *Id*.

73 United States v. Gagnon, 635 F.2d 766, (10th Cir. 1980); United States v. Kelly, 527 F.2d 961, (9th Cir. 1976); United States v. Walton, 514 F.2d 201, (D.C. Cir. 1975).

74 21 U.S.C.A. § 802 (Law. Co-op. 1984 & Supp. 1994)(Interpretative Notes and Decisions) Neither the annotations nor an extensive search of the Westlaw state and federal databases revealed any cases interpreting the definition of "marihuana" in the context of the commercial hemp industry. The only case involving commercial hemp was a suit in tort by the United States to recover damages to some of its hemp in storage in a warehouse in 1946. United States v. City of Columbus, 209 F.2d 857 (1954).

75 Hearings, *supra* note 59.

76 For an explanation of the ultra vires doctrine in the context of administrative law, see ARTHUR E. BONFIELD & MICHAEL ASIMOW, STATE AND FEDERAL ADMINISTRATIVE LAW 423 (1989).

77 *See supra* text accompanying note 60.

78 Alcaraz v. Block, 746 F.2d 593, 613 (9th Cir. 1984)("substantive rules are rules which create law and are usually implementary to an existing law, incrementally imposing general, estrastatutory obligations").

79 Administrative Procedures Act, 5 U.S.C. § 553 (1994).

80 An exhaustive search of the F.R. indicates that the D.E.A. never proposed an amendment to the federal definition of "marihuana" to include industrial hemp.

81 Hearings, supra note 7.

82 Exec. Order No. 12,919, 59 Fed. Reg. 29,525 (1994).

83 Rosenthal, supra note 8, at 44.

84 Hemptech, supra note 26, at 31-38.

85 Id.

Canada grows North America's first modern hemp crop

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Hemp farming was a thriving colonial enterprise that played an important role in the genesis of the world's third largest nation. An essential home industry, hemp was grown in considerable quantities to supply the cordage and textile needs for the vast farm, forest, fisheries and mines that now form the economic engine of present-day Canada. Hemp cultivation was encouraged by French and British colonial administrators to supply European military and merchant marine needs for almost 400 years. As Canada is favorably situated within latitudes of the globe most suited to hemp cultivation and blessed with well watered parcels of fertile soil, it is no surprise that 'Canadian hemp' was the choice for European purchasing agents seeking the finest quality naval cordage and heavy textiles at the height of the golden age of sail (1750-1850). This, in turn, made possible a golden age of Canadian hemp.

The sowing of legal hemp on a former tobacco farm in southern Ontario has allowed Canada, once more, to join the ranks of hemp growing nations. In June 1994, farmer Joe Stroebel and his partner Geof Kime owner-operators of Hempline Inc., sowed 5 varieties of low-THC hemp from Europe under license from the federal Ministry of Health on 6 acres (2.5 ha) of sandy loam soil. Their pioneering efforts inspired 12 other Canadian farmers to grow hemp in 4 provinces in 1995.

The pending reforms of Canadian law governing hemp will soon enable other farmers across Canada to sow hemp without the cumbersome paperwork currently required. Legislation dating from 1938 is being revised to advance progress for the agricultural sector while meeting our obligations to the international community. Canada is expected to release a comprehensive new drug policy in 1996 that may allow exceptions for the cultivation of hemp. However, *Cannabis* continues to be a controlled crop under present day Canadian law. There is no distinction made between marijuana and hemp. As the entire *Cannabis* plant, its derivatives and cellulose products (excluding sterile seed for canaries) are technically illegal, Hempline Inc. was unable to obtain reliable information concerning cultivation practices or methods from Canadian government sources who maintain no files on illicit crops. In order for their pilot project to get off the ground, Hempline Inc. turned to private-citizen hemp-activist groups such as H.E.M.P. Canada and the Hemp Futures Study Group, where they found both data and much needed encouragement. Prominent Canadian lawyer Allan Young helped to navigate them through an ocean of bureaucratic reluctance and legislative red tape to the point where they were ready to submit their application for the first Canadian hemp licenses in three generations. There are, of course, no grants or subsidies available for growing hemp in Canada, and Hempline Inc. was obliged to pay its own way, including police surveillance fees.

When Hempline's application to grow hemp began to take shape in early 1993, they were aware that the Federal government did not welcome their proposal and would take a strictly business stance in the matter. After careful evaluation and consultation with the Ministry of Health, crop specialists and law enforcement agencies (under who's jurisdiction the *Cannabis* plant falls), their initial application to grow hemp was seriously considered. There was no review body in place to process hemp applications and there was no precedent in living memory to base criteria for granting licenses. Special arrangements were required for monitoring the fields by federal and provincial police. This was deemed necessary as Royal Canadian Police experience with a government research project growing high THC *Cannabis* in 1971 that was a target for numerous thefts. Their sense of caution is therefore comprehensible, but apparently, they do not understand the non-psychoactive aspects of the industrial hemp plant.

Currently, Canadian hemp growers must have a license to cultivate hemp, a license to distribute *Cannabis* products, a license to import "narcotics" (hemp seed) and a license to import agricultural seed before they can sow. Under the terms of their license, Hempline Inc. was required to obtain a separate permit for each variety of hemp seed they imported, as well as secure additional permits to cultivate *Cannabis* and distribute the harvest to certified "end users" and still another license to export their hemp across international borders into the United States for special testing. It is hoped that formalities will be streamlined in the future as this application process, monitoring, and security exceed the time, cost and effort required to actually grow the hemp crop.

Law enforcement officers monitored every aspect of Hempline's project from importation of seed to delivery of the dried stalks to the end user. Samples of growing hemp were regularly gathered for analysis during the summer of 1994 to determine if the levels of cannabinoids were within limits set by the Ministry of Health Department of Dangerous Drugs guidelines. Low levels of THC were expected and found. There were no instances of theft or permit violation. Because of this, surveillance during the 1995 crop was relaxed somewhat.

Hempline Inc. endured as their first application was regularly sent back to them for revision. This caused a six week delay from their optimal sowing date of mid-April 1994. In spite of late sowing on June 1, germination was uniform and the fields were full. Traditional methods of soil preparation were employed and seeds were sown with a close spacing of 2-3 inches in rows 6-9 inches apart. A modified seed drill placed seed at a density of about 250 seeds/m^2. Fertilizer and lime were applied prior to seeding to bring fertility and pH levels within ranges suitable for hemp. The plants grew 2-3 inches per day during one of the hottest and driest summers of the century. They reached an average height of over 12 feet (4.0 m) in only 75 days without irrigation.

