2nd BioLyfe Conference

4th June 2011

21st European Biomass Conference and Exhibition, Copenhagen - Denmark

Biolyfe 2nd generation bioethanol plant: Feedstock harvesting and supply

Fabio Sissot

Agriconsulting S.p.A.
(Italy)

Feedstock: dedicated crops

Dedicated crops (annual or perennial):

- Fiber sorghum (*S. bicolor*) - 10-26 tdm/ha
- Miscanthus (*M. spp*) - 10-38 tdm/ha
- Giant reed (*A. donax*) - 20-30 tdm/ha
- Switchgrass (*P. virgatum*) - 10-25 tdm/ha
- Cardoon (*C. cardunculus*) - 10-20 tdm/ha
- Poplar (*P. spp*) - 7-18 t dm/ha
- Willow (*S. spp*) - 3-12 tdm/ha

diversify agriculture productions
(alternative business strategy to farms)

- economical figures of traditional food crops
- a field becomes “marginal land”
- land already used for non-food productions

Yields in dry matter vary with:

- Species
- Local climate and soil
- Annual weather of the site

Feedstock: agricultural residues

Agricultural residues (annual):

- Wheat/barley straw - 2-4 tdm/ha
- Rice straw - 3-6 tdm/ha
- Oat straw - 2-3 tdm/ha
- Corn stalks - 3-5 tdm/ha
- Fruit trees prunings - 2-3 tdm/ha

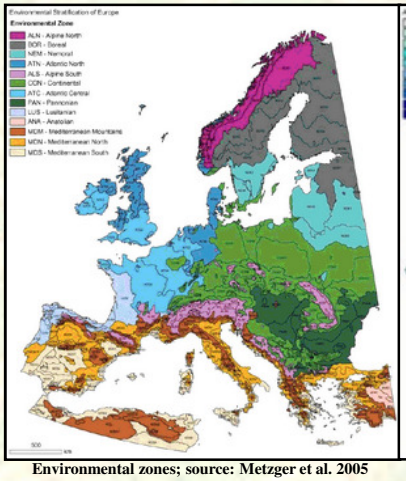
By-products

- no land competition
- easy storage
- other uses (animal feeding, litter)

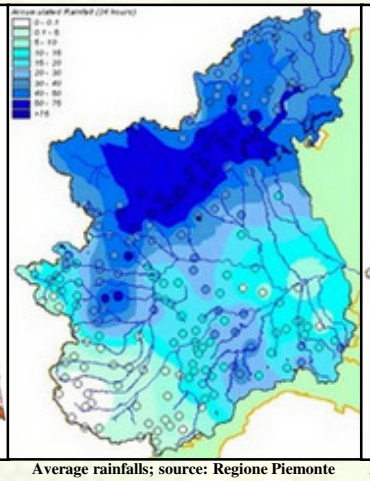
Feedstock: the choice for the BioLyfe demo plant [1/4]

Main issues:

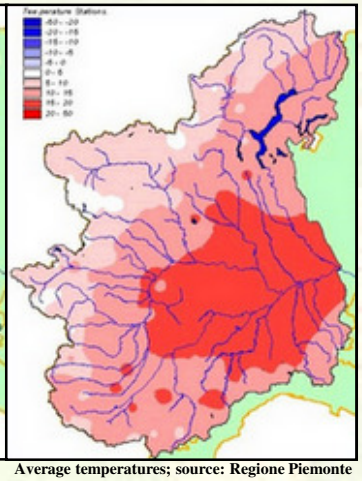
- **Local pedoclimatic environment**
- Local agricultural contest
- Chemical composition of feedstock



