



Novel fibre value chains & ecosystem services
from sustainable feedstocks

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1. Introduction

This document outlines the research sites of FIBSUN project. Poor understanding of the multiple benefits of well-planned, novel applications currently restrict the implementation of sustainable value chains with balanced environmental, economic and social outcomes. Every step in the novel bio-based fibre value chains targeted by FIBSUN need to be optimised, from cultivation practices, industrial processes, and business models, through to understanding the needs of consumers. The use of novel industrial feedstocks must not lead to undesirable land-use changes, such as the conversion of forest or land currently used for food production into land used for fibre biomass production. Instead, the related land use must be designed to alleviate the harmful effects of desertification, contamination, flooding or mining, by using degraded soils and marginal land to cultivate underutilised biomass feedstocks which can restore soil productivity and enhance the provision of diverse ecosystem services.

In total 60-70% of soils are under pressure and prone to marginalisation in the EU (Efthimiou 2024). The crops, cattail, reed, hemp, cardoon and wood, selected for FIBSUN sites represent species well suited for marginal land or agricultural land with constraints in conventional cultivation.

Nearly five million hectares of drained peat soils are currently used for agriculture or peat extraction in Europe (Schils et al., 2008). Peatland drainage degrades soil services and productivity. Given the growing societal emphasis on sustainability, identifying solutions for their sustainable management has become increasingly urgent. As rewetting to near-natural conditions is not a suitable option for the complete area, trials on paludiculture (i.e. productive use of rewetted marginal peat soils) and especially the industrial use of the biomass produced on rewetted soils, are needed to make it a realistic option for landowners.

Europe is the fastest-warming continent in the world, and especially Southern Europe will suffer from increasing droughts (EEA 2024). In 2023, EU reported a drought impact area of approx. 143 513 km² (EEA 2024). As a result, there will be more and more land that is not suitable for traditional agricultural production. As hemp and cardoon are very resilient species, they are suitable for the dry and degraded regions.

There is an estimation that 2.5 million industrial metal contaminated sites potentially exist in Europe (JRC 2014), and purifying these soils is expensive. The abandoned sites will eventually vegetate, and if the vegetation binds the pollutants effectively, utilizing the biomass from such sites is an option to remove pollutants gradually. As regards biomass production, this is of minor importance but the environmental benefits and cost savings in soil remediation may make such site management an appealing option.

FIBSUN research sites outlined in this deliverable were chosen to showcase the impact of fibre crop production on ecosystem services and economy of the landowner.



2. Site descriptions

2.1 Ankeveen - Cattail




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Cattail (Typha latifolia)

Broadleaf cattail, *Typha latifolia*, thrives in wet nutrient-rich environment. It is a wetland plant found in temperate and subtropical regions, typically growing to the height of 1.5 to 3 meters.

Cattail takes 2-3 years to reach full maturity. If the environmental conditions such as light, moisture and nutrients are unfavorable, the establishment can take up to 5 years. Mature plants produce fiber rich leaves and distinct brown, cigar-shaped flowers, which develop from the upper part of the plant. A single plant can live for several years, with new shoots emerging from the rhizome each growing season.

Cattail plants have high water content and grow relatively denselyle compared to many other wetland species. Cattail is a resilient species and usually shows little physical damage unless affected by extreme environmental factors such as heavy storms, ice, or herbivore feeding. Cattail is also very disease resistant. In favorable conditions cattail can yield up to 25 tons of dry weight per hectare.



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ANKEVEEN, NL

PVT manager: Christian Fritz (christian.fritz@ru.nl)

The one ha Ankeveen site is located on a rewetted peatland in The Netherlands. Before cattail cultivation this area was drained as an agricultural grassland and the surrounding area is in intensive agricultural use, which is responsible for agricultural nutrient legacy in and around the site and peat degradation. On this site there is production of two different cattail species. Cattail thrives in this wet nutrient-rich environment while contributing to nutrient removal, and the wet conditions protect the peat from oxidation.

