E.U. INCO Programme

COTTONBIOMAT Project

Opportunity study about the processing of cottonseed proteins into materials for agro-industries in South-America

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Presentation items

- Introduction
- Opportunity study

Introduction (1/2)

- Issue of variable scope of Economic analysis
  - Feasibility study helps for investment decision…
    - Once potential investors and production sites are identified
  - Economic analysis is further demanding in the case of environment-friendly material
    - Should encompass product life cycle analysis
      - Dealing with cost and benefits from the production of a good to its disposal
    - Show positive balances in terms of environmental impacts (energy consumption, efficiency, CO2 emission…)
  - Analysis restrained to an opportunity study
    - helpful to capture the attention of potential investors
      - Our objective at this stage
    - Dealing with alternative/better use of existing resources

Introduction (2/2)

- Scope of an opportunity study
  - Assessment of resource availability
  - Market assessment of bioplastics goods
  - Rough estimation of production costs
    - Limited to plastics material…and not yet final products

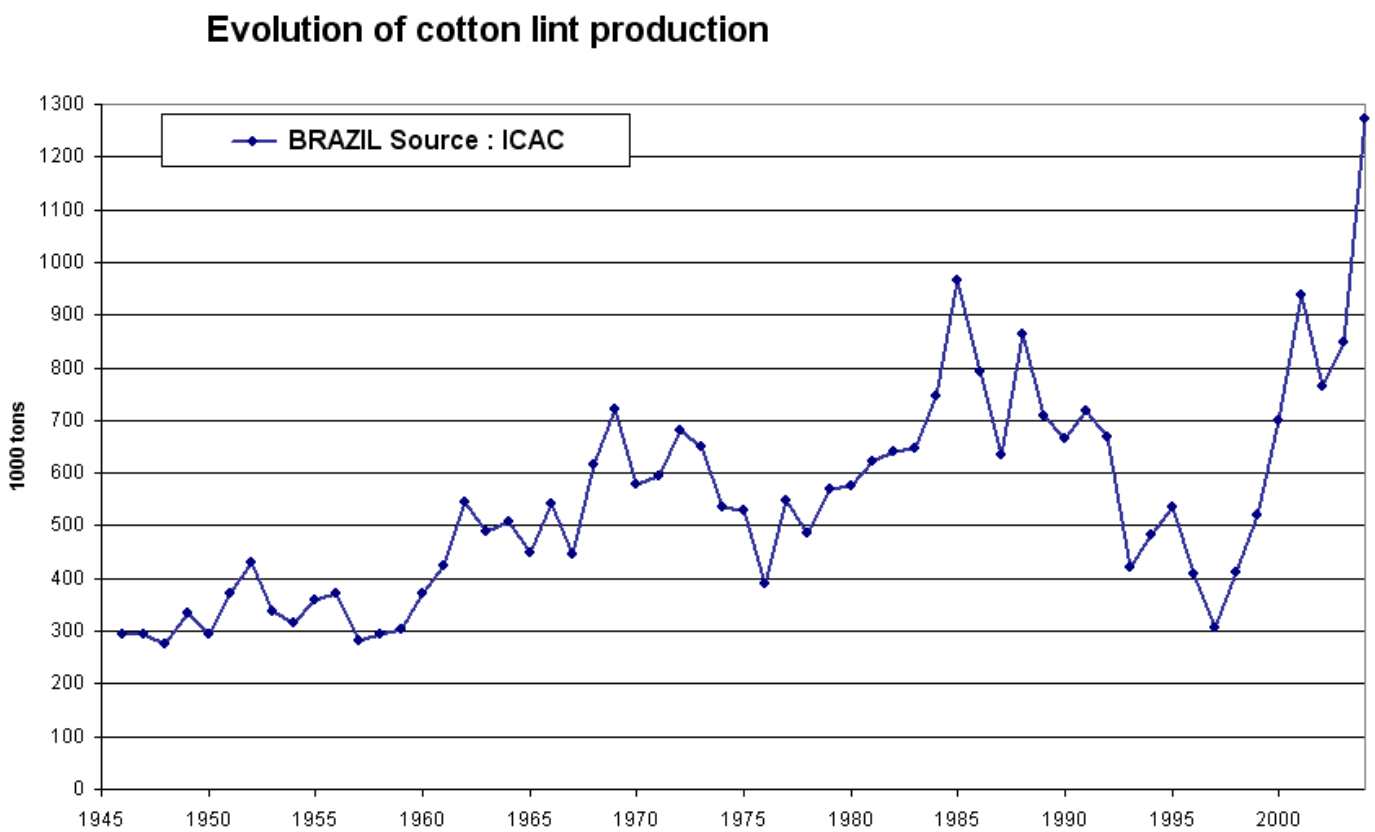
Resources are available

- Resources concerned
  - Cottonseeds
  - Cotton seed cakes (after crushing)
- Availability because production is upward
  - Particularly in Brazil
- And not all cottonseeds are exploited
  - Around 20% of cottonseeds are neither crushed nor exported
- And part of the cotton seed cakes is exported
  - Then suitable for further local processing