Environmental zones; source: Metzger et al. 2005

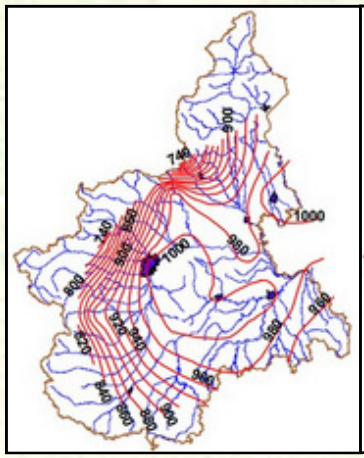


Average rainfalls; source: Regione Piemonte

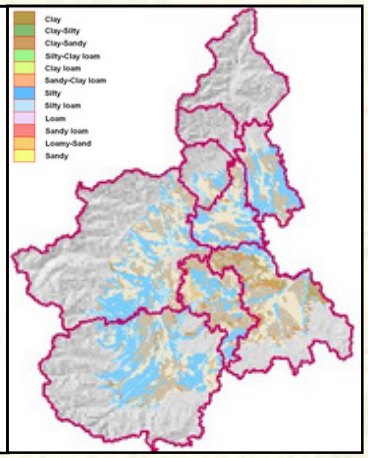


Average temperatures; source: Regione Piemonte

- Each crop has its own proper cultivation area
- Rainfalls and temperatures (trend during the year)
- Evapotranspiration and water request
- Soil characteristics



Evapotranspiration; source: Regione Piemonte

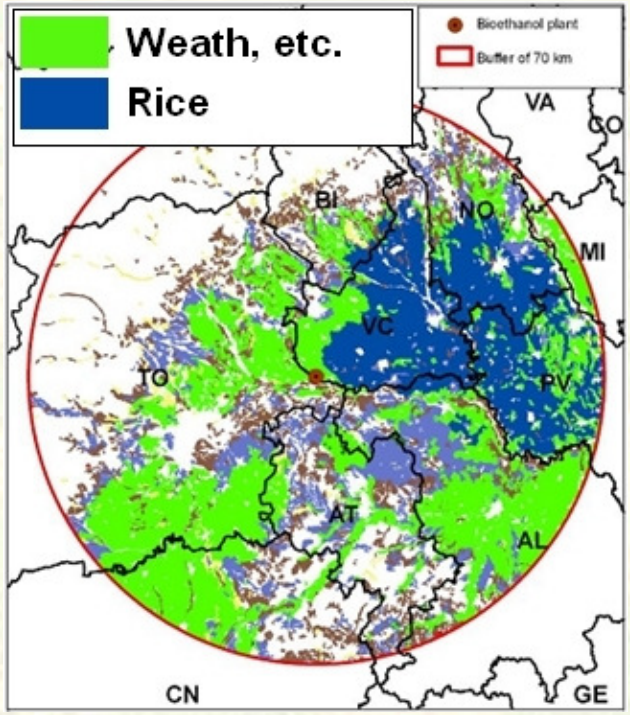


Soil texture; source: Regione Piemonte

Feedstock: the choice for the BioLyfe demo plant [2/4]

Main issues:

- Local pedoclimatic environment
- **Local agricultural contest**
- Chemical composition of feedstock

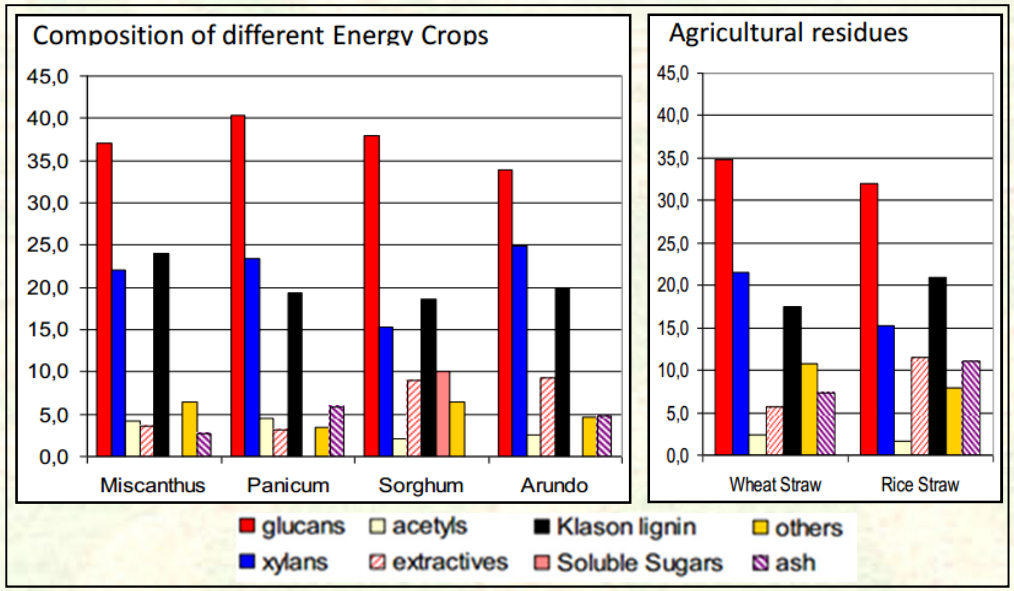


- Main crops → residues?
- Economic figures of traditional crops
- Production cost of food crops → marginal land?
- Surface of fields and farm sizes → existing of large contractors and potential aggregated biomass offer?
- Agricultural equipment fleet on the territory
- Nitrogen supply → Maps of groundwater vulnerability to nitrate contamination

