



**BIOLYFE - Second generation BIOethanol process:
demonstration scale for the step of Lignocellulosic hYdrolysis and FERmentation**

Workshop on sustainable feedstock sourcing - 7 June 2011, ICC Berlin, Germany

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**Arundo donax:
a promising energy crop**

Fabrizio Rossi
Fabio Sissot

Agriconsulting S.p.A.
(Italy)



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BIOLYFE WP1 TARGETS

DEFINE



the most appropriate high-yield and sustainable crops for 2nd gen. biofuel production

DEMONSTRATE



eco-compatible bioethanol production and social-economic development

SET UP



all the necessary actions to produce the sufficient amount
of feedstock for the industrial demonstration plant









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Arundo donax (Graminaceae) is one of the crops able to fit these targets.

In this presentation the development of Arundo production chain in the frame of the Biolyfe project is briefly described:

-  Rhizomes production
-  Arundo cultivation for biomass production
-  Harvesting and logistic
-  Advantages for farmers
-  Traceability and sustainability
-  Demonstration activities



Data comes from the on-going work in the frame of the WP1 Biolyfe project.
Thus, at the moment not all the info are available or conclusive.

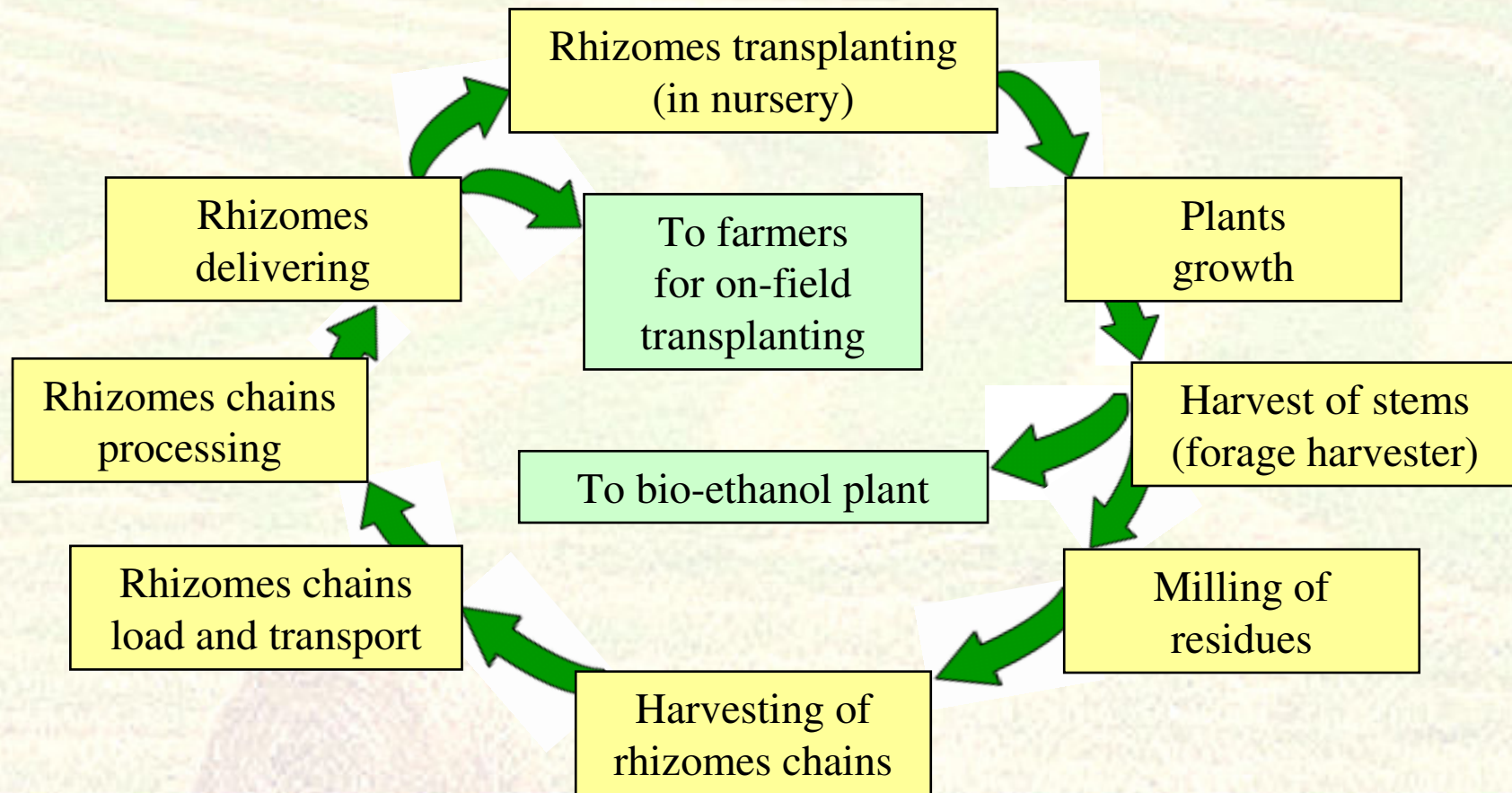


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RHIZOMES PRODUCTION

Arundo donax is reproduced by rhizomes, bred in specific nurseries.
The first nursery is located in Savigliano (CN), Franco Alasia Vivai.





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RHIZOMES PRODUCTION

Rhizomes transplanting (in nursery, from February to May)

- ✂ Soil preparation (ploughing, harrowing, weeding)
