



Switchgrass and Miscanthus as Energy Crops – Agricultural aspects

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ENERGY CROPS &
BIOGAS

PATHWAYS TO
SUCCESS? September
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Bioenergy at WAGENINGEN UR



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Attribute?	Miscanthus	Switchgrass
Latin Name	Miscanthus spp.	Panicum virgatum L.
Native Range	South East Asia, Japan	North America
Yields tons DM per year	12 to 35 tons DM	10 to 30 tons DM
Photosynthesis system	C4	C4
Height	Up to 4 m	Up to 2,5 m
Rotation time	15 years	15 years
Propagation method	Rhizomes	Seed
Adaptation	Moderate winters, sufficient/low moisture	Moderate winters, sufficient/low moisture
Adaptation range in Europe	Cool and warm region of Europe	Cool and warm region of Europe
Harvest time	Fall to early spring	Fall to early spring
Energy output/input	15 to 20	
Break even	50 years	6 years
Fertiliser input	In northern EU 0 to 50 kg N. In south 50 to 100 kg N	In northern EU 0 to 50 kg N. In south 50 to 100 kg N
Water use	Low	Low
Erosion control	Rel. Good	Very good





Switchgrass and Miscanthus:

Traditionally used for:

- Fodder
- Erosion control
- Ornamental

Recently developed for:

- Heat and Power
- Ethanol
- Fibre/pulp

- Delayed harvest system is used!!



Estimated dry (spring!) yields in Europe

Crop	Environmental zone	Highest experimental yields = 100%	Low yielding soils = 45%	Average soils = 55%	Good soils = 70%
Switchgrass	Atlantic Central	14.8	6.7	8.1	10.4
	Atlantic North	11.3	5.1	6.2	7.9
	Mediterranean North	23.0	10.4	12.7	16.1
<i>Miscanthus giganteus</i>	Atlantic Central	17.2	7.7	9.5	12.0
	Atlantic North	16.0	7.2	8.8	11.2
	Continental	22.8	10.3	12.5	16.0
	Mediterranean North	30.0	13.5	16.5	21.0

Expect a steep leaning curve (2% = 37% yield increase 2004- 2020)



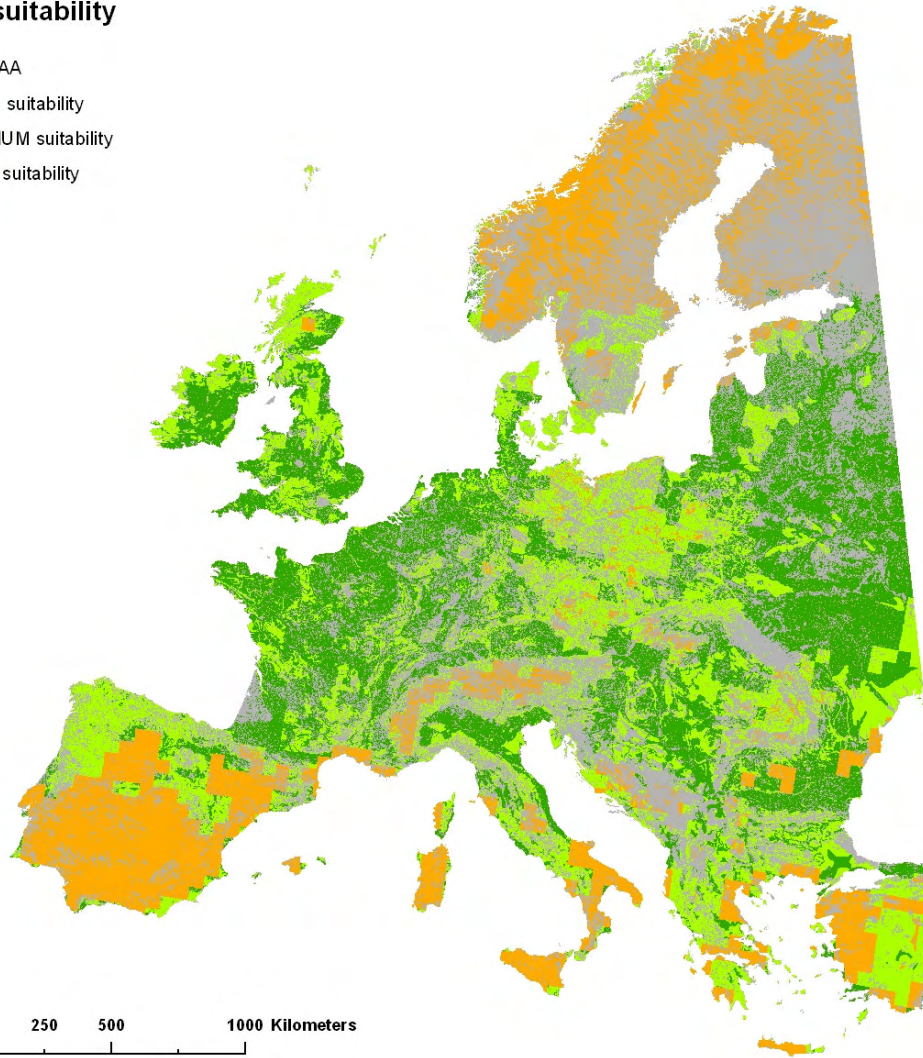
Delayed harvest system:





C3/C4 suitability

- No UAA
- HIGH suitability
- MEDIUM suitability
- LOW suitability



Combined climate and soil suitability for perennial biomass grasses



Comparison *Miscanthus* and switchgrass

Attribute	<i>Miscanthus giganteus</i>	Switchgrass
Establishment cost	3000 €	300€
Establishment risk	Higher	Lower
Yield	Higher	Lower
Return on investment time	Longer	Shorter
Quality	Lower ash melting point?	Higher ash melting point?
Fertilization response	Low	Low

Does higher *Miscanthus* yields compensate for higher investment cost?

Maybe under good conditions, else use switchgrass



Delayed harvest system advantages

- Dry biomass
- Lower transport cost
- No drying
- Easy storability
- Low ash
- Low free sugars
- High fibre/lignocellulose
- Low nutrient off take
- Translocation of nutrients to below ground
- Good regrowth in spring
- Good stand management

Harvest time	N	P	K
Fall	0,46	0,12	0,95
Winter/Spring	0,33	0,04	0,06

	Yield on 1 November 1994 (ton/ha)		
Harvest date	Location 1	Location 2	Location 3
1 September 1993	7.6	8.4	8.0
1 October 1993	7.4	8.4	7.9
1 November 1993	8.8	9.4	9.1



Delayed harvest system disadvantages

- Yield losses due to winter losses
- Low biomass digestibility
- Market for dry biomass not there yet
- There is a market for “biogas biomass”!

Harvest date	Yield (ton/ha)	
	93/94	94/95
1 September	13.6	
1 November	11.1	8.6
13 January	10.2	8.3
1 April	10.0	7.8

- Switchgrass and Miscanthus delayed harvest system produces very low quality biomass for biogas production.
- Can we develop a management system for perennial biomass grasses that deliver high quality high yield biomass for anaerobic digestion?



Try:

- 1 early harvest (more will probably lower stand maintenance)
 - 1 August
 - 15 August
 - 1 September
 - 15 September
- Allow time for re-growth and senescing
- Will need higher fertilization rates
- Silage storage system?



Further information:

- www.switchgrass.nl
- www.biomassandbioenergy.nl