Feedstock: the choice for the BioLyfe demo plant [3/4]

Main issues:

- Local pedoclimatic environment
- Local agricultural contest
- **Chemical composition of feedstock**



- Each feedstock has it own composition and yield in bioethanol using the BioLyfe process
- At the Biolyfe facility lignine is used for power generation, thus it is a source of biopower and not a process waste to be disposed

Feedstocks: the choice for the BioLyfe demo plant [4/4]

On the basis of such considerations, the biomass sources for the BioLyfe bioethanol plant are:

- Giant reed (*Arundo donax*)
- Fiber sorghum (*Sorghum bicolor*) as a second choice
- Cereal straw (maize excluded)



- Each feedstock has it own operational aspects
- Cultivation, harvesting, storage and transport are affected by biomass source characteristics

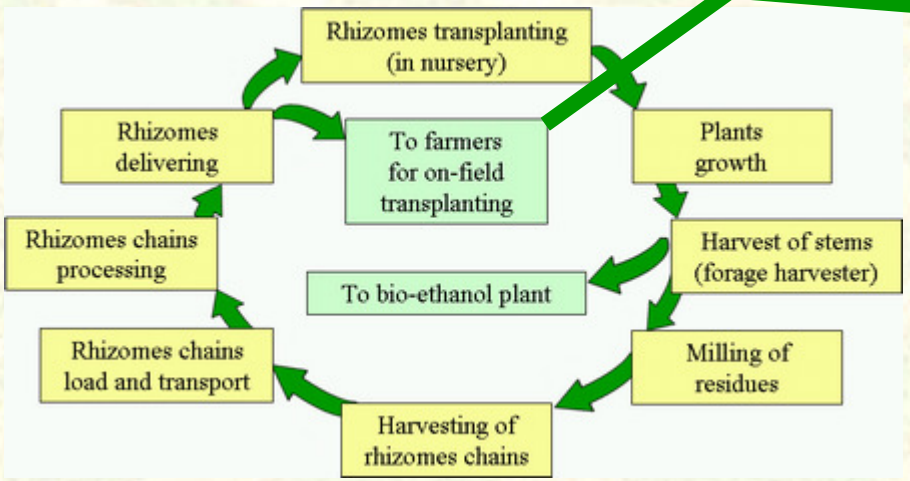
Giant reed (*Arundo donax*) - [1/4]

Type		herbaceous
		perennial
Life	(y)	10-15
Sowing/planting	(month)	Feb-Mar
Harvesting	(month)	September-June
Maturity	(y)	3rd
Yield at maturity	(t dm /ha * y)	20-30
Moisture	(% at harvesting)	45-55
Mechanization	(state of art)	Existing
Notes		It is the most promising crop since it is a perennial one, with the lowest cost of production. It can be harvested all the year long (depending on weather conditions) mainly with forage harvesters : simplified logistics and storages.

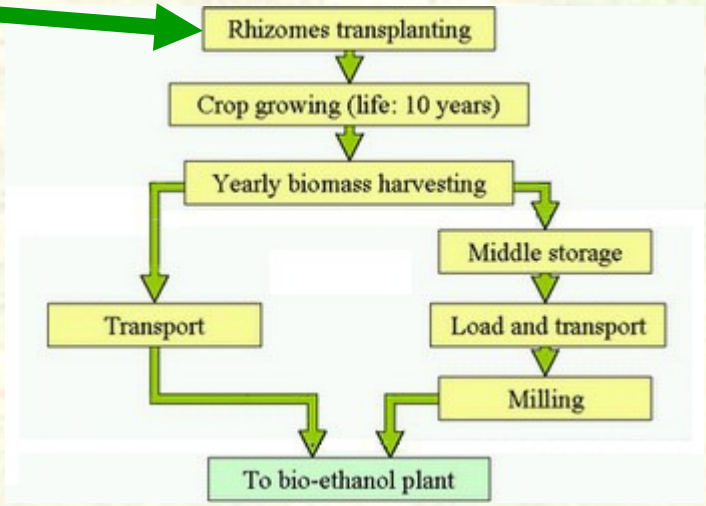
Giant reed (*Arundo donax*) - [2/4]