Hempline Inc. harvested their second successful 18 acre (7.5 ha) crop of two Ukrainian varieties (YuSO11, YuSO13) this past summer divided between their original Tillsenburg plot, a second location near London, Ontario and a third smaller field. The fields were harvested using a conventional sickle bar attachment to a standard farm tractor as the male plants began to shed their pollen and well before the female flowers reach maturity. The license did not allow seed to form. The yield and quality were good ranging from about 2.0-3.5 tons of dried stalk per acre (5.0-8.5 tons/ha). This approximates modern hemp yields in Europe and Asia. Further field trials may well lead to an increase in both fiber quality and yield.

The hemp industry is sorely lacking machinery that will cut and bale hemp in one pass through the field. The design and development of such machines will make the hemp harvest advance beyond existing limits of efficiency. Designers could begin by copying the principles used in turn-of-the-century equipment exhibited in museums and the more modern equipment from Europe.

Hempline Inc. sent the major portion of their initial harvest to an Oregon Forestry product research laboratory where it was ground up, mixed with a binder and processed into sheets of 1/2 inch (1.3 cm) wallboard. This medium density building material was found to meet or surpass industry standards of strength and finish. Other experiments with the first hemp crop produced fist-sized super-compressed pellets for low smoke/high calorie fuel suitable for urban institutional heating plants. Additional experiments are still in progress and more experiments are planned for the output of the 1995 crop.

The 1995 growing season included additional participants. Gordon Schiefele, a research crop specialist with the Ontario Ministry of Agriculture and Food, performed a small (400 m^2) planting density trial at Ridgetown, Ontario. The extrapolated yield was 2.7-4.8 tons/acre (6.5-12.0 tons/ha) which is high and probably results from the small trial size. Some ripe seed was also produced. Dr. A. Slinkard from the Crop Development Centre of the University of Saskatchewan also sowed three varieties on small (5 m^2) test plots.

Dr. Joe Moes, a new crops agronomist with the Manitoba Department of Agriculture, along with the Manitoba Hemp Alliance sowed 6 varieties on 10.5 acres (4.2 ha) in four locations across Manitoba. Their yields ranged from 1.8-3.1 tons/acre (4.5-7.7 tons/ha). Fiona Briody of the Northwest Peat and Crop Company grew three varieties on 2.5 acres (1.0 ha) near Barhead, Alberta. Other small plots were also grown in Alberta and Ontario. In British Columbia one small farm of supposedly "low THC" hemp was raided and the grower arrested. No hemp cultivation licenses were issued in British Columbia.

It is anticipated that the Canadian government will issue many more hemp licenses in 1996 than in 1995. The arrival of hemp is encouraging to Canadian farmers facing declining farm income. As food imports from the USA displace such staple crops as cereals and oilseed from Canadian agricultural strategies, hemp looks very attractive to the farmer seeking new opportunities for the next century. Canadian large scale farming is readily transferable to growing hemp on a scale that cannot be easily matched in Europe. Access to the huge American market is also nearby. We remain on friendly terms with our trading partners since joining the North American Free Trade Agreement (NAFTA), whose collective policies favors North American grown fiber and penalizes foreign imports. No cotton can be grown in Canada, yet Canadians consume many millions of dollars worth of cotton goods each year grown primarily in the United States and Mexico. There is reason to believe that the United States will not allow *Cannabis* cultivation within this decade, as her trade and industry policies are wedded to the criteria dictated by its "war on drugs". All the better for Canada to be the first and only continental source of hemp. This should be a potent motive for the Canadian farmers to offer the most reliable and highest quality hemp to the biggest market the world has ever known. The 21st century may well see hemp fiber from Canadian farmers competing vigorously with cotton.

Hemp growing and research in Austria - 1995

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From a forgotten to a booming plant

Austrian farmers were never forbidden to grow hemp. Scientific institutions were even allowed to grow varieties with a relatively high (>0.3 %) THC content for research purposes (Muster 1995). Nevertheless, between 1958 and 1995, farmers were not interested in growing this plant as a market for hemp did not exist (Kainer 1995). As late as 1956 Grünsteidl & Mayerl published a report on experiments with hemp in Styria focusing on the potential of this crop, but hemp growing was already in decline and they could not prevent its demise. The reasons for this are the same as for other countries and are well explained by Karus & Leson (1994). For the last three decades it was commonly accepted that growing hemp meant producing drugs. The old Austrian tradition of growing and processing hemp seems to have been lost (Kainer 1995).

It was the book by Herer & Bröckers (1993) that freshly inspired Austrian hemp activists. They started a hemp promotion campaign that rapidly attracted the interest of media and farmers. The Austrian Hemp Institute (Oesterreichisches Hanf Institut - OEHI) was founded and is sucessfully promoting hemp with its magazine "hanfMAGAZIN". When Austria joined the EU, Austrian representatives of the Ministry of Agriculture and Forestry were also introduced to hemp in Brussels. The first Austrian workshop on hemp was held in December 1994 (Bundesanstalt für Landtechnik 1995). It was organized by the Ministry for Agriculture and Forestry and the Federal Institute of Agricultural Energeering, Wieselburg, with international participation (Höppner 1995, Pittet 1995).

Since then, anyone who has heard about hemp has struggled to get more information on growing the crop, to develop contacts with experienced members of the hemp world and, last but not least, to get seeds of EU-conforming varieties for which a subsidy of about 10,619 ATS/ha (7 ATS = 1 DM = 0.70 US$) can be claimed (Zoch 1995).

The first growing season in Austria

Kautzen, a small village in the north of Lower Austria, is known for its innovative energy policy, based on locally produced biomass by Rapsenergie GmbH. The local biomass complex also includes engines fueled with various cold-pressed seed oils. Farmers from Kautzen together with their local provider of seeds, Scherner GmbH, and Rapsenergie GmbH, requested 25 tons of Felina 34. Hechenbichler GmbH from Innsbruck ordered the seeds from France, Scherner GmbH sold it at 110ATS/kg and the rush began.

In 1995, about 250 ha of Felina 34 and a maximum of 50 ha of other varieties (Hungarian, Polish, Romanian) were sown in Upper Austria, Lower Austria, Burgenland, Styria and Carinthia. Not all imported seed was sold (as farmers bought less seed than anticipated) and not all farmers growing hemp applied for the EU-subsidies, because of their sowing non-EU-conforming varieties (Agro Market Austria 1995, Hechenbichler 1995).