- ✂ Distance: 1,1 m x 0,3 m (30.300 rhizomes/ha)
- ✂ Depth: 5 cm
- ✂ Measured operative capacity: 0,12 ha/h (1 ha/d; speed 0,5 km/h)
- ✂ 3 men and 1 tractor driver (3 rows, working width 3,3 m)





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RHIZOMES PRODUCTION

Plant growth

- ✓ Time for germination: 1-2 weeks
- ✓ Irrigation: necessary only for latest transplantings
- ✓ Fertilization: not necessary
- ✓ Time of growth till harvesting: 1 year (after 1 year the field is available for other crops)



Stem harvesting (March)

- ✓ Forage harvester: operative capacity 2,0-2,5 ha/h
- ✓ Material (2,0-2,5 t dm/ha) is sent to the bio-ethanol plant





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RHIZOMES PRODUCTION

Milling of residues

- ✂ The 20 cm stem residues are milled with a mulcher



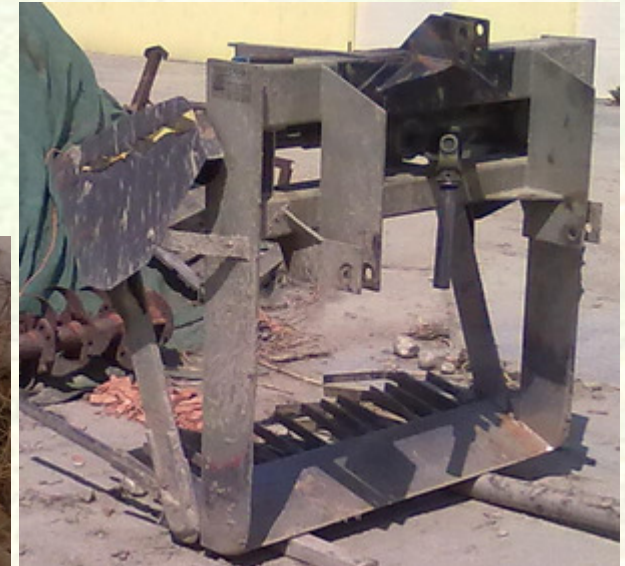
Harvesting of rhizomes chains (March)

- ✂ Specific equipment: a blade pulls rhizomes chains (around 50 cm in length) out of the soil and rear vibrating arms scroll away part of the soil particles

- ✂ 2 men and 1 tractor driver

- ✂ Rhizomes chains are manually load on a front loader and loaded on an agricultural trailer

- ✂ Around 940 rhizomes chains are harvested per hour





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RHIZOMES PRODUCTION

Processing of rhizomes chains

- ✓ Washing (not necessary for sandy soil nurseries)
- ✓ Cutting (6 rotary blades; around 10 rhizomes per chain)
- ✓ Quality and size control
- ✓ Big-bag loading (around 1.500 rhizomes per bag)
- ✓ 2.000 rhizomes per hour ready for delivering and transplanting: to improve the available material more mechanization is needed and more installations have to be in operation. New machinery will improve these capacities of production

