EUBCE 2024
32nd European Biomass Conference & Exhibition

UNIVERSITY OF HOHENHEIM

european bioeconomy university

EXPERT WORKSHOP ENVIRONMENTAL SUSTAINABILITY OF CROPS FOR BIO-BASED INDUSTRIES IN EUROPE

Wednesday 26 June 2024 - 12.00-15.45 Room Samena

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MISCANTHUS

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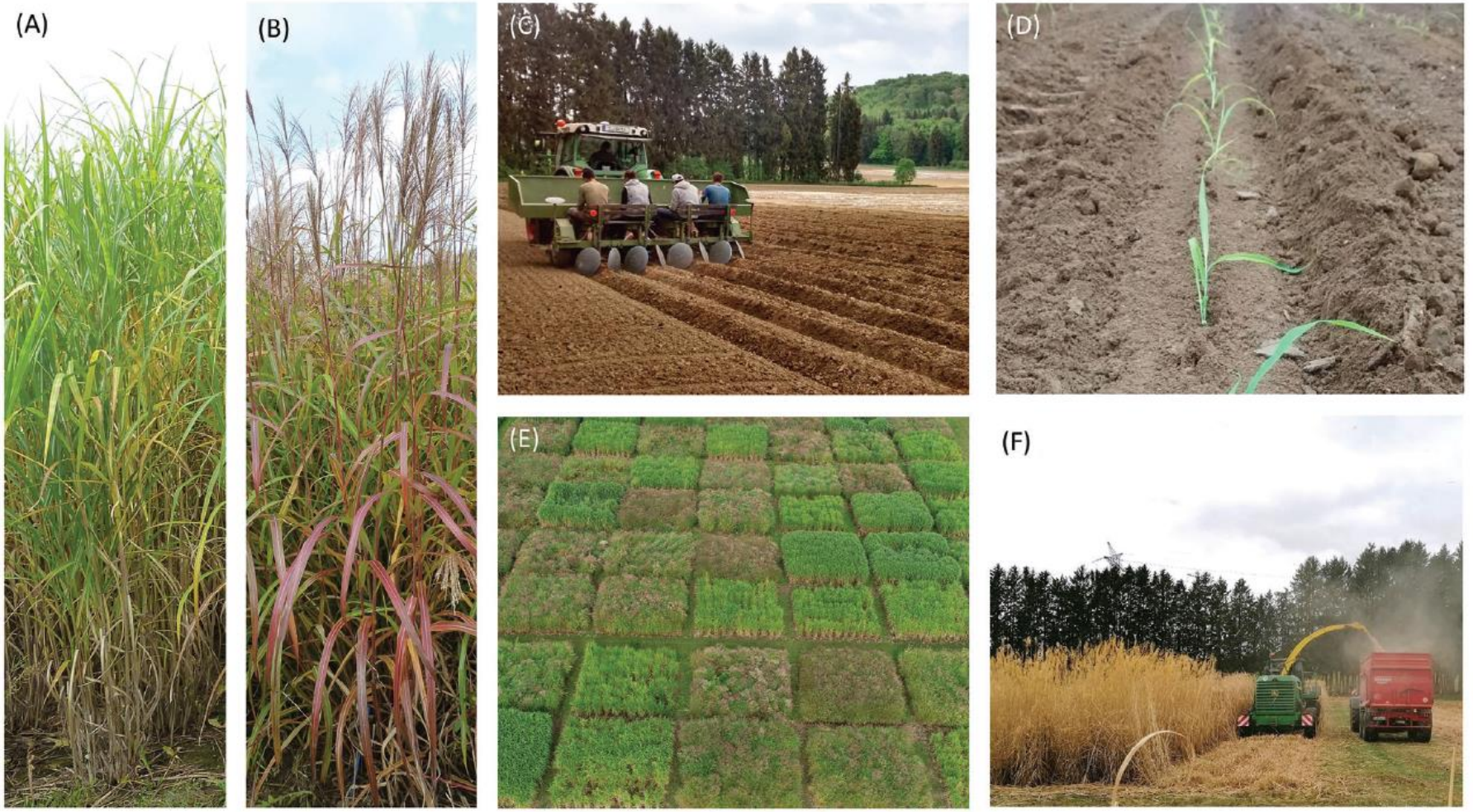

A,B) Novel seed-based hybrids, e.g., *Miscanthus sinensis* x *sinensis* (A), are compared with the rhizome-based standard hybrid *Miscanthus* x *giganteus* (B) in multilocation, plot-scale field trials on marginal land (E). C) Establishment of rhizome-based miscanthus hybrids using a commercial-scale planter. D) Seed-based miscanthus plantlets after planting. F) Direct harvest of standing, dry miscanthus crop after winter using conventional agricultural machinery (Source: Elena Magenau).