At sowing time in April 1995, farmers had no agronomically valid information on how they should do their job. They were told by “hemp fanatics” and agriculture magazines (all copying Herer & Bröckers 1993, but adding still more optimism) that hemp grows everywere, suppresses all weeds, needs almost no nutrients, leaves a healthy soil and has no problems with pests and diseases. They were advised to drill 50 kg/ha at 10 -15 cm inter-row widths. For seed production, they were told to sow "less" at a "greater" inter-row distance. Farmers then waited for the infamous 4,000 kg oil yields (Herer and Bröckers 1995), plants that grew up to 7 m in 100 days (Hübner 1995) and more biomass than any other plant would produce (Anonymous 1994, Forsthuber 1994, Kessler 1995). More realistic agronomic facts from hemp producing countries (*e.g.* The Netherlands, Spain, France, Hungary and Romania), as well as information from old publications were only available to a few producers and at institutions already engaged in hemp research.

The farmers learned from their own experiences. The author’s own observations at 40 hemp growing sites and interviews with conventional and organic farmers show that farmers undertook experiments by sowing seeds at rates between 2 kg/ha and 50 kg/ha, and with row width ranging from 10 cm to 45 cm. Where the soil was compacted or influenced by a high ground water level (including localized flooding after heavy Spring rains) hemp did not germinate or only grew a few centimeters, while weeds developed successfully. Where nutrients were not easily accessible between the fourth week of growing and flowering, hemp stopped its development and allowed weeds (*e.g.*, *Cirsium arvense*, *Setaria glauca*, *Panicum crus-galli* and *Anthemis arvensis*) to invade. In these cases decreased row widths did not affect weed development. Even with narrow row widths (*e.g.*, 12 cm) and high plant densities (*e.g.*, 300 plants/m^2) weeds were more successful than hemp in the cases mentioned. Hemp grown on sandy soils with low pH also exhibited poor growth in several cases. The sporadic presence of deer, birds, beetles, grasshoppers and slugs, as well as development of *Botrytis cinerea*, caused only a small amount of local damage. Heavy thunderstorms during early summer caused losses in some cases from lodging (knock-down). The farmers suggested that this toppling was probably due to overuse of nitrogen fertilizer.

This year hemp fiction became hemp reality for many farmers in Austria. The majority had no problems. The crop grew well. All these successful farmers are waiting anxiously and with curiosity for the harvest. Different harvesting techniques will be tested and nobody really knows which ones will work successfully. At the time of writing, harvest is ongoing and these first experiences cannot be systematically described.

Hemp growing - a new fact of life for the police, too

Although growing hemp to produce fibre or seed is legal in Austria, a lot of farmers had problems with local authorities and were accused of producing drugs. They had to suffer interrogations and frequent visits from federal and local police. This shows that information about hemp at the federal level often does not reach local police authorities. It is now recommended that local authorities be notified of hemp plantations in advance. The Ministry of Health should also be notified of the intended non-drug related end products. Seedbag labels and EU subsidy applications should be ready to be shown when the farmers are interviewed by police. Copies should be kept separate from the originals to prevent confiscation of the latter.

Hemp processing and trade

Among the major motivations for farmers to grow hemp were reports repeating the fallacy that hemp seed yields are higher than with rape seed (7.0-11.7 t/ha) (Herer and Bröckers 1995). An energy use in Kautzen (see above) in Elsbett-Engines was planned for seeds, and hemp straw was to be burned in local biomass energy conversion facilities. With realistic reported seed-yields of between 500 and 1,000 kg /ha, seed production is still interesting, but only for conversion to oil by individual farmers. Some farmers, like J. Schühmann from Upper Austria, have experience in pressing and selling oil (soy bean, rapeseed, sunflower) for assorted purposes. Various groups of farmers plan to press oil in regional oil pressing facilities (*e.g.,* Brennerei Heidenreichstein). They are in contact with buyers who will sell the oil for direct consumption, for body care products, natural paints or for other purposes. Even bakeries are interested in the seed for the production of special breads and pastries.

Still more complicated is the marketing of hemp stalks or fibre, as no hemp processing plant exists in Austria. Both of the Austrian flax processing plants (Rastenfeld and Knittelfeld) are interested in testing hemp and helping to develop hemp fibre as a complement, but not competitor, to flax. They are not however able to buy or process large quantities. Karl Ströml from Rohemp Romania is not only producing hemp fibre and seed in Romania, but has recently founded Rohemp Austria. He plans to build a complete hemp processing line in Styria. As transport of bulk stalks is difficult because of their volume, the broad marketing of hemp fibre is, with some exceptions, only a hope for the future. This year, large quantities of straw will probably be chopped and left on fields or burned in local biomass power-plants.

The Austrian Hemp Association (OEHI) published a list of enterprises interested in buying and processing hemp in its February '95 issue of hanfMAGAZIN. Members get help from the OEHI in making contact with industrial partners. The following examples for hemp-based product development in Austria show that not only farmers, but also processors and traders want to be a serious part of the hemp movement and want to develop the market:

- a fire-emergency-ropeladder and a tow-rope by Friedrich Teppernegg
- designer furniture and storage boxes by Zellform,
- a line of bodycare products by Peter Rausch's Nektar-Hanfkosmetik,
- a collection of caps and hats by Querkopf.
- a collection of clothes by Rosemarie Fink

Raw material for the products above still comes from Romania, Hungary or other countries. There is an urgent need for local processing of fibres in order to avoid disappointing Austrian producers.

Research on hemp in Austria

Research on hemp started when scientists at the Institute for Plant Production and Plant Breeding at the University for Agriculture / Vienna began to examine the suitability of hemp biomass for energy production in 1991. Plots with different plant densities and soil nutrient levels were established and the first experience gained in growing and burning hemp (Liebhard 1995a). In 1995, experiments were conducted with 4 different varieties at four different sites in Austria to examine yields of fibre, seed and biomass in relation to different sowing and harvesting dates (Liebhard 1995b).

Since 1994 scientists have been working with hemp at the Federal Experimental Farm Wieselburg (Bundesversuchswirtschaft Wieselburg) and the Federal Institute for Agricultural Engineering Wieselburg (Bundesanstalt für Landtechnik Wieselburg). Last year a first experience with the cultivation and harvesting of hemp was gained (Pernkopf 1995a, Wörgetter 1995). In 1995 two French varieties were grown in experimental plots to examine yields of fibre, seed and biomass. Special attention is being given to various harvesting techniques (Pernkopf 1995b).

At the Federal Institute for Plant Production (Bundesamt für Landwirtschaft) 13 varieties on seven different sites are being tested. Work is in its first year. After three years of testing a decision will be made on whether new varieties will be listed in the official Austrian List of Varieties. Varieties accepted by Austria can be listed in the EU and therefore sold easily (Hinterholzer 1995a, Hinterholzer 1995b). The aforementioned Federal Institute is working in close collaboration with the Department for Innovation and Development of New Varieties, RWA/Raiffeisenware Austria. This Department represents foreign breeders of new promising varieties. It is there that import of seeds and testing of potential of new species and varieties is organized (Schlagenhaufen 1995).