Two main aspects:

Rhizomes production



Biomass production



Giant reed (*Arundo donax*) - [3/4]

Operations for biomass production:

- **Soil preparation** (ploughing, harrowing, weeding)
- **Distance of transplanting** 1,0 m x 0,7 m or 1,0 m x 1,0 m, **depth of transplanting** 20 cm
- Measured **operative capacity of transplanting** (on 1,0 m x 0,7 m): 0,4-0,6 ha/h
- **Personnel**: 4 men and 1 tractor driver (4 rows, working width 4 m)
- **Nutrient uptakes**: 10 kg N/t dm, few kg of P_2O_5/t dm, 13 kg K_2O/t dm
- **Fertilization**: 1st-2nd year. From the 3rd year died rhizomes mineralization could give a good nutrients supply
- **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

Giant reed (*Arundo donax*) - [4/4]

Yield in dry matter:

- In the Mediterranean environmental zones the medium yield measured at the 3rd year ranges between 10 and 35 t dm/ha, depending on the region and water availability.
- During the second year of cultivation the yield in dry matter is generally 8-10% of these values.
- Generally yields rise up in a logarithmic way starting from the 2nd-3rd year of cultivation. After the 8th year a considerable yield decrement was observed.
- Harvesting: all the year (except Summer) with a forage harvester (working capacity 1,5-2 ha/h)

Fiber sorghum (*Sorghum bicolor*) - [1/5]

Type		herbaceous
		annual
Life	(y)	1
Sowing/planting	(month)	Apr-May
Harvesting	(month)	Aug
Maturity	(y)	-
Yield at maturity	(t dm /ha * y)	15-30
Moisture	(% at harvesting)	70-80
Mechanization	(state of art)	Existing
Notes		All the production is concentrated in a short period of the year. High level of biomass production only with high inputs (mainly water supply at the right moment). Harvesting and logistic optimization have to be improved. It has to be considered as a secondary resort.

Fiber sorghum (*Sorghum bicolor*) - [2/5]

Cultivated as **main crop** (sown in April):

- **Soil preparation**: ploughing, harrowing, weeding

0,6-0,9 ha/h
40-70 l/ha

0,8-1,5 ha/h
35-55 l/ha

2,0-4,0 ha/h
3-5 l/ha

- **Fertilization**: depends on the soil. E.g. 225 kg/ha of slow release nitrogen fertilizer (high cost of urea) with a broadcaster distributor

10-13 ha/h
2-3 l/ha

- **Seeding**: precision pneumatic seeder; depth around 3 cm; distance between rows 70 cm, between plants 7 cm

2,0-2,5 ha/h
5-7 l/ha

Fiber sorghum (*Sorghum bicolor*) - [3/5]

Cultivated as **main crop** (sown in April):

- **Weeding**: before sowing or in pre-emergence phase with a non-selective broad-spectrum systemic herbicide.
  To control dicotyledons a second spreading with a selective product or a mechanical weeding can be done.

8-12 ha/h
2-3 l/ha

- **Fertilization**: before seeding with a ternary fertilizer (broadcaster distributor)

- **Irrigation**: **generally** in northern Italy rainfalls and soil water reserve allows the growth without irrigation.

Fiber sorghum (*Sorghum* bicolor) - [4/5]

Cultivated as **intermediate crop** (sown in June-July after winter cereals or rape):

2,0-5,0 ha/h
28-36 l/ha

- **Seeding**: minimum tillage with combined equipment; depth around 3 cm; distance between rows 24 cm, between plants around 5 cm
- **Weeding**: Done in the pre-emergence phase non-selective broad-spectrum systemic herbicide (e. g. Glyphosate 31%, plus ammoniacal sulphate as fertilizer), 2 l/ha in 3 l/ha of H_2O
- **Irrigation**: **generally** in northern Italy rainfalls and soil water reserve allows the growth without irrigation.

Fiber sorghum (Sorghum bicolor) - [5/5]

Harvesting (fall August-September):

- Immediate conversion: forage harvester (a Kemper type head, as rows distance independent, is suggested). It is served by dumpers.

