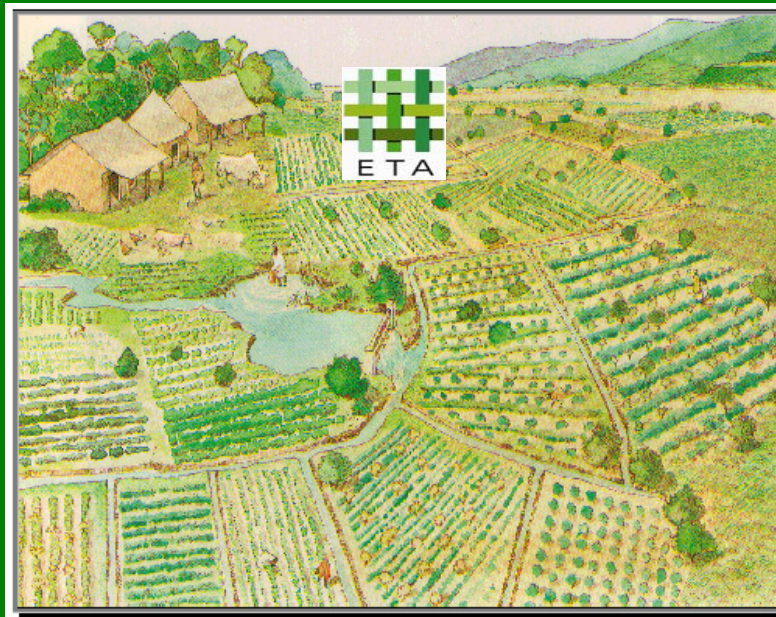




# *Decentralised Co-production of Food-Animal Feed-Bioethanol-Power*

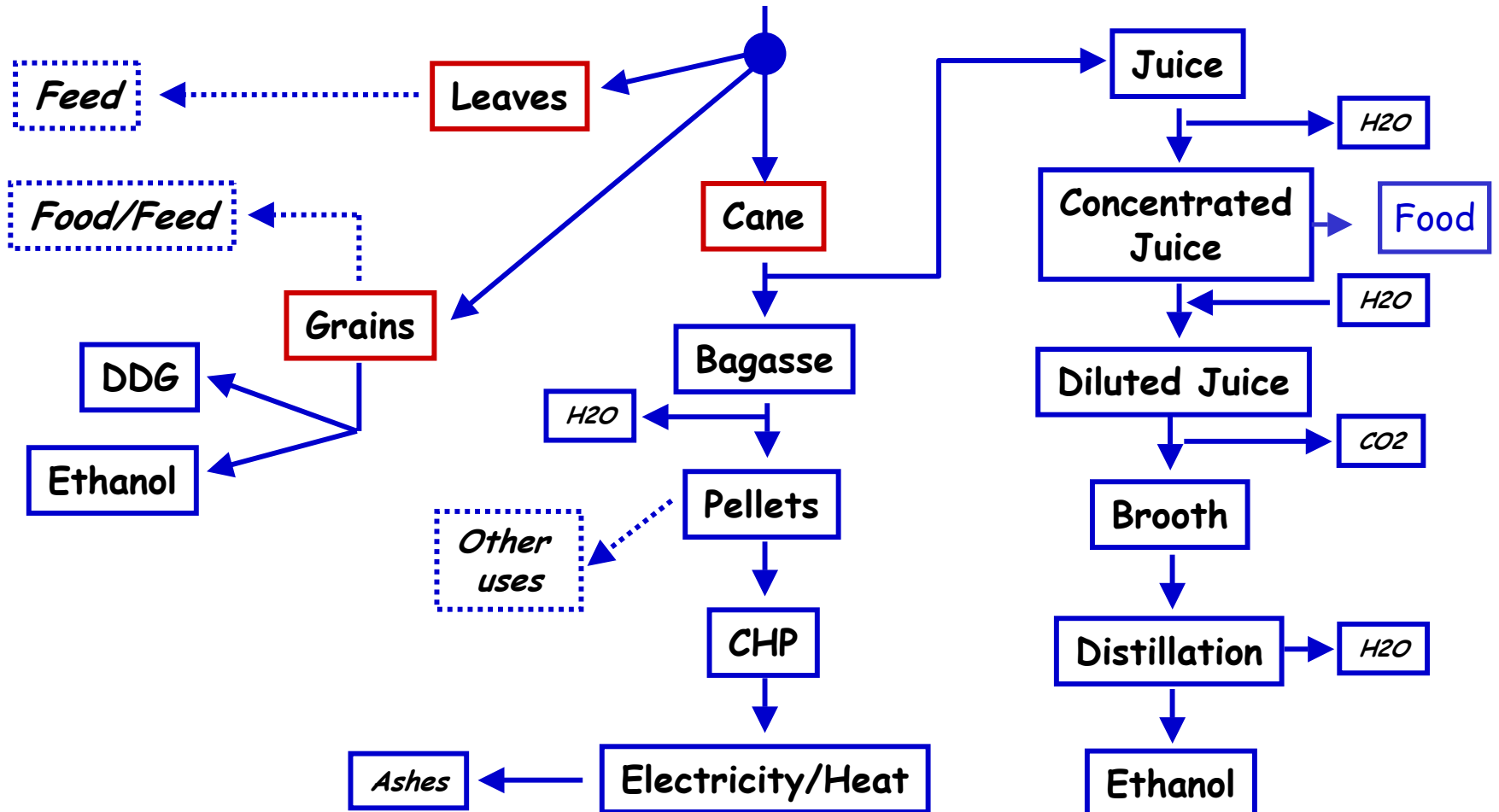
*Giuliano Grassi - EUBIA - Brussels, Belgium  
with the support of ETA-Renewable Energies*