A diploma thesis is being written on the history of hemp in Austria at the University in Graz, by Helga Kainer. The thesis will include the results of 1995 experiments which examine the application of compost or synthetic fertilizer to sites with various hemp varieties (Kainer 1995; Kainer 1996).

At the Department for Organic Agriculture at the University for Agriculture, Forestry and Renewable Resources in Vienna the authors and other scientists have been discussing the risks and potential in the production of renewable resources in organic agriculture. In 1995, 10% (22,875) of all Austrian farmers practiced organic agriculture. As a consequence, the conversion of whole districts to organic agriculture is being increasingly discussed in Austria. All major Austrian supermarket chains already sell organic produce. Awareness is growing that not only food, but also a variety of raw materials that society needs must be produced in a sustainable way to build up a sustainable economy (Riddlestone 1994, Lindenthal et al. 1995). The most sustainable form of agriculture is organic farming (Heissenhuber et al. 1992, Deutscher Bundestag 1994). Production of renewable resources is not compatible with the input of synthetic fertilizers, pesticides or other direct or indirect input based on fossil energy. Organically grown hemp could, therefore, be a promising renewable resource (Riddlestone et al. 1994, Stickland 1995, Waayer 1995). In 1995, experimental plots of hemp with French and Hungarian varieties, with different plant densities and in different crop rotations, were established on organic farms to gain first-hand experence with hemp in general and to test yields of biomass, fibre and seeds.

Prospects for 1996

The year 1995 provided a learning experience which will help to establish expanding hemp production in 1996 based on more accurate information concerning sowing, fertilizing, harvesting and processing. Hemp is a promising renewable resource, even if it is not a universal remedy or a “miracle plant”. The development of hemp in Austria will depend on the farmers’ experiences with selling their hemp products in 1995. Even if hemp has a high theoretical potential because of its positive ecological effects or its variety of possible end uses, it will not flourish if farmers do not get a satisfactory price. The arrangement of fibre processing facilities close to sites of cultivation will present a challenge not easily met. If hemp is to be one of the alternatives through which farmers get better prices, the Austrian and EU policy makers must support the hemp movement, especially through the establishment of different processing facilities. If hemp is also to be one of the sustainable alternatives to conventional agriculture it must be produced and processed in an ecologically sound way.

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Textiles from hemp fibers - New ways for German hemp

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The farming of fiber hemp has been made legal in Germany for 1996. A complete adoption of applicable EU guidelines is generally expected. One additional national permit requirement may be that German farmers show guarantees of crop purchases by processors or end users. This development raises the central question for Year One of German hemp farming: what product lines based on hemp can be implemented in the short-term, considering the technical, ecological and economic criteria and constraints? In the following, this question is discussed for the use of hemp for apparel textiles.

During the last two years a number of high quality hemp textile collections have been created in Germany. Thirteen firms presented their latest hemp collections at the first exclusively German BIOROHSTOFF HANF Fair in Dresden in September 1995. The largest current manufacturers are HanfHaus Berlin and THE HANF COMPANY (THC) near Cologne. Distributors of the collections include the national HANFHAUS chain and the ecological mail-order companies Hess natur and Waschbar. In addition there are a large number of smaller manufacturers and retailers, eighteen of which have recently formed the HANFCOM association for joint product development, especially in the textile sector.

The quality of hemp fabrics and collections is much improved since 1993. Some textiles now on the market were considered impossible to produce from 100 % hemp only two years ago. They include the hemp T-Shirt of HANFHAUS and the shirts of THC, both knit and woven, finished and manufactured in Germany. Another example is HANFHAUS' eco-hemp jeans, finished in Brandenburg without the use of synthetic chemicals, dyed with natural dyes in southern Germany and manufactured in Brandenburg using nickel-free buttons.

Until now, fibers for these textiles have originated mainly in Eastern Europe, predominantly Hungary and Romania, and in China. In Eastern Europe, the raw fiber is separated by traditional methods: water retting, breaking, scutching, and hackling. This produces the high quality long fiber that is first spun on special long fiber spinning equipment (up to 14 Nm) and then woven. (The Nm scale of yarn fineness is determined by the number of kilometers of yarn in one kilogram. Therefore larger Nm values indicate smaller yarn diameters.) In addition to this traditional method, China also uses modern physical-chemical methods which create a cotton-like short fiber. But the quality of the resulting yarns still needs improvement, especially in the area of long-term wash-and-wear resistance. This may be due to excessive removal of the natural binders lignin and pectin. Long-fiber yarns from Chinese hemp are also marketed by Linificio e Canapificio Nazionale of Italy, the world's largest linen and hemp spinning mill.

Initially German firms bought finished hemp fabrics and had them manufactured domestically or abroad. Since late 1994 they have also increasingly bought unfinished fabrics or even hemp yarn for processing in Germany in order to guarantee processing and product quality under ecological criteria. By now there are several German textile companies which specialize in the weaving and finishing of hemp fabrics and achieve surprisingly high qualities. The weaving of hemp textiles still is more an art than a science, since the quality of the yarns from Eastern Europe leaves much to be desired. The finishing of the fabrics is done largely without the use of synthetic chemicals. If their use becomes necessary only those chemicals which meet strict ecological criteria are employed. Mechanical or enzymatic processing is preferred as it provides remarkable wearing comfort.

The need for weaving and finishing in Germany resulted from the initially low and inconsistent qualities of Eastern European and Chinese fabrics and the lack of attention to ecological processing conditions. Surprising to some, this has led to the formation of a small hemp textile industry in Germany, mainly involving existing textile processing firms. Its value-added chain starts with imported yarns and ends with ready-to-wear textiles. Because of higher quality and the reliability of their products, this industry is, despite higher wages, price-competitive with Eastern European firms.

This returns us to the question of product lines that can be realized in the short term in Germany, from seed to final product. As discussed above in the textile sector, the second part of the value-adding chain, stretching from the yarn to the finished textile, has in fact been realized on a high quality level, although the market volume is still rather small. The question is whether the first part of this chain will be realized in Germany as well or whether raw materials will continue to be imported. Practically all of the available hemp textiles are based on the valuable long fiber and its traditional long fiber spinning. In our opinio, the revitalization of this processing strategy in Germany is very unlikely. This is mainly due to the fact that there is no longer a functioning infrastructure for long fiber processing. Its reconstruction would require specialized machinery that has limited availability in the world market and is expensive to install and operate. Furthermore, ecologically acceptable water retting (e.g. in or near a sewage treatment plant) is labor intensive. Whether the alternative use of field retting achieves acceptable fiber quality, as it does with flax, is questionable. Field retting is further hindered by Germany's unpredictable weather conditions in September.