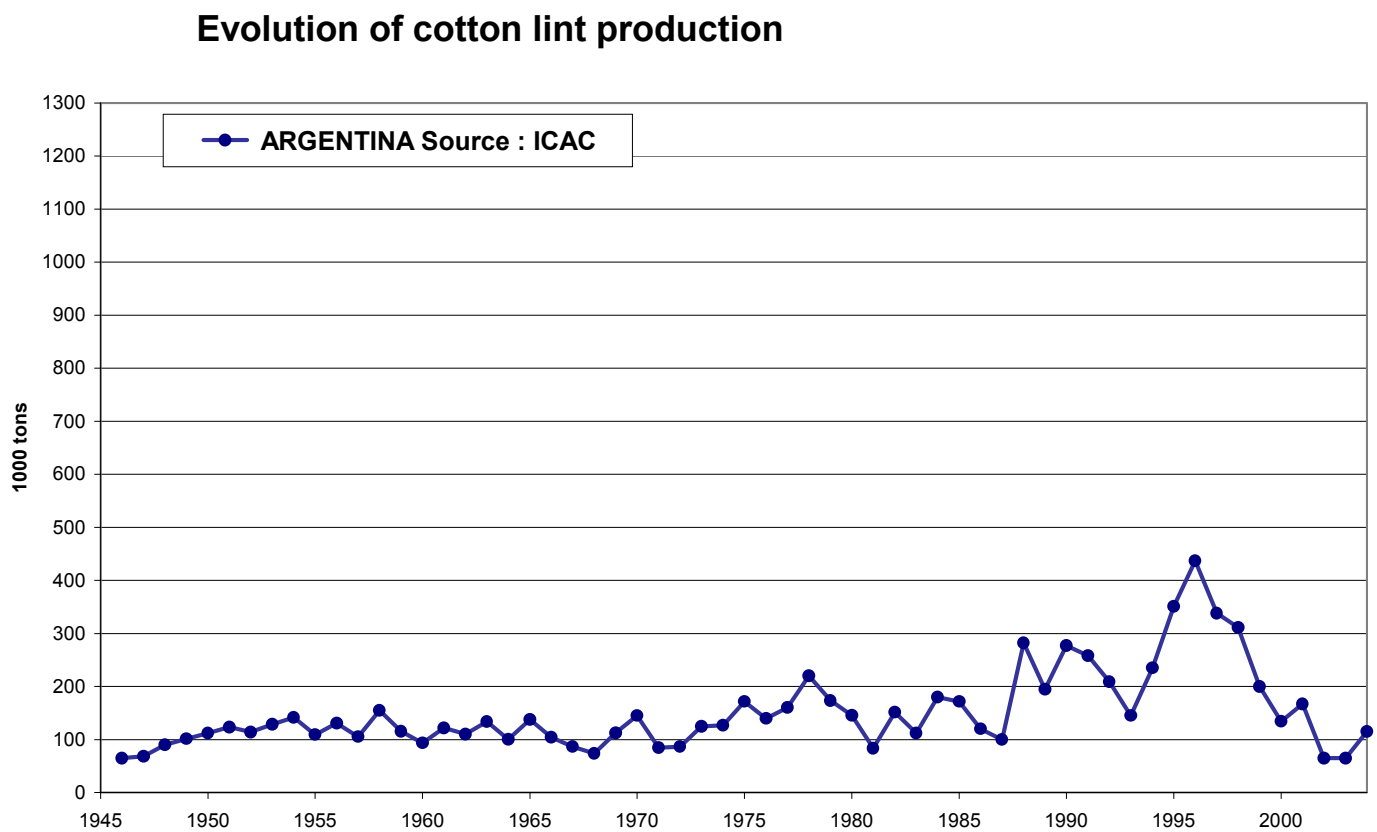
World level ratios about cottonseeds

- Cottonseed production : +/- 34 millions tons
- Percentage of production being crushed: +/- 75%
- Percentage of cottonseeds being exported : +/- 4%
- Share of Un-used cottonseeds : +/- 20%
- Processing ratio at crushing mills : +/- 45%
  - World production of 15.3 millions tons of cotton seed cakes
  - Only 4-5% of cotton seed cakes are exported (available for alternative use or destination)

Positive production trend in Brazil



Far compensating the production decline in Argentina



Estimation of the regional resources figures

- No access to official statistics
- Estimation (average value for the last four years)
  - Cottonseeds production: 1.52 millions tons
  - Cottonseeds crushed: 0.99 millions tons
  - Cottonseeds available: 0.53 millions tons
    - Available in particular for processing bioplastics materials
  - Cotton seed cakes production: 0.44 millions tons
  - Seed cakes exported: 0.02 millions tons
    - Could be diverted for processing bioplastics materials

Market assessment

- Plastics consumption
- Biodegradable plastics
  - Generalities
  - Market still is small…
  - …but prospect is bright
    - Price gap should be reduced
    - Regulations are favorable