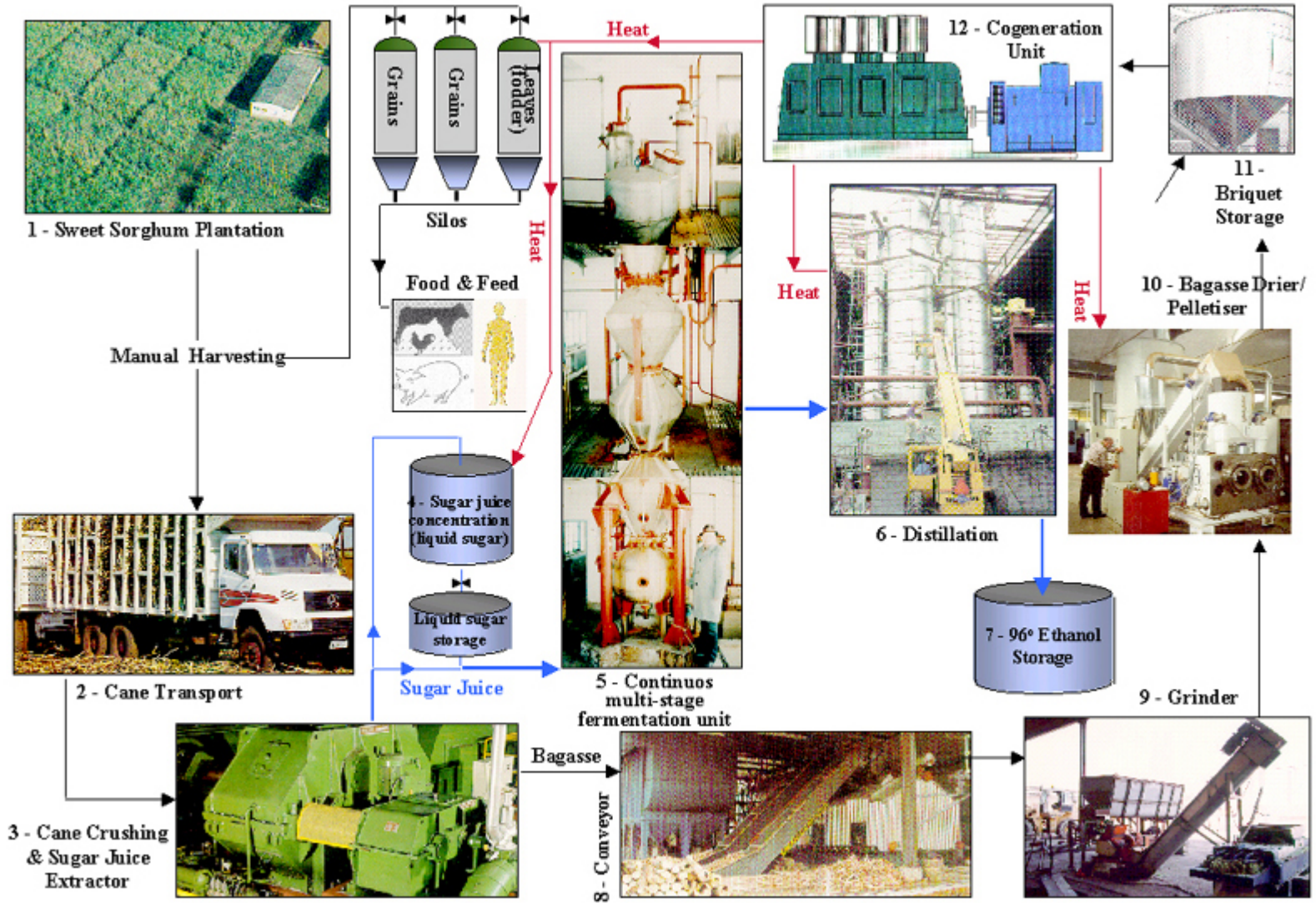
# Concept of Village Complex

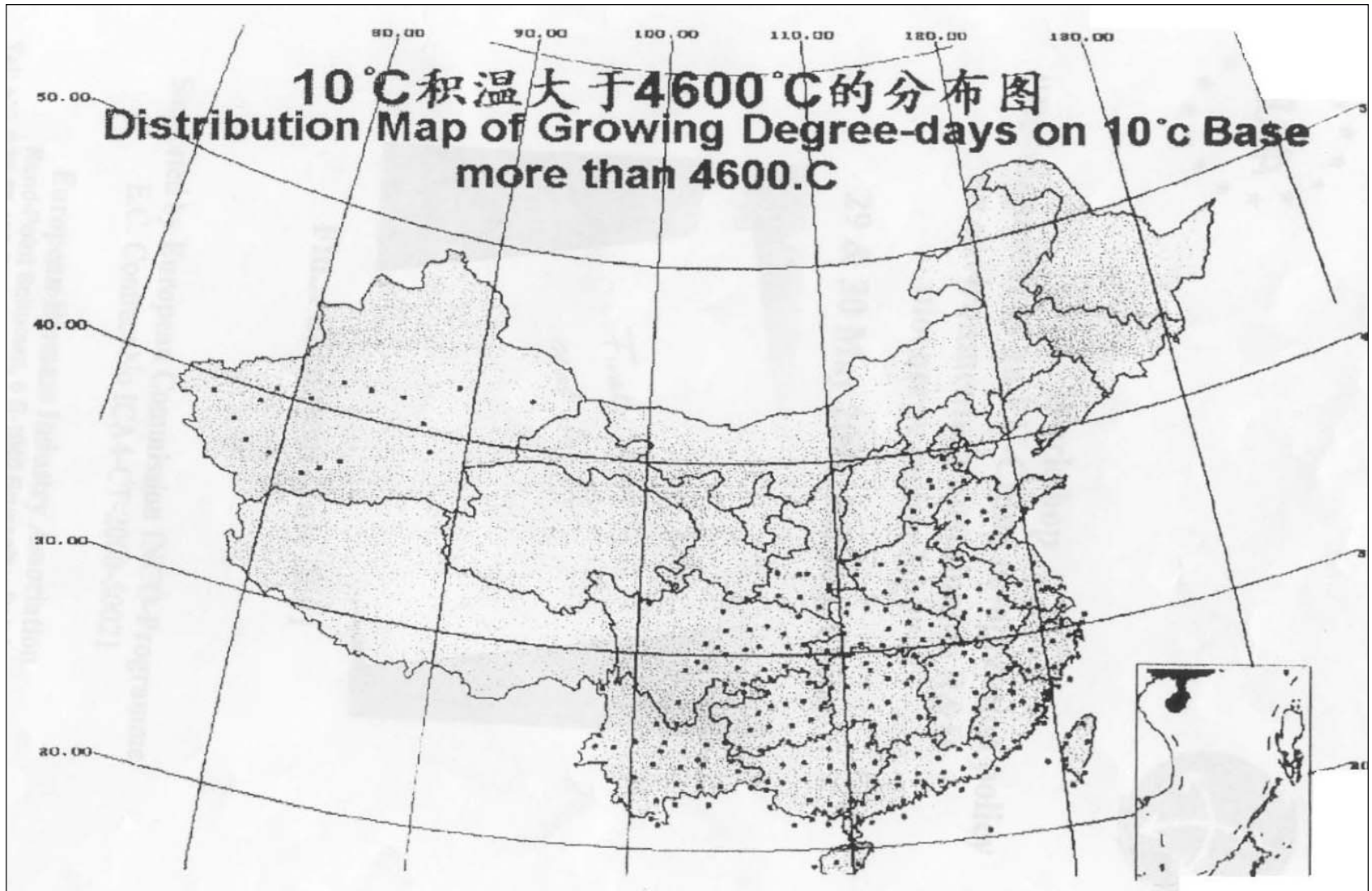
250-800 ha

## Sweet-Sorghum Cultivation and Harvesting



# Typical Scheme (1)





# Coal resources in China





# Basic Configuration (1) *3000 inhabitants, 250 ha*

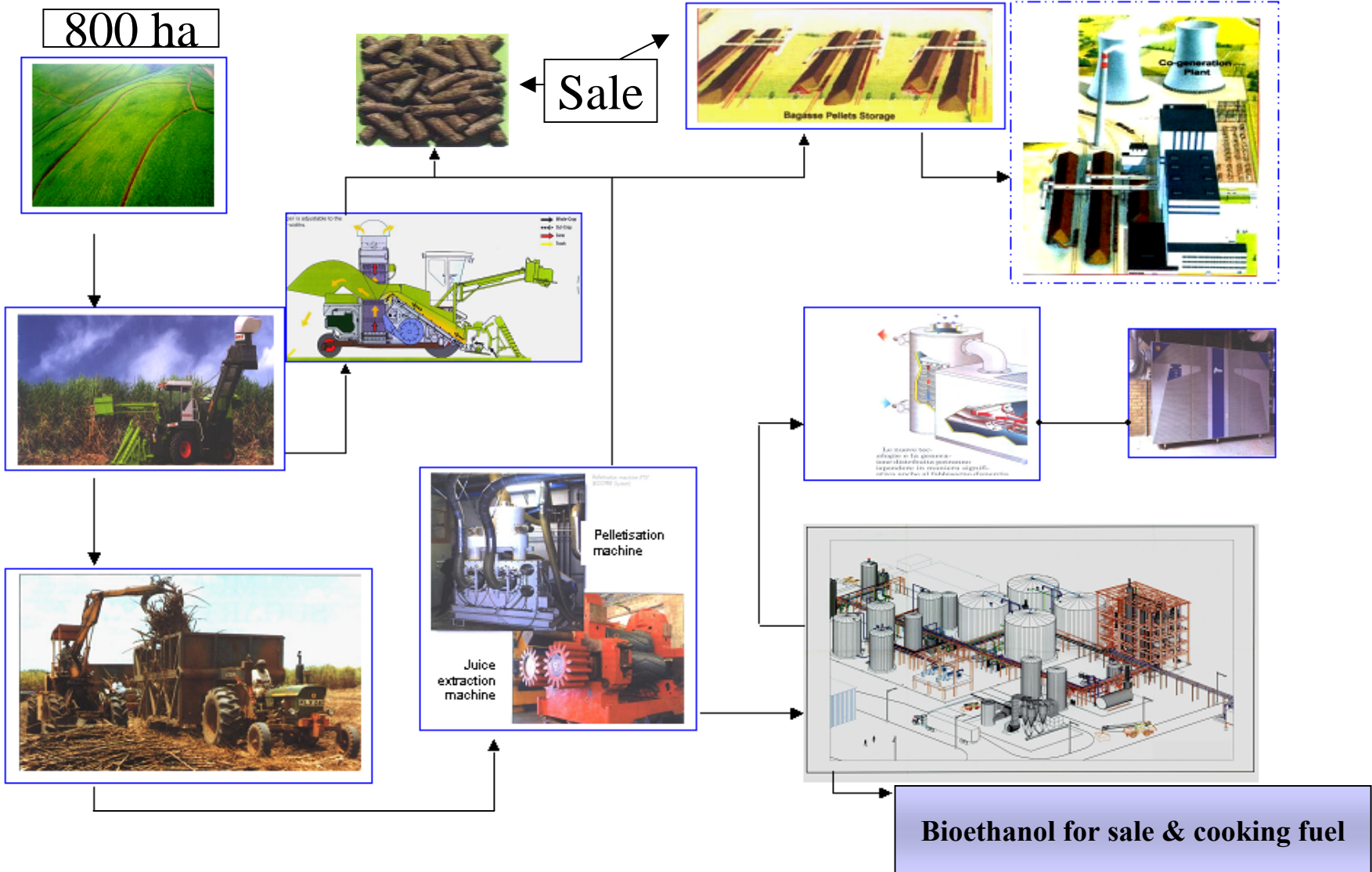
- Biomass production:

- Bagasse (*15 % moist*): 15.7 t/ha  $\Rightarrow$  3925 t/y