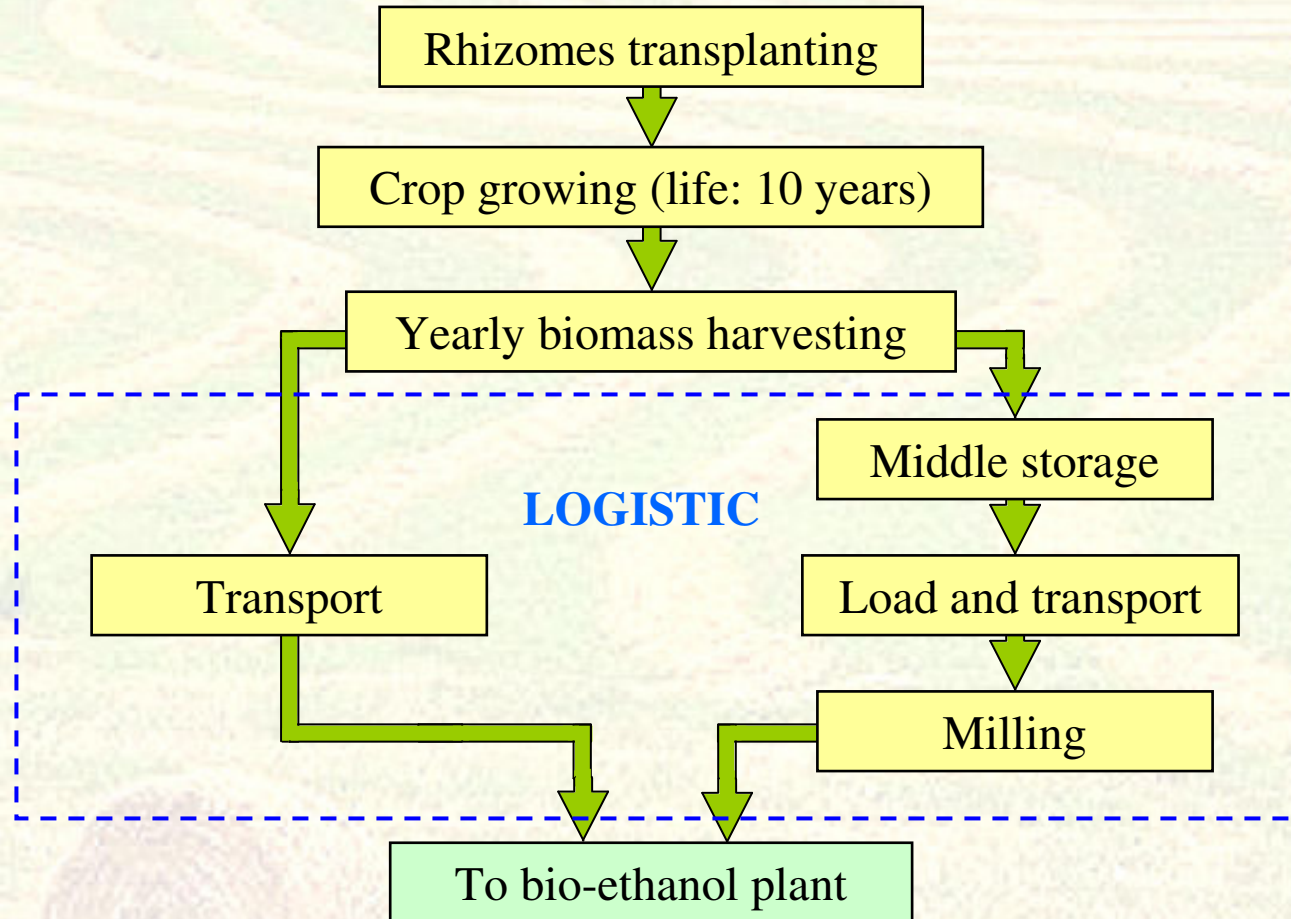




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CULTIVATION FOR BIOMASS PRODUCTION





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CULTIVATION FOR BIOMASS PRODUCTION

Rhizomes transplanting

- ✂ Soil preparation (ploughing, harrowing, weeding)
- ✂ Distance: 1,0 m x 0,7 m or 1,0 m x 1,0 m (14.285 or 10.000 rhizomes/ha)
- ✂ Depth: around 20 cm
- ✂ Measured operative capacity (on 1,0 m x 0,7 m): 0,4-0,6 ha/h (3-5 ha/d; working speed 2,6 km/h)
- ✂ 4 men and 1 tractor driver (4 rows, working width 4 m)





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CULTIVATION FOR BIOMASS PRODUCTION

Rhizomes transplanting

Performances were better (0,4-0.6 ha/h) that in the nursery (0,12 ha/h) because of:

- ✂ The larger vessel for rhizomes loading
- ✂ The larger working width and the larger size of fields

Anyway:

- ✂ Lost time for vessel flooding: 0,25 h/ha
- ✂ Vessel loading time: around 1,0 h/ha
- ✂ Rhizome cleaning and vessel loading systems need to be improved









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CULTIVATION FOR BIOMASS PRODUCTION

Crop growing

-  Nutrient uptakes (to not to be confused with the amount of fertilizer): 10 kg N/t dm, few kg of P₂O₅/t dm, 13 kg K₂O/t dm
-  Fertilization: 1st-2nd year. From the 3rd year died rhizomes mineralization could be sufficient
-  Water availability: crucial in the first months after rhizomes transplanting
-  Weeds control: only in the first year.
 - Immediately after transplanting: chemical weeder to avoid weeds seeds germination
 - During the 1st year: mechanical weeding
 - After the 2nd year: it performs strong competition








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CULTIVATION FOR BIOMASS PRODUCTION

Promising yield in biomass:

-  1st year: less than 3-5 t dm/ha
-  After the 2nd year: due to the natural tillering of the crop, the yield gradually increases with the age of plants up to 20-30 t dm/ha. Depending upon soil quality, local climatic conditions and inputs level, in some cases 35-40 t dm/ha could be reached
-  Life cycle: more than 10 years









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HARVESTING AND LOGISTIC

-  Mainly directly harvested with forage harvester (measured operative capacity 2,0-2,5 ha/h)
-  Milled material is converted into bio-ethanol in a few days (silage is not suggested due to the low pH level of the material, not suitable for bio-ethanol production)
-  Drying and baling for short-medium term storage has to be checked
-  Middle storage logistic has to be developed





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ADVANTAGES FOR FARMERS

Land suitable for diversification



Marginal land: for technical reasons and for the yield the gross margin is too low



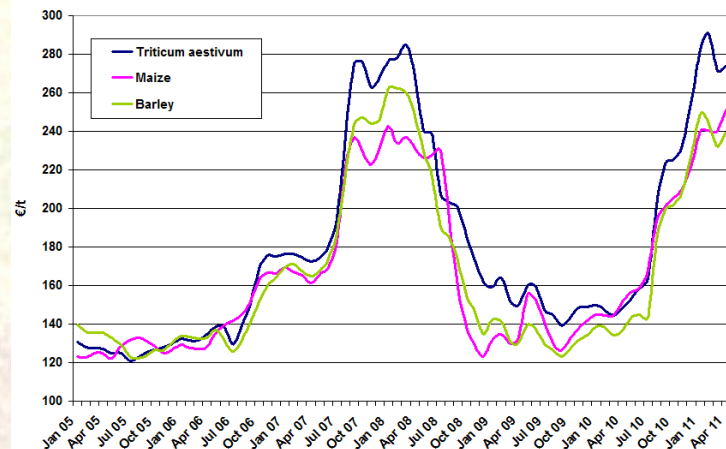
Low input dedicated energy crops are an alternative



Winter cereals and maize: gross margin is not always profitable (high production costs, absence of EU' subsidies, unforeseeable price variations of commodities)



Dedicated energy crops give a secure income for many years







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TRACEABILITY AND SUSTAINABILITY

 The supply contract between farmers and the bio-ethanol plant reports also the technical rules for the cultivation and the duties of the parts:

- operations to be done and quantity of inputs
- operators in charge for each operation
- the price of biomass (per unit of delivered dry matter)

 Land register data have to be reported as well. This is the start point for the traceability of biomass.

Farm _____





Municipality	Owned/rent	Land register data		Surface in land register		Cultivated surface	
		Quadrant	Cadastral map	ha	are	ha	are



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TRACEABILITY AND SUSTAINABILITY

-  Traceability is propaedeutic to sustainability.
-  In Italy (at the moment) no standard methods for traceability of biomass to be converted into biofuels exist (as for bioliquids, in e.g. RVO for power production - Guidelines of the Ministry of Agriculture of March 2010), but these principles are set and can be adopted for the biomass used in 2nd generation bio-ethanol production. An example is the voluntary system developed for the Italian biodiesel.
-  Italy adopted the methodology about bioliquids and biofuels sustainability reported in the Directive 2009/30/CE (Decree of 3rd March 2011).
-  The work for Arundo is on-going. During Biolyfe project energy consumption in Arundo cycle and cultivation is measured, in order to give useful data for the effective reduction of GHG emissions calculation.