1,5-2,0 ha/h
45-50 l/ha

1,5-2,0 ha/h
8-10 l/ha on field plus 15 l/h
(distance and 30 km/h speed)

- Storage needs drying (< 30-20% in moisture content) : mower-conditioner, wind-rake and round-baler or large square baler. Bales are loaded on an trailer.


Mowing-conditioning

3,0-4,0 ha/h
18-20 l/ha


Windrowing

2,0-3,0 ha/h
8-12 l/ha


Baling

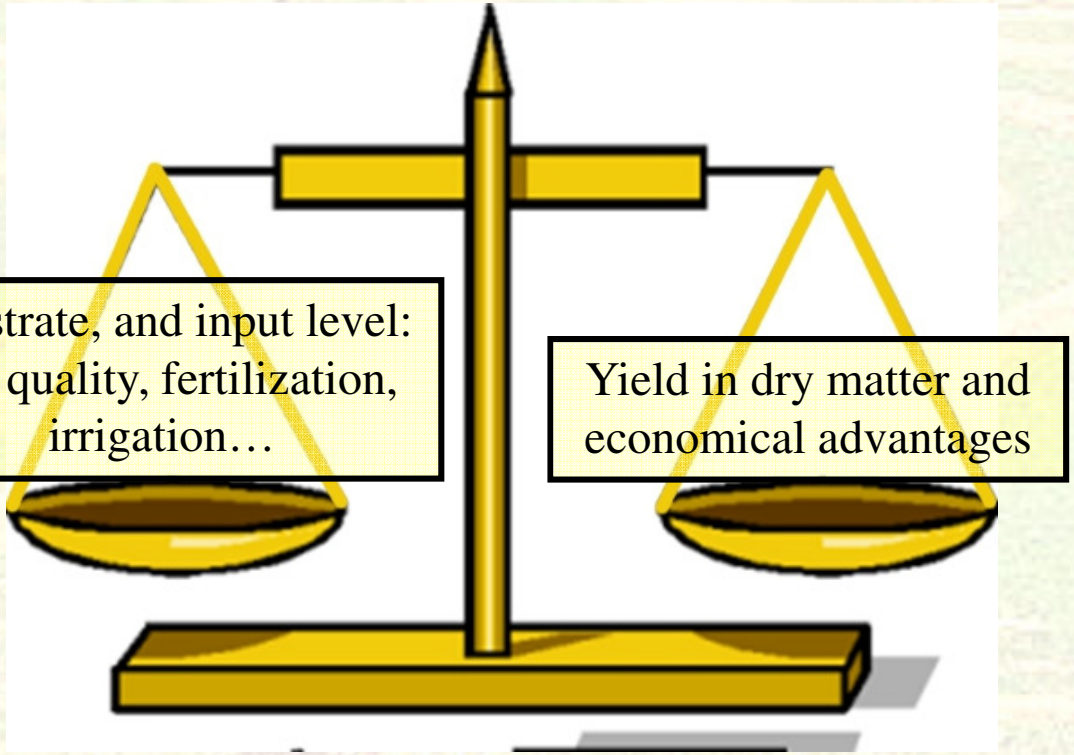
4,0-5,5 ha/h
15-20 l/ha


Loading

22 bales/h
0,2-0,5 l/t dm

Dedicated crops: general aspects for the choice

On the basis of the experiences of the Biolyfe activities: balance between input and yield.



Failure of a dedicated crop

Dedicated energy crops should not be considered as "marginal" and/or "wild"crops

Cereal straw - [1/2]

The most wide source of agricultural residues. Main advantage:

no additional land is needed → no competition for land

- Maize (*Zea mais*) - not considered for the BioLyfe plant
  - little market
  - heavy ridged in the area: high content in soil particles
- Wheat (*Triticum spp*) barley (*Hordeum vulgare*) oat (*Avena sativa*)
  - yield 2-4 t/ha (MC<15%)
  - harvesting: June-July
  - existing large market (animal feeding and litter)
  - availability for other uses affected also by wet weather
  - impact on the local market has to be taken into account
- Rice (*Oryza sativa*)
  - yield 3-6 t/ha (MC<15%)
  - harvesting: September-October
  - not widely used for animal litter
  - no impact on the straw market is expected

Cereal straw - [2/2]: harvesting (baling)

- Round_bales (generally 90-180 cm in diameter and 100-120 cm wide).