- Grains (food-animal feed): 5.2 t/ha  $\Rightarrow$  1300 t/y
- Sugar (bioethanol-food): 7.4 t/ha  $\Rightarrow$  1850 t/y
- Leaves (forage): 1.88 t/ha  $\Rightarrow$  470 t/y

- End-use Product: Bioenergy

- Electricity:  $\sim 1.150 \text{ kWh}_{el}/\text{y}$  per capita (500  $\text{kW}_{el}$ , 2  $\text{MW}_{th}$ )
- Heat:  $3.150 \text{ kWh}_{th}/\text{y}$  per capita
- Bioethanol: 1,168 t/y ( $\sim 1,498 \text{ m}^3/\text{y}$ )
  - 437 t/y from grains, 731 t/y from juice
  - from 731  $\text{m}^3/\text{y} \Rightarrow 937 \text{ m}^3/\text{y} \Rightarrow \sim 300 \text{ l}/\text{y}$  per capita ( $\sim 100 \text{ l}/\text{y}$  cooking, 200 l/y for sale)

# Alternative scheme (2)





# Basic configuration (2)

- Plantation : 800 ha (or 400 ha x2 times per year)
- Total amount of grains: 4,000 t/y
- Total amount of sugar: 6,000 t/y
- Total amount of pellets: 13,000 t/y





---

# Essential Needs and Available Products for rural population

---

## Needed (per capita)

Grain	220 kg/y for feed
Sugar	10 kg/y ( <i>20.8 world avg. '91</i> )
Cooking (ETOH)	70 Kg/y - 100 l/y
Electricity	150 KWhe/y

