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Production and technical utilisation of flax in China

The situation, the problems and their solutions

Flax has been known in northeast China for over 5000 years. Earlier, it was cultivated for medicinal uses and only since the 16th century used for production of fibre and oil [4]. Currently 91,000 ha flax are cultivated producing 53,000t of fibre. 36.3% of the flax fibre and its products are exported representing a 6% share of the world market [1].

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After cotton (93% of the fibre crop area) and jute (2.5%), flax is the third most important fibre plant in China with an area of 1.5%. 91% of total flax cultivation area in China is in the province of Heilongjiang where flax cultivation area represents 99% of fibre cultivation area [1]. Helongjiang is in northeast China (*fig. 1*) covering 4.7% of the total area of China and thus one fifth larger in area than Germany. The climate is particularly suitable for flax, the cultivation of which has a long tradition there. The research facilities and the preparation and processing industries are consequently well developed.

Cultivation and production technology

Flax is sown from mid-April to mid-May in China and harvested from the middle to the end of July. Flax cannot be grown in monoculture. Rotational requirements (to avoid so-called „flax exhaustion") involves sowing in the same soil only every fifth to seventh year. Preferred as opening crops for flax are plants that leave only a limited nitrogen reserve in the ground, a good and, above all, homogenous soil with very little root weeds and flax parasites. Crops which have received a large amount of mineral nitrogen or have left large residues of organic material in the soil are not recommended as opening crop. Cereals, for instance, are regarded as suitable previous crops, whilst potatoes, oilseed rape and peas are less suitable. In general, flax belongs to the types of crop with little demands from the previous crop. Flax itself is actually regarded, among others, as a good opening crop. The following rotations are practiced [3, 4]:

- maize – flax – soybeans – sorghum
- maize – flax – soybeans – millet
- maize – flax – sugar beet – soybeans – wheat

Flax cultivation and harvesting methods are very different in China and Germany, with the procedures fully mechanised in Germany and not so in China. This has much to do with the different retting methods with dew retting part of the traditional production in

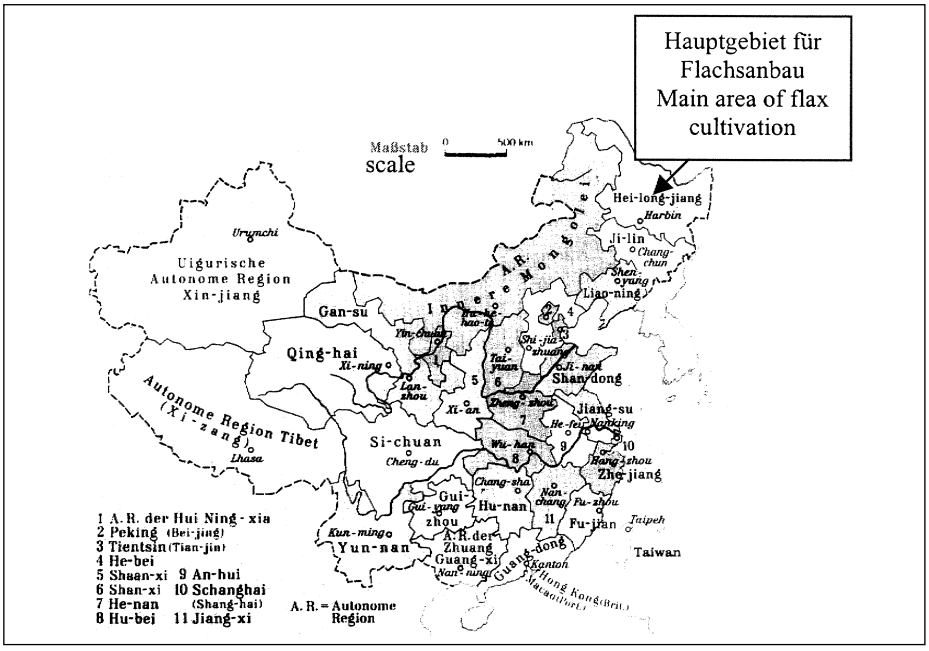


Fig. 1: Provinces of China and location of the main flax cultivation areas

Table 1: Labour requirement for the work processes [6]

Operation	Working time requirement (mh/ha)
Cultivation	2
Sowing	2.5
Plant protection	7.5
Hand plucking	115
Machine plucking	1.5
Decapsulizing	30
Other [1])	28
In total	
With hand plucking	185
With machine plucking	72

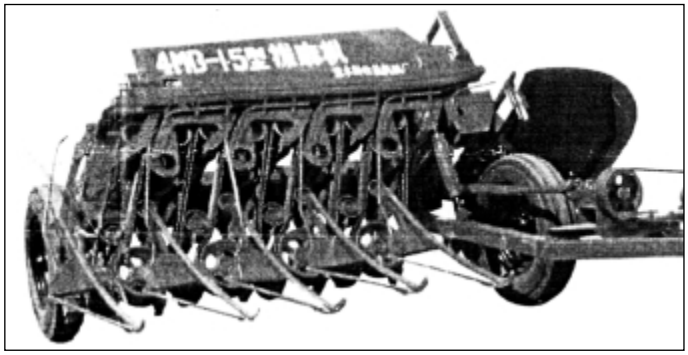
1) Drying, threshing, bundling, loading, transporting and stacking.