  - An opportunity for an industry yet important in the region?

Increasing world consumption of plastics

- Consumption in million metric tons
  - 1950: 5
  - 2003: 180
  - 2005: 200
  - 2010: 258
- Consumption annual growth rate
  - World level: 4-5%
  - Higher in emerging countries
- Consumption zones
  - Leading: western countries
  - South-East Asia: catching up quickly
    - 40% of the world consumption by 2010
- Per capita consumption rate
  - World: 24.5 kg in 2002
  - World: 37.0 kg by 2010
  - Western countries: >100 kg
  - India: 3 kg
  - Brazil: 23 kg
  - Argentina: 30 kg

Distribution of Plastics types

	World	Brazil/Argentina
PE	37%	41%
PVC	17%	14%
PP	19%	20%
PS	9%	6%
PET	5%	12%
Others	13%	7%

Usages and processing of plastics in Brazil

Market segmentation per destination	
Technical components	10%
Agriculture	***8%***
Household appliances	5%
Footwear	3%
Laminated goods	1%
Toys	1%
Packaging	41%
Civil construction	12%
Disposables	***11%***
Others	8%

Market segmentation per processes	
Rafia	3,0%
Lamination	1,0%
Coating	1,0%
Expanding	0,8%
Rotomolding	0,4%
Films	***31,0%***
Extrusion	19,0%
Blowing	17,0%
Injection	***16,0%***
Thermoforming	***6,0%***
Others	4,0%

Historical background on biodegradable plastics

- 1907: cellophane
- 1970s: using starch
- 1980s-1990s: grafting polymeric components