---



---

# Products for sale:

---

- Grains: 2,956 t/y
  - Bioethanol: 2,500,000 l/y
  - Bio – pellets: 11,400 t/y
-



- 
- Total Investment : 5,8 milion \$
  - Annual Income :  
1.9 milion \$ + 0,22 milion \$ for rural population
  - Annual expenses : 1,3 milion \$  
**R.O.I. : 15%** (min 11%)
-



# Technologies

- Harvesting
- Cane crushing - sugar juice extraction
  - Large scale machines, mainly from Brasil
- Pelletisation
  - Advanced generation pelletisers
- Ethanol production (for sale or for use as cooking jelly fuel)
- CHP by micro-gas turbine generator (bioethanol fuelled)
- Other possible option: carbonisation, activated charcoal

# New Pelletisation Technology



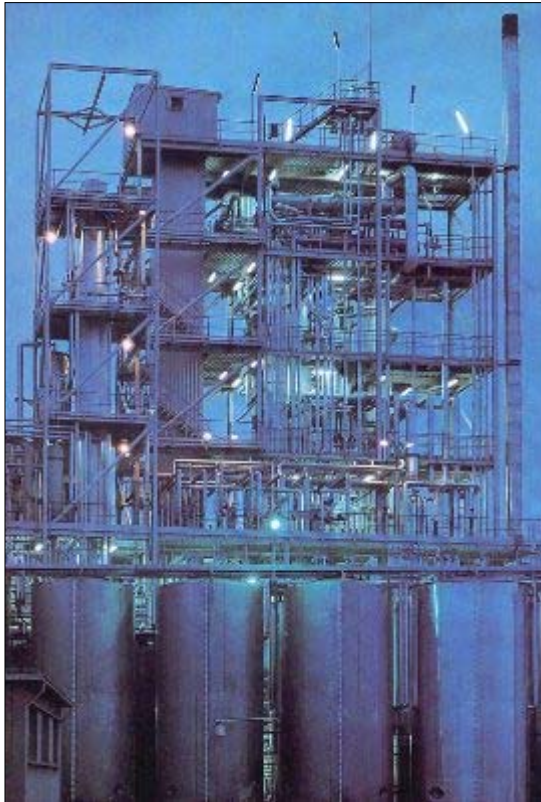
Double die - Pelletiser

# 500 Kw<sub>e</sub> Steam Engine Power plant (1<sup>st</sup> generation)





Gasifier + Cogenerator (ET.Martezo)



Small Distillation Plant (10t/day)





# Conclusions

- It is possible to design different bioenergy schemes based on Sweet Sorghum plantation
  - These Integrated Complexes could provide a significant contribution to sustainable rural development
  - Several technologies are commercially available (but small range)
  - Economics are still affected by the high cost of small scale bioenergy technologies produced in small number.
- ➔ The comprehensive utilisation of the resource in integrated complexes is essential for economics improvement.