Germany and water retting preferred in China where it is carried out in factories which buy the flax straw from farmers before retting and flailing to produce fibre.

Flax cultivation and harvesting in China comprises soil cultivation, sowing, fertilising, plant protection, plucking, drying, decapsulizing, threshing, bundling, loading, transport and stacking. Cultivation, sowing, threshing and transport are mechanised. Plant protection is carried out with knapsack sprayer. Fertiliser is applied during cultivations or sowing. Plucking is either manual or mechanised. Decapsulizing, drying, bundling, loading and stacking are manually conducted.

On 70% of the cultivation area flax is manually plucked, the remainder being pulled out by machine resulting in a great difference in labour/time requirement for flax cultivation and harvesting (*table 1*). The manual operations mean more crop risk and, with this, more capital risk. The main reason for limited mechanisation is the difficulty in financing the purchase of plucking machines (*fig. 2*).

Fig. 2: Flax pulling machine 4MB-1.5



Fibre loosening

In China, water retting is mostly used for the fibre-loosening process. This, however, leads to three big economic and ecological problems: high costs, high water requirement and high production of wastewater. The retting of 1 t flax straw produces around 18 m^3 wastewater [4]. The ecological damage caused by this wastewater comes from its high biological oxygen demand. Where it is run directly into surface water, the fish population suffers from the lowered oxygen content of the water over several kilometres. Using the wastewater for irrigating seeded fields or pastures leads to immediate crop death. Biological purification of the wastewater can be applied, but involves high costs in the building of larger holding and clarification lagoons. Sand and coke filters cannot be used because the slime in the retting wastewater blocks the filters very easily. Environmental problems also remain when the material is used for biogas production [2].

The above problems can be avoided by using dew retting, although long periods of continuous rain can mean the retting getting out of control with subsequent flax fibre damage which can, in the worst cases, lead to total harvest loss.

Enzyme loosening procedures involving adding enzymes (Novoflaxyme among others) to the retting water are being tested in China. The trials indicate that the resulting retting time, at 30 to 40 h, represents a reduction of 1/3 to 2/3 and that, at the same time, the amount of fibre produced can be increased by 3 to 4%. The resultant fibres are lighter, have more lustre and are therefore more valuable. Reduction of retting period means less facilities are required for the water retting. Investment and area for the facilities are each reduced by around 50% and energy requirement by some 20%. The use of fresh water and the amount of wastewater are also reduced, as can be wastewater odour. The oxygen requirement is only 60 mg/l. The wastewater can be released directly into surface waters [5]. This method represents an innovation in water retting and is also being used in China currently.

Fibre usage and the related products

Up until now, flax has been mainly used in the textile branch in China and this continues as the main application. At the same time, however, there is great potential for flax in the technical sector.

The technical flax uses being realised in China currently are:

1. Production and use of linseed oil. The extraction process is mainly used in China for producing the oil. The linseed oil is mainly processed directly and used in the production of natural paints, varnishes, glycerophthalic resins and colourings.
2. Pressing of shavings into fibreboard. This can serve as substitute for timber material and thus relieve the timber market.
3. Manufacture of paper from tow and shavings. Both are cost-efficient raw materials for papermaking. Tow fibre lengths are around 2.49 to 6.76 mm those of shavings around 0.45 to 0.68 mm. From different blends of the two by-products various types of paper can be produced. For instance corrugated paper comprises 30% tow and 70% shavings [4].
4. Manufacture of various products through mixing of flax chaff with recycled PE, both of which are actually waste materials. For every ha of flax grown, around 300 kg of chaff is produced annually, thus around 30,000 t per year in the province Heilongjiang. At the same time around 100,000 t of PE plastic mulch can be collected from the fields of the province each year. Foreign objects are first of all removed from the collected flax chaff and PE for recycling. The dried and chopped chaff is mixed with the washed and dried PE film plus colouring and technical chemicals and then melted down. Objects such as basins and crates can then be manufactured from the panels and forms manufactured from the melted mixture [4].
5. Production of woven covers from short fibres: for each 1 t of long fibres 1.4 to 1.6t of short fibres are produced. To avoid waste and to use the short fibres in a practical way, added value utilisation of short fibres must be sought – of which the production of woven covers offers a good possibility.

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