To establish the *Typha latifolia* field, a basin of 10 x 120 m was created in 2018 by recycling 0-10 cm of topsoil for bunds (dikes), bringing the water level up to approx. 15 cm above the surface level and sowing the seeds. The main continuous management effort is to maintain high water level, while the agricultural legacy in the soil and irrigation water from the surroundings ensures a sufficient nutrient input without fertilisation. *Typha* cultivation offers an opportunity for protecting the underlying peat while providing a source of income to the landowner in form of wetland farming. Cattail has a lot of potential applications for animal and human feed, textile industry and notably feedstock for construction industry. Biomass from this site is already used as raw material for insulation boards and is normally harvested once a year in the winter. Within FIBSUN we are testing different harvesting times, a new fiber extraction method and the fibers as a raw material for insulation boards.



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2.2 Tuhkaneva - Reed



Common reed (Phragmites australis)

Common reed, is a wetland grass that is typically 2-4 m tall and distributed worldwide. It is common in both alkaline habitats and brackish water.

Phragmites australis commonly forms extensive stands, reed-beds, which may be as large as 1km² or more. Where conditions are suitable it can also spread at 5 m or more per year by horizontal runners. It can grow in damp ground, in standing water up to 1 m deep, or even as a floating mat. The dark purple branched flowers are formed in late summer.

When sown, it typically takes about 2-3 years for reeds to reach maturity, with new shoots emerging from the rhizome every growing season. Northern European reed can yield 10 tons of dry weight per hectare.



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TUHKANEVA, FI

PVT manager: Kristiina Lang (kristiina.lang@luke.fi)

The Tuhkaneva site in Kauhajoki is a rewetted peatland in Finland. This 4-ha site was drained and used for peat mining until 2019. The site was dammed in 2021 to restrict water flow and now the water table has raised close to the soil surface. Vegetation is allowed to spread spontaneously, and the main aim is to prevent loss of the remaining peat and to create a site of high biodiversity. The vegetation diversity is high already, and the open water areas of the site attract waterbirds.

The site has been harvested only in small scale, for cattail in food applications. Common reed is normally harvested from natural stands in watercourses but there will likely be the need for commercial production as its industrial use develops. In FIBSUN, we examine the potential for its cultivation by following the establishment of a common reed stand in one part of the site. The site is not fertilized but it receives nutrients from surrounding agricultural areas. The yield of this site is well comparable to natural reedbeds suggesting that abandoned peat mining sites are suitable for commercial reed production.

Reed cultivation on abandoned peat mining sites is a promising form of after use. It provides economic income for the landowner, GHG mitigation, water purification and nesting sites for waterbirds. Reed is used for example in thatching and production of growing media. In FIBSUN, reed fibers are tested as a raw material for insulation boards.



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2.3 Bühl - Industrial hemp



Industrial hemp (Cannabis sativa L.)

Industrial hemp, is a robust annual herb. FINOLA2 is an auto flowering dioecious hemp variety that flowers early and has a very low tetrahydrocannabinol (THC) content at maturity.

Hemp can be described as a fast-growing and fibrous plant that grows between 2 to 4 meters tall with average stem diameter 1cm.

With sufficient fertilization and favorable growing conditions, typical yields of grain range from 1.5 to 2 tons per hectare and the whole plant from 4 to 6 tons per hectare in central Europe, typically without herbicides, pesticides and fungicides.

FINOLA2 is suitable for cultivation in southern Europe, the United States and other regions below 50° N latitude. Grain yields are less than optimal at latitudes above 50° N.



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BÜHL, DE

PVT manager: Almut Frank (almut@bafa-gmbh.de)

The 2.7 ha Bühl site is located in Germany, Waldhegenich, in a nature and landscape conservation area. The site was previously used for corn production and is now growing hemp for three years.

Every year before crop establishment the field has to be checked and remedied for soil compaction by tillage. In case the field is sensitive to soil erosion, it is advisable to plant a cover crop during the winter before establishing hemp. Hemp requires a firm seedbed and good soil contact for optimal germination. After soil preparation hemp is sown in spring, usually in April-May. To ensure the crop establishment the field is irrigated, and an adequate nutrient input is ensured by using organic fertilizer during the growing season. Hemp can be harvested after 100-130 days from sowing, typically August-September when the seeds are ripe.