# Integrated Project For Commercial Demonstration in China (case study)

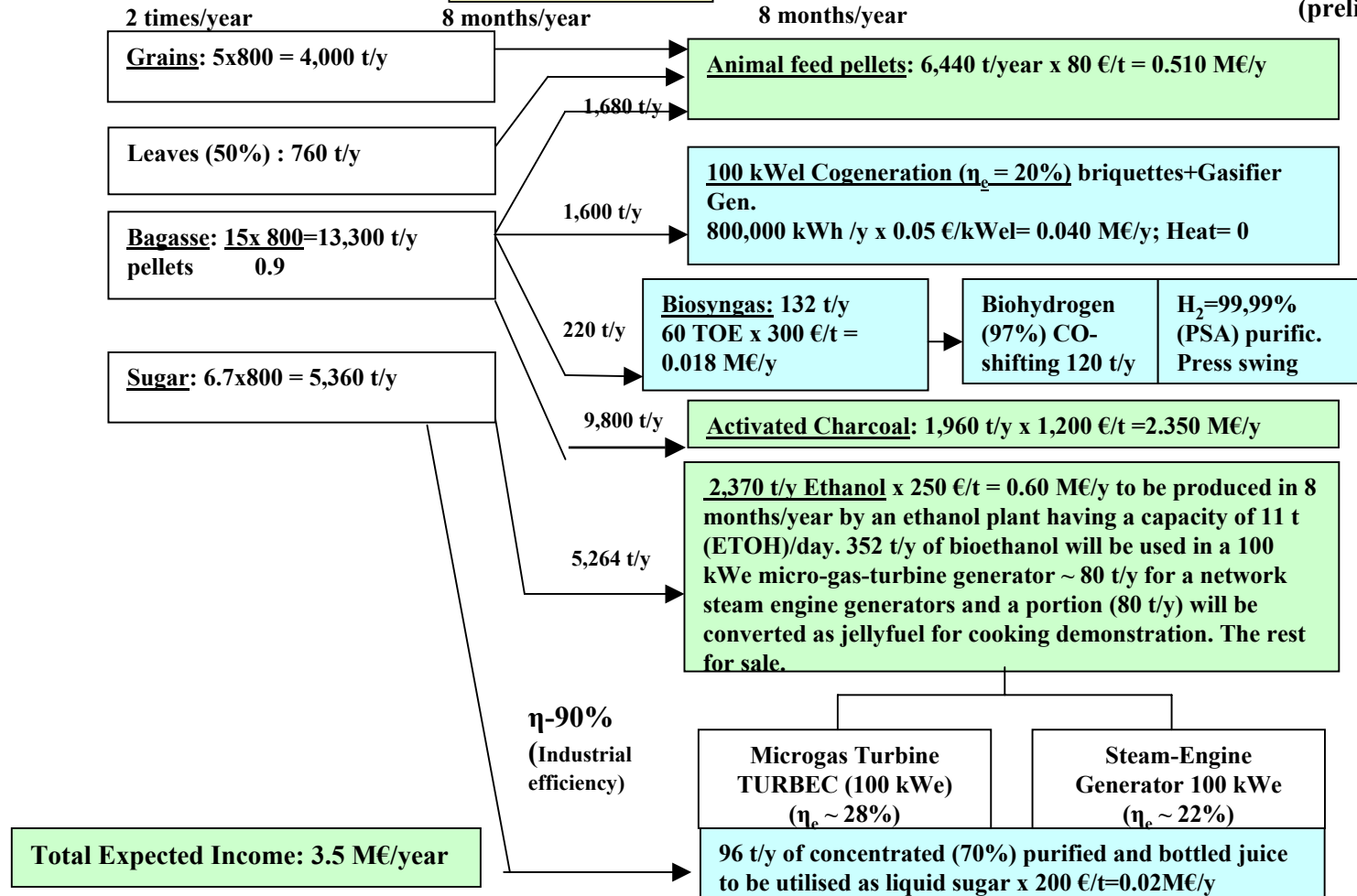
**S. Sorghum Plantation:**  
 400 ha (€600/ha) x 2 times a year  
yield  
 -grains: 5 t/ha-sugar: 6.7 t/ha  
 -bagasse: 15 dt/ha-leaves: 1.5 dt/ha  
 2x75 t/ha fresh x year  
 (480 K€/y prod. cost)

**Harvesting:**  
 15 days every month  
 for 8 months/year  
 (230 K€/y Class H.  
 investment)

**Sugar Extraction**  
 10 t/ha (cane  
 crushing)  
 (500 K€ investment)

**Pelletisation**  
 5 tonn pellets/hr  
 (850 K€ investment)

INCOME  
 (preliminary estimation)





---

**Thank you for your courtesy**

**Ing. Giuliano Grassi  
(EUBIA)**