Windrowing


Baling


Loading

- Large square bales (tipical size is 50-100 cm x 80-120 cm, with an adjustable length of 70-240 cm or more). Best solution for handling and logistic (storage and transport).


Windrowing


Baling


Loading

Logistic: principles - [1/3]

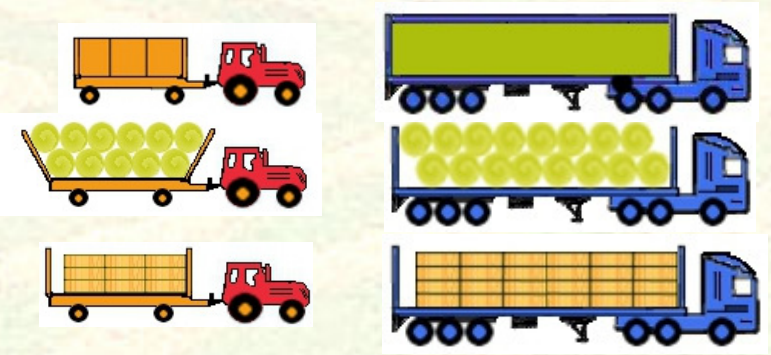
- the conversion plant cannot be stopped for a biomass lack
- take into account the seasonality of harvesting of the dedicated crop and residues

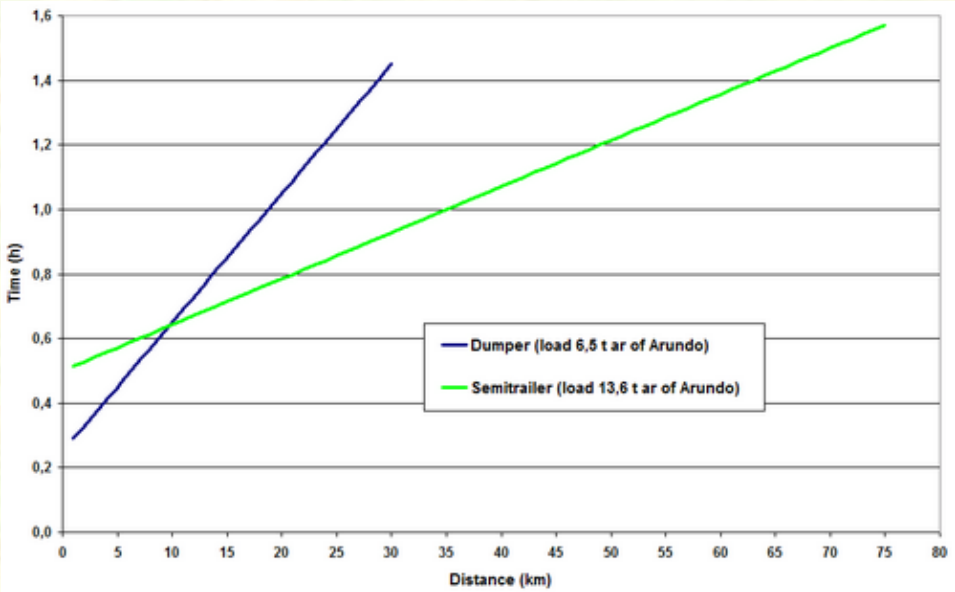
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Arundo												
Sorghum												
Straw												

- ensure the delivering of the biomass according to the requested specifics → plan storage methods allowing a good quality of biomass and limited losses of dry matter

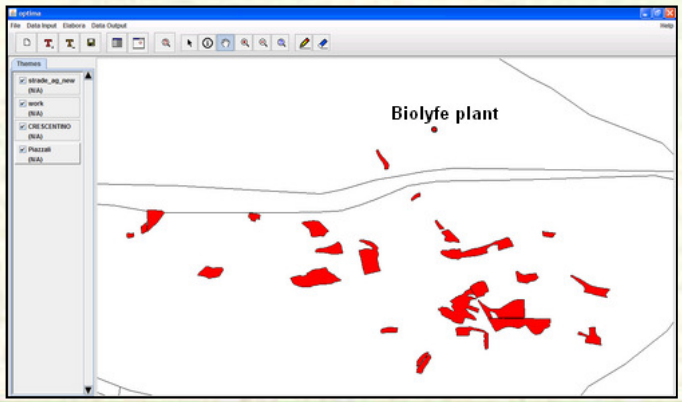
Logistic: principles - [2/3]