The site soil is sandy and nutrient-poor which poses challenges to conventional practices due to its rapid warming and low water holding capacity. Resilient hemp is very tolerant of heat and drought, making it a suitable crop for this area. FIBSUN aims to explore whether hemp cultivation improves soil properties and microbial activity. Additionally, hemp is commonly used to produce seed oil and only the seeds are harvested. Second goal of FIBSUN is to test using the rest of the plant for hemp fibers to produce non-woven insulation material and composites for cars.



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2.4 Ourique - Cardoon



Cardoon (Cynara cardunculus)

Cardoon is a perennial herb with an average height of 2.2 meters with approx. 6 flower heads per plant. Its above-ground plant parts die in summertime, a period of severe drought, but the plant regrows in early autumn, when conditions are more favorable for its growth.

Cardoon develops an extensive root system that helps bind the soil and reduce erosion, particularly in dry, degraded plains where wind and water erosion are major concerns. By breaking up compacted layers, these roots also improve water infiltration and aeration.

In good conditions, cardoon can yield up to 10 tons of biomass per hectare. As a perennial plant, cardoon sheds leaves and roots seasonally, contributing to organic matter buildup.



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OURIQUE, PT

PVT manager: Pedro Varão (pedro.varao@food4sustainability.org)

The one hectare Ourique site is characterized by vast expanse of low-relief, almost treeless plains. The land use on the region is usually associated with livestock and later rainfed cereal crops. The southern Portuguese region is dominated by open and continuous fields, with its agricultural matrix being occasionally interrupted by patches of shrubby and/or arborous natural vegetation, including cardoon.

Climate change and climatic conditions have led to drought in this region, with very low ground water level compromising the traditional agricultural practices and the needs of the natural vegetation. Resilient cardoon can withstand these harsh conditions, which makes it a suitable crop at this site. Cardoon cultivation is expected to improve soil qualities and provide a source of income from these degraded plains.

To establish a cardoon production field the plants just needed to be sown once, as they regenerate from their roots every year. It is a low maintenance crop with irrigation systems being installed on this site to ensure good harvests. The plants can be harvested in the late spring or summer.

Cardoon flowers and seeds are already used in the food industry. Within FIBSUN we are testing the stalk and leaves as a source of fibre to produce textile yarn.



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2.5 Pont-de-Claix – Wood on contaminated soil



*Poplar (Populus sp.), willow (Salix sp.)
and black locust (Robinia pseudoacacia).*

Poplar, willow, and black locust can all be characterized as fast-growing small to medium sized (6 - 30 m) leafy trees, being excellent choices for phytoremediation, the process of using plants to clean and restore contaminated soils.

They are known for their deep root systems, allowing them to reach contaminants deep in the soil and are capable of absorbing heavy metals such as cadmium, lead, and zinc, as well as organic pollutants like petroleum hydrocarbons and pesticides. They also contribute to a process called phytovolatilization, in which certain contaminants are transformed into less harmful compounds. Additionally, their roots support microbial communities that break down toxins in the soil, making them valuable species for restoring land affected by industrial pollution.

A poplar plantation can produce between 200-250 cubic meters per ha in western Europe after 15 to 20 years while black locust can produce between 140-450 cubic meters per ha after 20 to 40 years.



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PONT-DE-CLAIX, FR

PVT manager: Edern Philippot (edern.philippot@fcba.fr)

The land area of 4 ha was formerly occupied by a manufacturer of industrial paints and varnishes, but it has been a wasteland since the site closed in 2011. In 2019, the public landowner and the town of Pont-de-Claix joined forces with Envisol to set up Crisalid, a cooperative aimed at promoting the redevelopment of brownfield sites.

The site is currently being used as a full-scale laboratory for the implementation of innovative soil decontamination techniques with endemic species like poplar, willow and locust, which have established themselves spontaneously on this wasteland.

Due to the natural establishment, there is also no need for maintenance. For commercial uses the trees can be harvested after 15-40 years, depending on the species.

In FIBSUN we want to explore whether the plants are capable of removing contaminants from the soil and improving the overall soil properties while producing profitable biomass. Within FIBSUN, wood collected from this site will be used in mix with cement to produce bricks.



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