Various approaches in producing bio-plastics

- Direct use of renewable plant material
  - Starch, cellulose, fiber,…
- Direct use of renewable animal protein
- Genetic engineering of plant traits (to produce more materials in plants for plastics production)
- Genetic engineering of plants to produce directly bioplastics (PHA, PHB)
- Microbial conversion (fermentation): PHA, PHB, PLA
- Fermentation of wastes
- Biodegradable blends

Bioplastics: market share still small but greatly increasing

- World demand
  - 2000: 20 000 tons
  - 2003: 90 000 tons
- Market share
  - Less than 0.05% of the world plastics market
  - Forecast of great increase in market share
    - By 2010: 10-30% of the PE market! (Australia)
- Current Regions market shares
  - USA: +/- 50%
  - Europe: +/- 40%
  - Japan/Australia: +/-10%
- More countries are involved in production and use
  - South-East Asia

Domains of usage advantageous for bioplastics

- Related to environmental concerns
  - Suitability to natural environment
    - Agri. Materials, mulching film, pots for transplanting,…
  - Leisure goods
    - Golf Tees…
  - Suitable for cases where re-use or recycling is difficult
  - Frequently disposed goods
    - Pen cases, razors, tooth brushes, cups, bags, trash-bags…
- Adapted to specific features
  - Slow release
  - Medical use
  - Low oxygen permeability is required
  - …

Current usages of bioplastics

- Bags: 50%
- Non-recycled goods: 25%
- Coated-paper: 15%
- Food-packaging: 8%
- Other: 2%

Advantages and constraints for mulching films

- Advantages (or shortages of conventional plastics)
  - Re-use is not possible
    - Film is deteriorated after one season
  - Recycling is costly
    - Transport small amount to long distances
    - Soil contamination need cleaning cost
    - Pesticide residues
- Limitations
  - Still technical issues with biodegradation
    - Different Requirements for the degradation In the soil and on the soil

Optimum not yet achieved

- Bioplastics not yet functionally and economically optimal
  - Some materials have the right properties but they are expensive
  - Some materials are cost competitive but still short in some properties
- Prevailing opinion
  - Prices of Bioplastics are still too high
  - …but price should be more stable

Positive Price prospect

- Current unfavorable price gap
  - PE at around US$ 1/kg
  - Biomaterial : 3-4 times more
- Anticipation of reduced price gap
  - Crop/oil price ratio is decreasing dramatically
    - 1950-1970: 50
    - 1980s: 10
    - 2000: 5
  - PE price should increased up to US$ 1.30-1.50/kg
  - Technical progress should decrease biomaterial price down to US$ 2.50-3.00
- Argument of better price stability of bioplastics

Sources of technical progress to decrease price of bioplastics

- Technical factors
  - R&D to improve productivity
  - Economies of scale
- Management factors
  - Supply chain coordination
  - Reliable supply and ability to accommodate market growth
  - Investors' commitment

Regulations favor more and more bioplastics use

- Through taxing conventional plastics bags
- Through passing the cost of disposing plastics goods to producers
- Through banning conventional plastics for some usages

Bioplastics: exciting opportunity for a well established regional plastics industry?

- Brazil yet engaged in bioplastics production
  - A PHB Industrial S.A.
- Plastics industry yet important
  - Not negligible contribution to GDP
  - Willingness for further development
    - In particular through getting a greater market share in developed countries

Important and labor-intensive industry in Brazil

	Plastics industries		Nber employees	
	Argentina	Brazil	Argentina	Brazil
1986	3 000		36 800	
1990	3 500		38 000	
1996	2 600		30 000	
2000	2 385	6 879	29 000	192 747
2001		7 438		201 682
2002		7 898		218 140
2003	2 253	8 213	27 200	224 941
2004				236 626

Significant contribution to GDB in Brazil

	GDP share		Industry Share
	Argentina	Brazil	Argentina
1990	1,10%		4,30%
1993	0,80%		3,10%
1997	1,20%		5,00%
2000		1,66%	
2001	1,00%	1,31%	5,00%
2002		1,76%	
2003	0,80%	1,90%	4,90%
2004		2,26%	