Considering these obstacles, it is more likely that in Germany the production and processing of the so called “cottonized” hemp or “flock” hemp (a hemp short fiber refined by modern, mostly chemical or mechanical fiber separation methods) will be pursued. Unlike long fiber hemp, it can be spun and finished on slightly modified cotton or wool processing equipment, so that the existing and cost effective infrastructures for the processing of cotton and wool could be used. German textile equipment manufacturers are currently conducting spinning trials using flock hemp on modern rotor spinning machines. The trials, likely to be successful, would open up for hemp the gigantic market for rotor spun yarns. Large jeans manufacturers would then be able to produce hemp or hemp/cotton jeans on a large scale with their existing production capacities.

The realization of this route requires primarily that innovative fiber separation technologies, which have mainly been developed in Germany, are implemented on an industrial scale. There is certainly no lack of technical know-how and experience on the laboratory and pilot scales. For example, in October 1995, the technical college in Reutlingen presented Nm 27 hemp yarn of fineness and quality never before achieved. It was spun from flock hemp which in turn had been produced using steam explosion technology .

Rapid implementation of this route is currently hampered mostly by the lack of capital. It is unclear how long it will take to find investors willing to spend capital on these future technologies in Germany, particularly since such plants could also be installed abroad, generally at a lower cost. Consequently, implementation in Germany will require politically supported comprehensive planning to bring together the farming industry, local medium-sized processors, industrial customers and investors, and also support regional development and a sustainable economy based on ecological criteria. However, only the first signs of such integrated concepts are now noticeable, predominantly on state government levels in several former East German states.

Leading the way is the State of Sachsen (Saxony) where in 1996 a FLAKSY flax processing unit, developed by the Bahmer Company, will start up as the first modern, mechanical short fiber processing operation. The plant will process 4,000 t of fibers per year in a one-shift operation. Initially fibers will come primarily from regional flax cultivation. The plant is designed to process flax grown on approximately 800 ha. Slight design modifications will also allow it to process hemp straw. In case sufficient supplies of flax are not available, the company would begin processing hemp in appreciable quantities. This would allow implementation of the entire processing chain for hemp textiles as early as 1996. The operator of the FLAKSY plant, Erzgebirgische Flachs GmbH, targets the local textile industry as customers. This industry is capable of processing flax as well as hemp short fibers with their cotton rotor spinning equipment. Companies interested in processing hemp straw processed on the Bahmer equipment are requested to contact the nova-Institute in Germany for coordination.

Another short-term option for the processing of hemp fiber involves the only remaining of six flax swingle operations installed in Germany in the last few years. While the other five plants have since been shut down, the one still operating in the state of Schleswig-Holstein will likely continue to do so. Its operator, HOLSTEIN FLACHS runs a small-scale operation which mechanically produces short and long fibers of high quality. Some 1,000 tons of flax and smaller quantities of jute, sisal and hemp have been processed there to date. Egon Heger of HOLSTEIN FLACHS announced that there is capacity available for hemp in 1996 and that his firm is interested in processing it.

A third German hemp processing plant is currently in the planning stage: in the state of Brandenburg a second FLAKSY unit, at a capital cost of approximately DM 4.5 million, may soon be installed.

Of the more recent western countries cultivating hemp, the UK has been making noticeable progress in the textile sector which has been mostly neglected in other countries. For the first time in this century the UK succeeded in 1995 in reestablishing the entire processing chain for hemp textiles. The hemp was grown in Kent, the fibers separated in Bedfordshire, spun in Northern Ireland, and the fabrics woven in London. The entire project was coordinated by the BIOREGIONAL DEVELOPMENT GROUP which develops and implements regional concepts for a sustainable economy based on hemp. The project targets both a revival of the traditional long fiber processing, and the development of new short fiber processing technologies. The long fiber route is more easily revived in the UK than it is in Germany. The country hosts one of the very few existing manufacturers of long fiber hackling, carding and spinning equipment, MACKIE INTERNATIONAL of Northern Ireland. Part of the fibers was also processed in traditional factories in Belgium where there could be additional capacity for German hemp.

More of interest for Germany is a newly developed short fiber processing technology. As part of a UK government funded project (FIBRELIN), the so-called "Silsoe decorticator" has been developed for the decortication of flax and linseed at particularly low cost. With a modified design it may also be used to process hemp in 1996. The unit would produce flock flax or hemp in random layers. It has been developed at Silsoe Research Institute, Bedfordshire, by the Natural Fibres Organization (NFO) which is supported by the English agricultural merchant company Robin Appel Ltd. and the UK government. Nigel Bazeley of Robin Appel anticipates a large market potential for the new decorticator. One of the firm's goals is the regional manufacturing of jeans from English hemp. The HanfHaus Berlin in Germany is pursuing the same goal, wanting to replace their Romanian hemp fabrics completely with hemp from Brandenburg.

Whether in 1996 or 1997 the new fiber separation technologies needed for a complete textile chain are now beginning to be used commercially in Western Europe, and the dream of jeans collections manufactured from regional, ecologically grown hemp is likely to become a reality sometime soon.

Book Reviews

Parasite Damage and Diseases of Hemp

Parasitäre Krankheiten und Schädlinge an Hanf (*Cannabis sativa* L.)

Gutberlet, V. and Karus, M. 1995. *Parasitäre Krankheiten und Schädlinge an Hanf (Cannabis sativa L).* Univ. Köln, Germany. Institut für politische und ökologische Innovation Köln. 57 pp. + 24 figures.

A major uncertainty in the introduction of a new crop on a wide scale is the unavoidable arousal of pests and diseases. Although literature surveys cannot predict diseases, they assist one in being aware of potential problems. Gutberlet & Karus report, in the German language, on the pests and diseases of hemp described in the literature. A number of disease and pest species are treated: viruses (4), bacteria (2), fungi (16), nematodes (2), insects (20), birds (9), mammals (4), plant parasitic plants (2) and weeds (3). Each organism is followed by a short synonymy and a description, followed by some recommendations for control.

The descriptions are concise and apparently meant for those who are not educated in plant pathology. However, these descriptions and some of the plates of pest and disease organisms are insufficient for identification. The control measures described include a confusing mixture of present and potential (e.g., biological management) methods.

