



Yield and climate change adaptation using alley cropping

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How can trees maintain crop yields?

Climate change scenarios predict fewer but more intense rain events. Dry spring and summer weather reduces crop yields. Water loss from the crop is controlled by solar radiation, air temperature, wind speed and humidity.

Alley cropping systems can modify the crop microclimate by reducing wind speeds and temperature extremes. Lower wind speeds increase humidity levels around the plant surface, thereby slowing water loss.

Many crops that are protected by hedgerows of fast growing trees, managed as short rotation coppice, demonstrate increased photosynthetic rates and water use efficiency.



Close-up of poplar hedgerow with winter wheat.
Ref: Mirck, 2016



Winter wheat within poplar and black locust alley cropping system. Ref: Freese 2014

How can alley cropping be arranged?

For the establishment of alley cropping systems, seven fast growing tree species (willow, poplar, black locust, beech, alder, ash, and oak) are currently allowed in Germany. Soil pH should range between 5.5 and 8.5, soil depth should be at least 50 cm, and for growing willow and poplar there should be a minimum precipitation rate of 600 mm.

Effective site preparation and weed control are essential for the successful establishment of fast growing woody crop hedgerows. The trees should be planted in winter or spring. Planting material is available through commercial nurseries. The material will be either seedlings or, in the case of willow and poplar, cuttings produced from the previous year's growth are also available. Planting may be done by hand or with mechanized planters. During the first growing year, weed control using chemicals should be carried out. During the second year, after root establishment, further mechanical weeding may be required.

Tree hedgerows can vary in width between 2 and 10 rows (2-15 m wide). Both single and double row designs can be used. Spacing for a single row design could be 2.55 m between rows and 0.4 m within the row. For a double row design, there should be 1.75 m between double rows, 0.75 m within the double row and 0.9 m within the row. The crop alley spacing can vary between 24 and 96 m.



Sugar beet within poplar and black locust alley cropping system. Ref: Mirck, 2015

Advantages

- Improved microclimatic conditions within alley cropping systems benefit the arable crop at little additional cost.
- Tree hedgerows help to shelter crops and soils from climate change induced by extreme weather events and crop diversification can protect the farmer from complete crop failure.
- Producing a second crop of wood chips, in between the arable crop, facilitates product diversification and increases the productivity per unit of land.



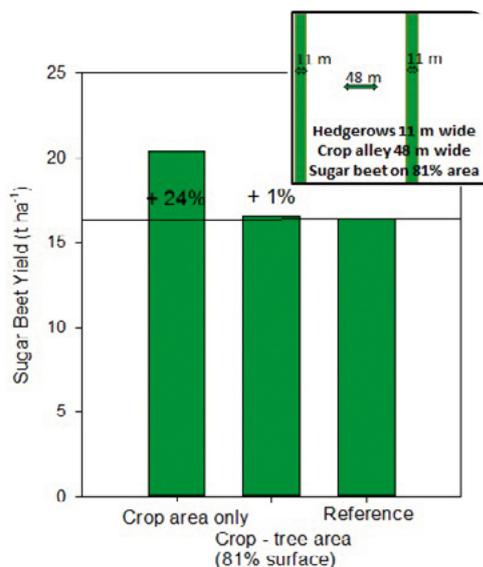
Mechanical harvest of tree hedgerows of the alley cropping system. Ref.: Kanzler, 2015

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Sugar beet crop yield before and after subtraction tree area in comparison with reference site. Measured in eastern Germany close to Forst (Lausitz).

Crop yield

Crop yields are expected to be impacted slightly or not at all. Studies in Germany have shown that, after subtraction of the hedgerow area, crop yields within the alley cropping system were similar to the reference area (+24% before hedgerow subtraction).

Tree yield

The above ground biomass can be harvested on a 3 to 5-year rotational basis. A hedgerow with 4 double rows and a 48-m alley width is expected to produce 1.045

– 1.300 t/ha/yr for the first rotation. Subsequent rotations are expected to produce up to 90% more biomass (Labrecque and Teodorescu 2003).

Pests and diseases

Both willow and poplar are vulnerable to a range of diseases, notably *Melampsora* fungi and poplar leaf beetle (*Chrysomela tremulae*). Septoria canker is of concern in North and South America, but it has not yet reached Europe. Fusarium canker, mildew and leaf-spot have been recorded on black locust in Germany. However, overall threats are much lower in Europe than in its native North America.

Labour, harvesting and marketing

When grown in straight lines, the cultivation of fast growing trees is not expected to interfere with conventional crop production. Labour levels are expected to increase slightly. However, when practiced on a large scale, mechanical equipment can be used for planting, weed control and harvesting of the biomass feedstock. The marketing of the wood chips should be researched before the establishment of the fast growing trees. For the marketing of the wood products from fast growing trees, the transport distance and water content are important factors to consider. This distance should be kept as low as possible, and the woody crop should be dried before transport.

Further information

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