Estimation of regional market for bioplastics material

- Assessment from the contest of the PE market
  - Total consumption of 2.2 millions tons
  - Market penetration of 1-3% leads to a demand of 22 000 – 66 000 tons
- Assessment from usages for which bioplastics have comparative advantage
  - +/- 20% of total consumption (11% for disposables and 8% for agriculture)
  - Total amount of 1 millions tons
  - Market penetration of 5% leads to a demand of 50 000 tons

Mercosur-oriented exchanges of plastics materials and goods

Argentina's exchanges of plastics goods with Mercosur

	2000	2001	2002	2003
Importations	22,1%	26,0%	30,3%	33,0%
Exportations	62,5%	56,1%	43,6%	41,2%

Bioplastics: opportunity to diversify market outlets

- Brazil is a marginal supplier of Western markets
- Bioplastics: a means to better conquer western markets

Market prospect for regionally-produced bioplastics

- Regional market: 22 000 to 66 000 tons.
  - Roughly 50 000 tons
- External market: good prospect
  - if supply of products which are functionally and economically sound

COTPROT Production cost

- Estimation for the COTPROT solution of 26° Brix
- Production size similar to most bioplastics materials
- Production cost seems attractive
- Investment plan matters in the production cost level

Production inputs & outputs

Inputs		Outputs	
Products	Total amount (tons…)	Products	Amount, tons/year
Cottonseed	7 406	COTPROT 26° Brix	2 602
TEA	414	Solid residues	4 449
Cans	14 000	Foam	986
water	8 509	water	3 275
steam	2 685		
electricity	238 857		

3000 – 4400 ha of cotton could provide enough cotton seeds for this production

With the estimation of available cottonseeds, around 70 units of this kind can be considered

Investment estimation

Infrastructures invest. In R$	400 000
Local Production equipment in R$	1 111 800
Local investment in R$	1 511 800
Local investment in US$	629 917
Imported Prod. equipment in $	2 600 000
Technology transfer	1 200 000
Imported investment in US$	3 800 000
Total investment in US$	4 429 917
Depreciation in US$	442 992

COTPROT Price looks attractive

COTPROT Prod. Tons	2602	Unit cost US$/kg	Unit cost, %
Fix cost	Direct fixed capital	0,55	32%
	Labor	0,02	1%
	admin. & Overhead	0,02	1%
	Total	0,59	34%
Variable cost	Raw materials	0,33	19%
	Other consumables	0,75	43%
	Utilities	0,05	3%
	Total	1,14	66%
Total cost		1,73	100%

The economic value of solid residues is not integrated: cost should be a little bit smaller

The share of consumables (TEA) is high
Economies of scale would be welcome

Higher Production cost for PHB, 2850 tons/year

	Product Recovery mode 1	
	Unit cost $US/kg	Cost share, %
Direct fixed capital	1,51	27%
Labor	0,49	9%
admin. & Overhead	0,23	4%
Raw materials	2,33	42%
Other consumables	0,00	0%
Utilities	0,47	8%
Waste treatment/disposal	0,56	10%
Total	5,58	100%

Production cost is high

The share of raw material cost is high

Source: quoted by Holdings 2004
Calculation derived from Lab.
Data obtained in Korea

Cost sensitivity analysis

- Production Cost is lower if
  - US$ is "heavy"
  - Investment is mainly self-financed
  - TEA price is lower
  - Production equipments cost less
- Production costs in 2 extreme cases
  - US$ 0.89/kg in the most favorable situation assessed
  - US$ 2.71/kg in the least favorable situation assessed

EMACOT production cost

- Production of a new plastics material, after its extrusion
  - Before its use to process plastic goods
- Opportunity to extend processing activities within cottonseed crushing plant
  - By using seed cakes (or better, using delipidated kernels)
- Production size limited by lack of economies of scale of extruding machineries
- Production cost is nevertheless attractive
- Investment plan matters in the profitability level