Lewandowski et al. (2024) Adv. Sustainable Syst. ***2024****, 2300518* https://doi.org/10.1002/adsu.202300518

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Commercial miscanthus production areas and biomass applications (most data from 2016)

Country	Area [ha]	Genotype	Biomass application
Europe	12,050		
UK	10,000	*M. x giganteus*	Co-firing in power generation
Germany	5,000	*M. x giganteus*	Heating, building materials, insulation, planting pots, mulch for gardening, packaging, oil binder, bio-composite, biogas, paper, 5-HMF and ethanol as platform chemicals
France	4,000	*M. x giganteus*	Heating, fuel for feed drying and pelleting (corn, grass, alfalfa etc.), animal bedding, building material (lightweight concrete)
Switzerland	500	*M. x giganteus*	Building materials
Poland	500	*M. x giganteus*	Building materials, bio-composites
Denmark	50	*M. sinensis*	Thatching
Austria	1000	*M. x giganteus*	Combustion (mainly heat), horse bedding, mulching
China	100,000	*M. lutarioriparius*	Paper making, building materials, pickles
US	3,200	*M. x giganteus*	Heat and power generation, animal bedding, fibre additive for animal feed

Adapted from Lewandowski et al. (2028) in Alexopoulou (Ed) Perennial Grasses for Bioenergy and Bioproducts; Elsevier

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Main relevant environmental impacts related to the cultivation of miscanthus?

Low-input perennial biomass crop combining production of biomass with diverse ecosystem services, also on marginal land (tolerance to drought, salinity, heavy metal contamination):

- 12 – 15 t DM $ha^{-1}y^{-1}$ harvestable yield achievable on **marginal land** (Germany).
- Overall Yield range of 8 - 38 t DM $ha^{-1}y^{-1}$ depending on site conditions
- **Environmental services** of 1008-2008 € $ha^{-1}y^{-1}$

Increasing productivity of agricultural soils:

- Increase of **soil organic content** by 0.7 – 2.2 t C $ha^{-1}y^{-1}$
- Miscanthus **reduces soil erosion** to 0.2–1.0 t $ha^{-1}y^{-1}$; strong effect in slope areas
- Tolerance to and **remediation** of **heavy metals**: *Miscanthus* × *giganteus* can absorb 55 g Cd, 85 g Pb, and 720 g Zn $ha^{-1}y^{-1}$
- Miscanthus **mitigates leaching of nitrate** to groundwater because it is deep rooting
- **N_2O emissions** from unfertilized miscanthus can be five times **lower** than from annual crops and up to 100 times lower than from intensive pasture
- enhanced **soil biodiversity**

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Main relevant environmental impacts related to the cultivation of miscanthus?

Miscanthus is a **C4 crop** with **high water and nutrient use efficiencies**:

- At the plant level, miscanthus **recycles about 40% N and 36% P and 45% K** during senescence from the above-ground stems (=harvested biomass) to the below-ground rhizomes (=overwintering organ) and leaf fall
- At farm level, miscanthus biomass can be used for applications such as animal bedding and biogas substrate, where the plant nutrients are accumulated to be provided to the fields as compost or digestates.
- Miscanthus mitigates leaching of nitrate to groundwater because it is deep rooting
- Nitrogen use efficiency: 0.35 t dry biomass per kg of applied nitrogen.
- Water use efficiency (e.g. 5.5–9.2 g aerial DM (kg H2O)$^{-1}$, 78–92 kg DM ha^{-1} (mm H_2O)

Improvement of Biodiversity:

- Miscanthus can serve as habitat for **semi-woodland bird species**, which are commonly no longer present in intensive agricultural areas
- When harvested brown, miscanthus remains standing in the field over winter providing **shelter and habitat** functions during this time period
- Higher **insect abundance** than in annual crops

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Main relevant environmental impacts related to the cultivation of miscanthus?