The literature survey contains only part of the information available on hemp diseases, and the criteria upon which they based their selections are not clear. Much of the older literature is lacking, such as the publications of Ghillini, from 1951 and 1954, which described a number of fungal and bacterial diseases on hemp in Italy. Some of the more recent literature is not mentioned, for instance that of McPartland, who published on hemp diseases in 1983 and 1984, including the description of *Phomopsis ganjae*, a new species. Several potentially important diseases are left unmentioned. For instance, *Fusarium oxysporum* f.sp. *cannabis* first described by Noviello & Snyder in 1962, may cause persistent problems in the cultivation of hemp. On the other hand, the book's rather extensive elaboration of some birds and mammals is not justified by the damage they may cause.

If hemp is to be grown on a large scale, it is evident that some economically important pests and diseases will appear. Much of the literature is old and does not give a reliable picture of the severity of hemp pests and diseases and the yield losses they caused. This does not mean that we should become discouraged by the organisms listed by Gutberlet & Karus, but rather should regard this publication as a reminder of potential problems we may encounter in the future.

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Hemp for Textiles

Sue Riddlestone August 1995 *Hemp for Textiles* Bioregional Development Group, Sutton Ecology Centre, Honeywood Walk, Carshalton, Surrey, SM5 3NX.

"Hemp for textiles" concerns a fiber hemp cultivation experiment in Southeast England by the Bioregional Development Group in 1994. This was the first trial in England this century, in which hemp was cultivated for textiles in the UK and processed through the existing flax infrastructure. Key considerations in the groups vision are: environment, sustainability and local production for local needs. The goals of the experiment were to trial four fiber hemp varieties, produce hemp yarn and fabric, find the best way to establish a feasible UK hemp textile industry and make the results available to interested parties.

The first section of the report deals with the history of hemp: its botany, traditional growing, harvesting, dew or water retting, fiber potential and preparation, fiber quality, and spinning and weaving. The current situation on "hemp for textiles" in Western Europe, Eastern Europe and China is reviewed in detail, as well as the benefits that the cultivation of hemp has for the individual farmer and environment, and the criteria hemp must satisfy to be marketed successfully.

Section Two details the results of the experiment. Fiber quality and yield of four fiber hemp strains (Kompolti, Uniko B F2, Fibrimon 56 and Felina 34) were compared. Extraction of textile grade fibers was done by three methods; by traditonal hand processing, through flax scutching machinery, and through the novel UK-developed Fibrelin machine. Then the quality of the hemp yarn produced by these methods was compared.

The experiments made clear that hemp has remarkable weed suppressing properties and evident pest resistance. The French varieties could be harvested 2 to 3 weeks before the Hungarian ones (favourable for dew retting), whereas the Hungarian varieties had a 1.5 to 2 times greater biomass than the French varieties after retting, which resulted in a higher fiber yield for the latter. Fields were harvested when the male flowers were shedding pollen. Useful information is given on retting and the stem thickness/fiber content ratio. Improvement of fiber quality and/or quantity were achieved by: processing hemp 5 months after harvesting, boiling hemp fiber with caustic soda, bleaching with hydrogen peroxide, and softening the yarn. The best quality fiber was produced from the traditionally processed hemp. Flax-machinery-processed, wet-spun fiber resulted in a yarn of 10.8 Nm, whereas the finest yarn produced by the Fibriline machine was 7 Nm (wet-spun) and 3.5 Nm (dry-spun). Conservative potential yields were calculated: 5 tons hemp stalks/hectare = 750 kg fiber = 490 kg sliver = 360 kg boiled and bleached yarn = 900 m^2 of 400 gr/m^2 jeans fabric = 600 running metres x 150 cm wide. Hemp hurds for papermaking, composite board and animal litter production were determined useable as a co-product .

Section Three reports the conclusions and gives recommendations. In the short term, it was concluded possible to establish hemp textile production in Southeast England, working with early-maturing varieties, dew retting, adapted harvesting equipment, newly develloped turning equipment and a specially built hemp scutching mill. The resulting fiber can be spun and woven by the linen industry. In the long run more reliable retting methods have to be developed, as well as further development of the Fibrelin machine, and adaption of spinning preparation and spinning machinery to achieve cost effective results.

I would recommend Hemp for Textiles to anyone who desires a basic knowledge of hemp cultivation and processing for textile production, especially those considering hemp cultivation in northern Europe.

Henk van Dalen of Green Lands and the Dutch Fiber Hemp Foundation.

Scythian *Cannabis* Verification Project

The IHA visited St. Petersburg in April to confer with the staff at the Vavilov Research Institute and plan the *Cannabis* Germplasm Preservation Project reproductions for 1995. The VIR also had arranged for us to visit the Hermitage Museum and see some of the *Cannabis* remains recovered from the famous frozen Scythian tombs of Pazyryk Kurgan in Siberia. Dr. Elena Mikolaichuk of the Hermitage Museum Analytical Laboratory showed us some of the *Cannabis* seeds found inside of a 2,400 year old leather pouch associated with ritual censers. The seeds are quite small, mottled in appearance, with a pronounced abscission layer at the base. These three characteristics indicate that the seeds were most likely collected from the wild rather than cultivated. This finding is in keeping with the characterization of the Scythians as nomadic hunter/ gatherers rather than settled farmers.

Along with the pouch of *Cannabis* seeds were found two small metal censers and two sets of sticks used as legs to support a tent of hides enclosing each censer. According to the ancient Greek historian Herodotus, the Scythians would climb inside of such a tent like structure and burn *Cannabis* flowers by placing them on top of hot rocks held in a metal censer. Herodotus reports that the Scythians "breathed the vapors and howled with joy". Although the sticks found inside of the Pazyryk Kurgan are only about a meter tall and far too small to crawl inside of, they may be funerary models of the larger devices described by Herodotus and were only constructed to be placed inside of the tomb as burial offerings rather than to actually be used. However, the discovery of the censers and sticks in association with the pouch of *Cannabis* seeds is considered by many to be the earliest example of breathing the fumes of burning *Cannabis* to achieve a psychotropic effect.

Since *Cannabis* seeds themselves do not contain any psychoactive compounds, the seeds recovered from the leather pouch were unburned, and no other plant material was recovered from the pouch, more concrete evidence is sought for the hypothesis that the censers were used for burning *Cannabis* flowers for the purpose of becoming “high”. One solution may be to analyze deposits on the surface of the rocks from the censer for the presence of Δ-8-THC. (Δ-8-THC is a very stable molecule found only in trace amounts in fresh drug *Cannabis*, but it also forms in measurable amounts via the slow conversion of Δ-9-THC.) Detection of its presence would provide strong evidence that the censers were used to burn psychoactive *Cannabis*. The Hermitage Museum has given us permission to borrow the rocks and perform analyses with them if we can find a reputable laboratory to perform the analyses.