Production inputs & outputs

Inputs		Outputs	
Products	Total amount (tons…)	Products	Amount, tons
Cottonseed cakes	3 120	EMACOT	1 834
Glycerol	336		
Cans	9 169		
water	150		
electricity	355 964		

At least 6-7 units of this kind can be considered

Far more units if more cakes can be diverted from animal feeding

Investment estimation

Infrastructures invest. In R$	400 000
Local Production equipment in R$	222 600
Local investment in R$	622 600
Local investment in US$	259 417
Imported Prod. equipment in $	1 160 000
Technology transfer, US$	480 000
Imported investment in US$	1 640 000
Total investment in US$	1 899 417
Depreciation in US$	189 942

Production cost is attractive

EMACOT production (ton)	1 834	Unit cost US$/kg	Unit cost, %
Fix cost	Direct fixed capital	0,34	23%
	Labor	0,03	2%
	admin. & Overhead	0,03	2%
	Total	0,39	26%
Variable cost	Raw materials	0,20	13%
	Other consumables	0,89	59%
	Utilities	0,02	1%
	Total	1,11	74%
Total cost		1,50	100%

Consumable (glycerol) accounts a lot in the production cost

Cost sensitivity analysis

- Production Cost is lower if
  - US$ is high
  - Investment is mainly self-financed
  - glycerol price is lower
  - Production equipments cost less
- Production costs in 2 extreme cases
  - US$ 0.78/kg in the most favorable situation assessed
  - US$ 2.21/kg in the least favorable situation assessed

Conclusion (1/6)

- Market Prospect is bright at the world level
- Brazil & Argentina have enough raw materials to devote to the production of cottonseed-based bioplastics materials
- Production cost estimation are promising…for plastics materials
  - Production Costs are driven by the costs of consumables (chemicals)
  - …far less by the costs of raw materials
- But further analysis remains necessary
  - To determine production costs of plastics goods (film,…) beyond plastics materials…
  - …after clarifying what could be the final products to contemplate
  - To fine tune investment and functioning costs

Conclusion (2/6)

- Lessons to retain from existing experiences in launching bioplastics
  - Identify clearly market segments to invest
  - Make the proposed products be different...
    … and be felt different
    - Mis-selection and poor specification of new products led to failures
  - Determine properly the development rhythm
  - Adjust a sound investment plan

Conclusion (3/6)

- Challenge of meeting several acceptable trade-offs
  - Environmental costs and benefits
  - Nominal price and performance
  - Political acceptability
    - Under pressure from Plastics Lobby and consumers
  - Tensions and satisfaction regarding the environmental requirements
    - Energy efficiency and CO_2 emission

Conclusion (4/6)

- Low cost raw material is favorable for price competitiveness of bioplastics in general
  - …Yet the case of agricultural products and furthermore by-products
  - Our Challenge is to reduce the cost share of consumables
- Help the plastics converters in their decision in using bioplastics materials
  - By providing the full range of bioplastics attributes and costs
    - Product functions
    - Energy efficiency, CO2 emission
    - Other external cost and benefits

Conclusion (5/6)

- Worthwhile to invest in anticipating external benefits from bioplastics
  - Example of of the positive effect of reduced weight of bio-waste bag
  - The processing of bioplastics materials at the converting industry might lead to some technology change
    - Either cheaper or more expensive (e.g. thin wall injection moulding vs rotational moulding)

Conclusion (6/6)

- Narrowing the range of final products to contemplate is key (a matter of selection)
  - To prevent dispersion of human and financial resources
  - To concentrate on in-depth analysis
    - About the technical specifications to meet
    - About the processing improvements to achieve
    - About the identification of the full range of attributes and costs of the new final products that might result
- In other words?
  - Closer connection with industrial partners is needed
    - Including partners of the plastic converting branch