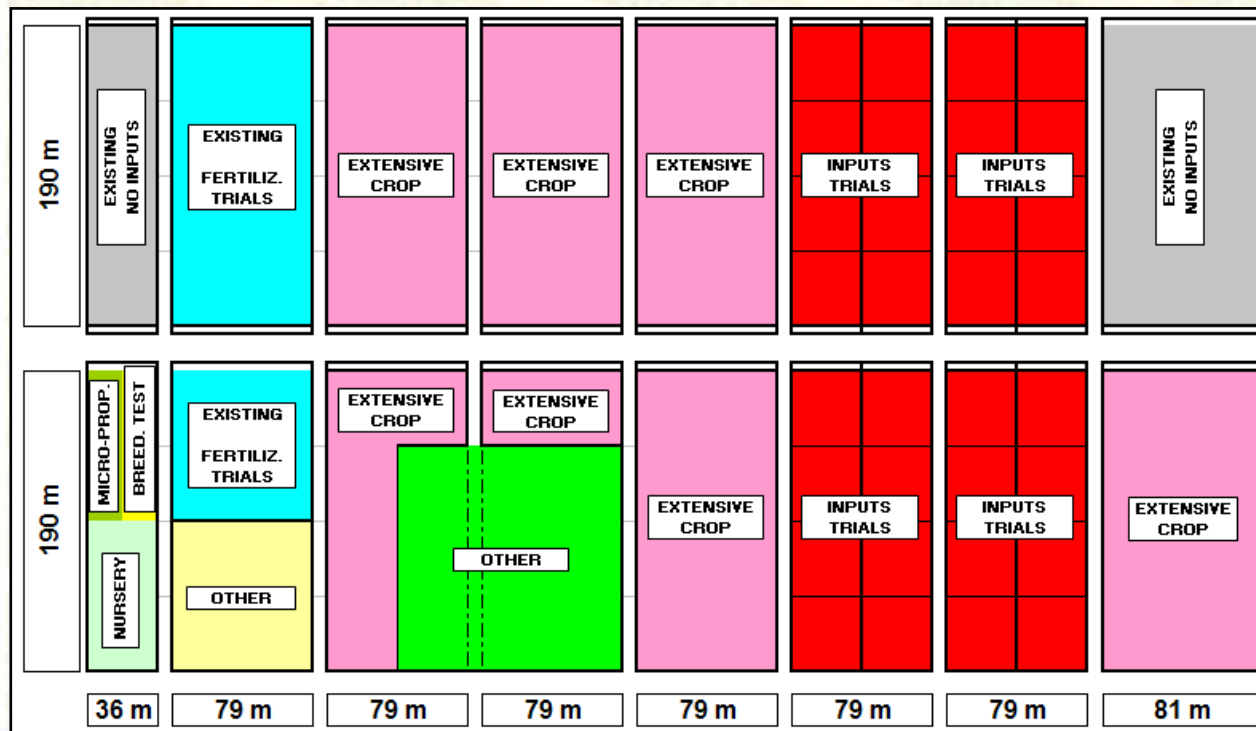
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DEMONSTRATION ACTIVITY

At the Cassana farm (Rivalta Scrivia, AL), under Chemtex management:

 Around 22,5 ha are/will be dedicated to Arundo for the demo activities on this crop such as: rhizomes production/planting/logistic, optimization of the mechanization of biomass harvesting, storage solutions, inputs (water and nutrients), etc.



6 ha are dedicated to input trials:

- 32 testing areas of 1.876 m²
- weeding (Pendimetalin)
- no irrigation / irrigation
- no fertilization / fertilization

Agriconsulting and Chemtex started the monitoring.



CONCLUSIONS

Arundo donax is a promising crop:

- good yield in biomass (20-30 t dm/ha after the 3rd year)
- low inputs needs (water, nutrients and chemicals)
- agamic reproduction through rhizomes (any influence of the specific cultivar on genetic recombination of other spontaneous Arundo genotypes in the area)
- a good choice for the diversification of agriculture production (secure margin for farmers)
- a good solution for the bio-ethanol plant supply (life cycle over 10 years)
- easy to be traced





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Thank you for your attention!

Fabrizio Rossi

Fabio Sissot

AGRICONSULTING S.p.A.

Via Vitorchiano, 123

00189, Rome, Italy

www.agriconsulting.it

f.rossi@agriconsulting.it

f.sissot@agriconsulting.it