Many leather and hide garments and felted wool textiles were also recovered from the frozen Scythian tombs. Although there is no evidence of weaving, such as the presence of loom models or spindle whorls, a nearly intact woven textile shirt and several small textile scraps were recovered. These may have been traded from China or Persia. The cloth is woven from fine yarn and could likely be either hemp or flax. The Hermitage Museum has supplied the IHA with small textile fragments from the shirt and other textile scraps for analysis to determine what fibers they contain. Perhaps a non invasive analysis such as scanning electron microscopy could be used to determine the fine structure of the fiber elements and identify their origin.

The Hermitage Museum has provided the *Cannabis* research community with a fascinating opportunity to unravel the ancient mysteries of the association of the Scythians with *Cannabis*. The IHA is searching for experienced researchers who are interested in attempting differing analytical methods in an effort to find positive proof for the use of *Cannabis* for either its consciousness-altering properties or its textile fiber by the ancient Scythians. If you have any ideas please feel free to contact Robert C. Clarke at the IHA. Any leads and suggestions will be greatly appreciated. -RCC

Minnesota Meeting

While the nascent North American hemp industry has made significant progress in the last several years, it is still perceived by mainstream society as somewhat of a counterculture anomaly. Thus, the meeting sponsored by the Wisconsin Department of Agriculture, Trade and Consumer Protection and held in Minneapolis, Minnesota, on October 19 and 20, 1995, was a positive step toward commercializing the industry and moving it into the mainstream.

Representatives of government, industry, agriculture, academia, and environmental groups met with hemp entrepreneurs to discuss the crop's commercial potential, agricultural characteristics, and political hurdles. Many of the participants, who earlier in the year had attended the Bioresource Hemp Conference in Frankfurt, Germany, were excited about hemp's future. They mentioned having been frustrated by the slow progress of efforts to commercialize hemp farming in Canada and the United States.

The participation of International Paper, the world's largest pulp and paper firm, and of Inland Container, a Fortune 500 company, along with that of individuals such as Jim Hangley, a textile executive formerly with Cotton Inc., Gordon Reichert of Agri-Food Canada, David Morris of the Institute for Local Self-Reliance, and Jeffrey Gain, former Executive Director of the National Corn Growers Association, prove that the hemp industry is developing a powerful coalition. According to Curt Koster of International Paper, "We're not married to wood pulp. We're very interested in the role hemp or other natural fibers can play in meeting our growing fiber needs."

The meeting's last session, titled "Strategies for Future Action", resulted in the election of a steering committee charged with developing bylaws and a mission statement by March 15, 1996. The working name for the group is The Industrial Hemp Council, and the current mission statement is as follows:

We, as concerned individuals, hereby create the Industrial Hemp Council, whose mission is to promote the sustainable cultivation and commercialization of the industrial hemp in North America.

For further information, contact Bud Sholts of the Wisconsin Department of Agriculture, Phone (608) 224-5135, Fax (608) 224-5110, or email at <sholtea@wheel. datcp.state.wi.us.> Readers can also visit the HEMPTECH Internet site at <www.hemptech.com> or use email for news of upcoming developments regarding the Industrial Hemp Council.

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Cannabis Germplasm Preservation Project

The Vavilov Research Institute (VIR) in St. Petersburg, Russia completed the third successful year of seed reproductions supported by a US$ 15,000 grant of humanitarian aid from the International Hemp Association (IHA). Reproductions were performed in four locations in Russia and the Ukraine and five locations in Italy. If sufficient funding can be arranged, 1996 will be the final year of reproductions and comparative field trials. Characterization, and evaluation of the collection will be completed in 1997. We expect the 1996 budget to be around US$ 20,000.00.

The Italian reproductions were greatly expanded in 1995 in response to a plea from the IHA to the Italian agricultural community to save their remaining hemp varieties before they become extinct. Reproductions of additional VIR accessions were also carried out. Nine accessions were sown at three locations near Bologna, Milan, and Rome in northern Italy, two accessions were sown in Sardinia, and three accessions were sown near Policoro in southern Italy. Ten accessions were successfully reproduced and 73-4,000 gm were harvested for each.

A full report of the results of the 1995 VIR/IHA CGPP will appear in our June 1996 issue. RCC

IHA *Cannabis* Textile Reference Collection

During the past three years the IHA has collected many samples of both historical and modern hemp textiles for a *Cannabis* Textile Reference Collection. The collection will be both a reference of historical interest as a chronicling of the development of hemp textiles for the Western market and function as the standard reference collection for the development of analysis protocols for identifying true *Cannabis* hemp.

When sample size allows, sets of 5 identical samples of each textile will be collected and mounted in five individual binders. The purpose of having five identical sets of samples is to maintain a primary and duplicate set at the IHA offices for reference and allow three other sets to be sent to textile laboratories for characterization and analysis.

The IHA is soliciting hemp textile samples for inclusion in the *Cannabis* Textile Reference Collection. We request that submitted samples be large enough samples to cut five 10 X 15 cm swatches, preferably with a selvage edge, so that a swatch can be mounted on plastic archival pages and included in each of the five volumes. We would prefer to cut the swatch samples ourselves. The 10 X 15 cm sample size is large enough to allow one to feel the texture of the cloth, take photographs, and remove small amounts for analysis. If only smaller samples are available please submit them anyway and they will be divided up in to as many of the collection volumes as possible. Please include any information about the sample such as date produced or aquired, fiber content, geographical origin, usage, manufacturing techniques, yarn and weave specifications, etc. A quistionaire will be provided for contributors. The more samples we receive the more valuable the *Cannabis* Textile Reference Collection will be.

The methods of hemp textile manufacture are changing from the traditional to the modern at a tremendous pace. Now is the time to take samples and chronicle this rapid development of the hemp industry before these valuable samples are lost. Eventually the IHA would like to assemble reference collections for hemp yarns, cordage, sliver, ribbon, paper, non-woven textiles, laminates, composites and other products manufactured from *Cannabis*. Thanks for your participation. -RCC

First Finnish Hemp Seminar

On Saturday September 9, Finland's first major seminar on industrial hemp in modern times was held at a beautifully restored historical building in the little village of Niemisjärvi, near the Hankasalmi home of organizers Jace Callaway, Anita Hemmilä and Ulla Kolehmainen. Many different facets of the "hamppu" phenomenon were reviewed through interesting lectures on the history and culture of *Cannabis* in Finland, growth of experimental oil and fiber crops, the environmental implications of hemp, its legal status and the agricultural regulations pertaining to this "new" crop. IHA Secretary Dave Pate gave lectures concerning both the various international policies on *Cannabis* cultivation and the hemp product development potential for Finland. Displays of antique fiber processing equipment, as well as modern hemp products, added to the enjoyment of wonderfully decorated surroundings and tasty food. The seminar served to consolidate and focus the hemp movement in Finland, as well as to attract considerable media attention.