Good integration of miscanthus into farming systems:

- Make use of marginal land areas
- Eligible for production on greening areas and factored in with 0.7
- Can be grown in water protection areas
- Shelter strips for erosion control

- Closing nutrient cycles: miscanthus biomass can be used for applications such as animal bedding and biogas substrate, where the plant nutrients are accumulated to be provided to the fields as compost or digestates.

- Improved animal health when applied as bedding material

- Provides opportunities for on-farm value generation through processing of biomass, e.g. as animal bedding or building material

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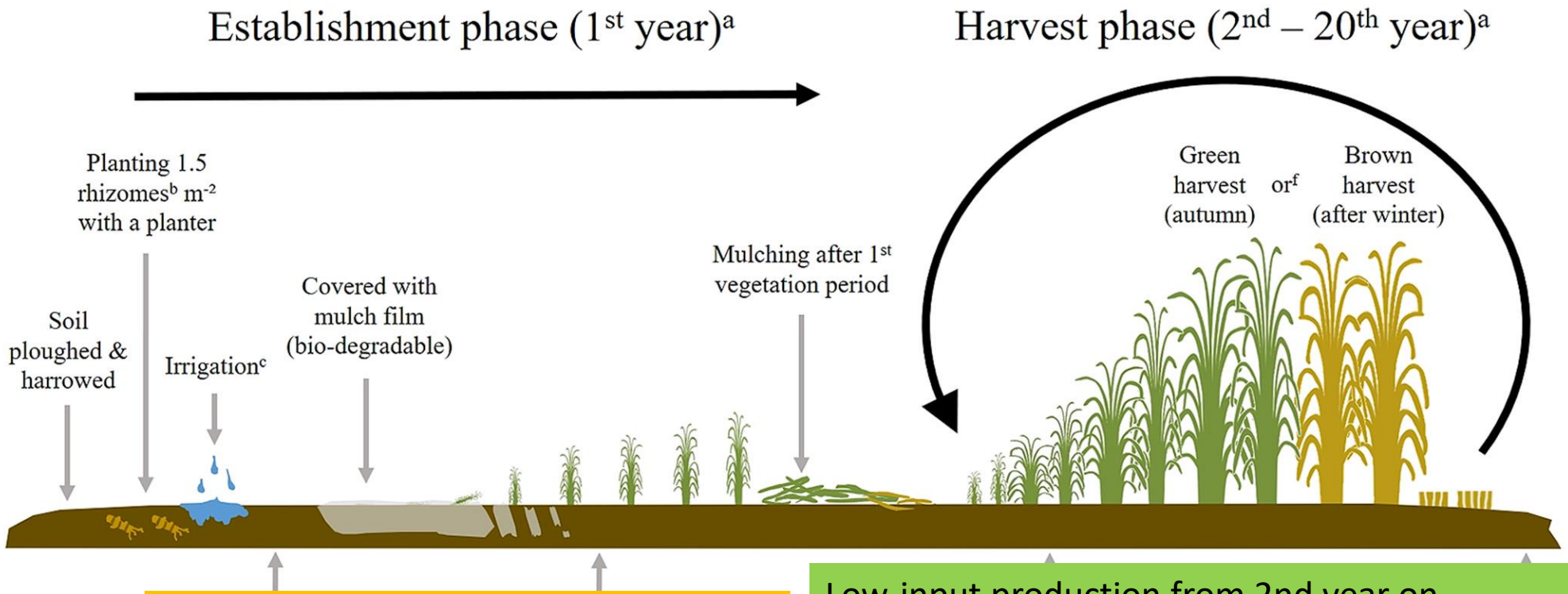
What are the main 'best available practices/technologies' to grow miscanthus minimizing the impacts and maximizing the benefits for the environment?



Establishment is most critical phase:
- Need to avoid erosion
- Demand for weed control

Low-input production from 2nd year on
- Little machine traffic improves soil quality and biodiversity
- Very Low N fertilizer demand with brown harvest

Winkler et al (2020) Renewable and Sustainable Energy Reviews 132 (2020) 110053; https://doi.org/10.1016/j.rser.2020.110053