- plan transport vehicle according to the distance between the field and the final user, as well as the form in which biomass is harvested





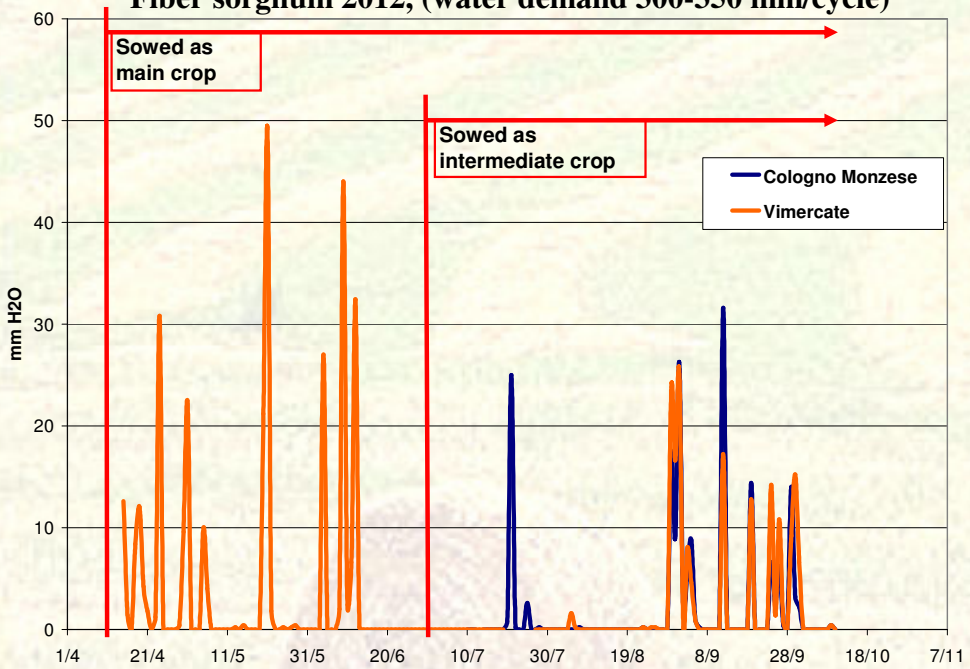
- according to the above mentioned issues, apply for intermediate storage yiards



Logistic: principles - [3/3]

- take into account the risk of a bad season with low yield or impassability of fields → diversify the sources of biomass: think that "this" year could not be a "common year"

Fiber sorghum 2012, (water demand 300-350 mm/cycle)



Fiber sorghum 2012, (yield 1 t dm/ha !?!)

Certification

The ouputs of the Biolyfe facility are:

Bioethanol, used as biofuel in transport. The Biolyfe plant can apply for:

- the national certification system (Decree of the Italian Ministry of Environment of 23th January 2012, setting up the National Sustainability System of Biofuels and Bioliquids
- a voluntary certification systems recognized by the Commission and adopted by the Biolyfe Bioethanol plant

For the Biolyfe bioethanol plant the ISCC system was chosen (*www.iscc-system.org*)

Power production from biomass (lignine): by-product recognized as biomass and converted into power in a facility plant

- the reference for this plant is the Decree of the Ministry of Agriculture of 2nd March 2010: the biomass produced at the plant needs just a self-declaration of origin, other biomass needs to be properly traced.

All the certification systems are based on the traceability of the biomass lots origin, chain of processing and delivering, as well as their sustainability (see RES Directive)

Supply contracts

Supply contracts have to identify rules and duties of the actors. Obviously they have to be in compliance with the National laws.
As for the Biolyfe plant:

- Dedicated crops: market not fully deveoped, specific supply contracts are set:
  - land leasing contracts (used also for the cultivation of propagative material)
  - cultivation contracts
- Ceral straw: existing commercial contracts, especially for weath/barley straw. Rice straw trading is not widespread and the efforts to get such material have to be underlined.

The clauses of contracts depend on the supply strategy of the company owning the bioethanol plant

Thank you for your attention

Agriconsulting S.p.A.
Via Vitorchiano 123, 00189 Rome - Italy
www.agriconsulting.it

Fabio Sissot : mail f.sissot@agriconsulting.it