Debate Corner

I commend the Journal for the high level of objectivity to which it aspires. You provide an important service as a forum for public dissertation and debate. A recent article[1] in your journal disputes two statements in my book, Hemp, Lifeline to the Future.[2] I wish to respond to those comments.

Popular Mechanics magazine published a 1938 article[3] [which states] that the woody core of hemp is "77 percent cellulose". I have since come to agree with you that their figure is incorrect. My review of scientific and technical literature indicates a cellulose content in the core ranging from 30 percent to around 40 percent. I see two possible explanations for the magazine's error. The writer may have inadvertently combined the cellulose content with hemi-cellulose, since together they approximate the stated figure. Or perhaps he meant not the core but the bark, which can surpass 77 percent cellulose.

Moving on, you dispute my statement that hemp produces "a larger amount of dry vegetable matter than any other crop in temperature climates" (p. 72). This is quoted verbatim from the 1913 US Department of Agriculture report entitled "Hemp".[4] Dewey clearly referred to the horticulture of his day with conventional farming techniques to produce annual rotational crops in a sustainable manner. The context as I described it excludes tropical, aqua culture, tree farming and genetically mutated crops. History shows us that hemp is a long-term crop that gives high yields on good soil using only natural organic fertilizers (e.g., manure and compost) and crop rotation. While a few crops can equal or surpass hemp's short term annual output, most of these require more water and attention during the growing season.

Furthermore, modern hemp reports come from different soils, different climates, different farming techniques, even different seeds lines than he used. No wonder they get different results. Genetics may be the defining issue. Dewey hybridized choice seeds from Europe with the best of China. He bred for maximum yields, not minimum THC, and he got a higher output under sustainable conditions. Perhaps THC plays a greater role in hemp output than is politically correct to admit. Perhaps the US government's century of hemp seed selection resulted in the most successful hemp breeding program ever achieved. Or perhaps you're right, and Dewey overstated his case. His hybrids were destroyed by the drug war, so we will never know for sure.

I hope to see some work done around the variables discussed here for a more accurate assessment of hemp's potential. Nevertheless, there is no mistaking Dewey's enthusiasm for *Cannabis*. It is an enthusiasm which I share, and I know you do, too.

Sincerely,

Chris Conrad
Author of *Hemp, Lifeline to the Future*
Director of the Business Alliance for Commerce in Hemp
President of the Hemp Industries Association

1 Werf, H.M.G. van der, 1994 Hemp facts and hemp fiction. *JIHA* 1: 58.
2 Conrad, Chris 1994 *Hemp, Lifeline to the Future*. Creative Xpressions. Los Angeles California.
3 New Billion Dollar Crop.. in *Popular Mechanics*. 3 February 1938: 238-239.
4 Dewey, Lister Hoxley 1914 *Yearbook of the U.S. Department of Agriculture*. US Govt. Printing Office. Washington, DC: 313.

Editor’s reply

My article had for its objective, the separation of hemp facts from hemp fiction. That is why I wanted to expose two commonly repeated "hemp myths", namely that hemp core yields more dry matter than other crops, and that hemp core contains 77% cellulose. I am glad that you now agree with me that 77% cellulose in the core is fiction rather than fact and that Dewey's claim may have been overstated.

In the article you have reacted to, I forgot to mention a third enduring hemp myth. Interestingly, in your attempt to explain why Dewey's hemp cultivar may have been more productive than modern varieties, you bring up this third myth. It can be summarized as "hemp bred for a low THC content is less productive and defenseless against pests". De Meijer (1994), in evaluating a collection of about 200 *Cannabis* accessions did not find associations between cannabinoid content and agronomic characteristics such as rate of stem elongation or occurrence of the fungus *Botrytis cinerea*. The Hungarian cultivar Kompolti Hybrid TC is similar to Dewey's cultivars: it is a hybrid of Chinese and European genotypes and relatively high in THC. In my experiments, its yield was not superior to that of other, low-THC Hungarian cultivars. So, until proven otherwise, I think the THC content of a hemp cultivar is irrelevant to its agronomic performance. I do, however, agree with you that a possible ecological role for the cannabinoids is an intriguing topic which merits further investigation (Pate 1994).

I would like to repeat that you should not take these criticisms personally. I, too, think that hemp is a marvelous and fascinating crop, but often read exaggerated statements made by some of the "hempsters". I feel the "hemp facts" are good enough and that this crop does not need "hemp fiction" to make it look better.

Best regards,

Hayo van der Werf
Editor-in-Chief

De Meijer, E. 1994. Diversity in *Cannabis*, Ph.D. Dissertation, Agricultural University of Wageningen, The Netherlands.

Pate, D.W. 1994. Chemical ecology of *Cannabis*, *JIHA* 1(2): 29, 32-37.

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CannabAds Information. Size : 4 cm high and 8 cm wide. US $100. Give ad location preferences. Ad must be delivered camera/computer ready to the *JIHA* 60 days before printing (1 June and 1 December). The *JIHA* reserves the right to refuse any ad we find untruthful, deceptive or objectionable.

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The IHA has assembled an educational package for teachers and policy makers. Included are valuable references containing sufficient information to prepare educators with the background needed to accurately explain the value of *Cannabis* as an agricultural crop. A slide series illustrating the various beneficial uses of *Cannabis* and actual examples of *Cannabis* products currently being made and sold worldwide are included. The *Cannabis* educational package is available to IHA members for US $50.00 which covers the cost of the materials and postage. Non-members may purchase the *Cannabis* Educational Pack for US $100.00, if the IHA has any remaining after member sales. (Note: The added US$50+ margin above cost for non-members is to encourage their membership!) Contact the IHA now to order your *Cannabis* Educational Pack. Supplies are limited.

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-Lip balm and body care samples from Alma Rosa N.V.
-Small hank of sliver from Naturetex B. V.
-Voucher from Ohio Hempery for sterilized hemp seed (North America only)
-Viable hemp seed (Europe only)
-Small package of hemp hurds from HempFlax B. V.
-Small square of composite board from HempFlax B.V.
-Small hank of hemp ribbon from Tai Shan Trading
-Short section of hemp stalk from Tai Shan Trading
-Small piece of “Hempstone” 100% hemp composite from Zell Form Gmbh, Austria
-Piece of hemp rope
-Hemp seed oil crayons and spot remover from Hanf Haus Gmbh, Berlin, Germany
-Example of *Cannabis* medicine

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