ABSTRACT: 159

ASSESSMENT OF HIGH-QUALITY PARTLY DEFATTED SOYMEAL SUPPLY CHAIN BASED ON COOKING-PRESSING PROCESS

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A demand for identity preserved (IP) GMO-free soymeal, based on local soybean cultivation, is expected to grow in the near future in France. Before any investment phase, the feasibility of such small to medium-sized IP soybean meal supply chain for use as feedstuff has to be assessed. A process based on thermal treatment (cooking) associated to pressing was selected to carry out the study because of its robustness. Conditions were optimized for oil extraction, yield, meal quality and economics.

Soyseeds of the 2010 French harvest were used as raw material and the seed composition was checked. The effects of cooking on the antitrypsic factors (ATF) inactivation and the protein solubility were modeled with a bench-cooker and up-scaled with a 75kg batch cooker. Convenient conditions were tested in a continuous flow 2 stage cooker at 150kg/h. Cooked seeds were then pressed at 150kg/h and the quality of the oil and meal were determined.

The results indicate that the cooking process is robust and efficient to inactivate ATF (3-5 TIU/mg). A good oil extraction was reached (6,7% of residual oil content in meal) and an acceptable level for the protein solubility in soda (related to digestibility value) was obtained (73%).

The economical study of a crushing plant of 20 000 tons soyseeds per year showed that the crushing cost is arround 40 €/t t. The crushing nett margin was then calculated using two technical assumptions (conservative and optimistic oil extraction levels) and several price scenarios for both seed supply and soymeal in the market context of the year 2011 (three IP and logistics premium values and valorisation or not of the residual oil of the meal). The crushing nett margins significantly depended on the tested technical and price combinations. Conservative combinations resulted in net margins of about 43 $/t of soyseed meanwhile optimistic levels reached around 60 $/t. Pessimistic ones gave negative values between -11 $/t and -18 $/t.

Additional work on the incorporation rate and related interest price of partially defatted soymeal in different animal feeding formulations and price scenarios would be required to better evaluate the potential value of the soymeal. However, at this point the cooking-pressing process seems to be a reliable option for building an integrated high quality soy meal supply chain based on local GM-free IP production in French soybean-growing areas.

ASSESSMENT OF HIGH-QUALITY PARTLY DEFATTED SOYMEAL SUPPLY CHAIN BASED ON COOKING-PRESSING PROCESS

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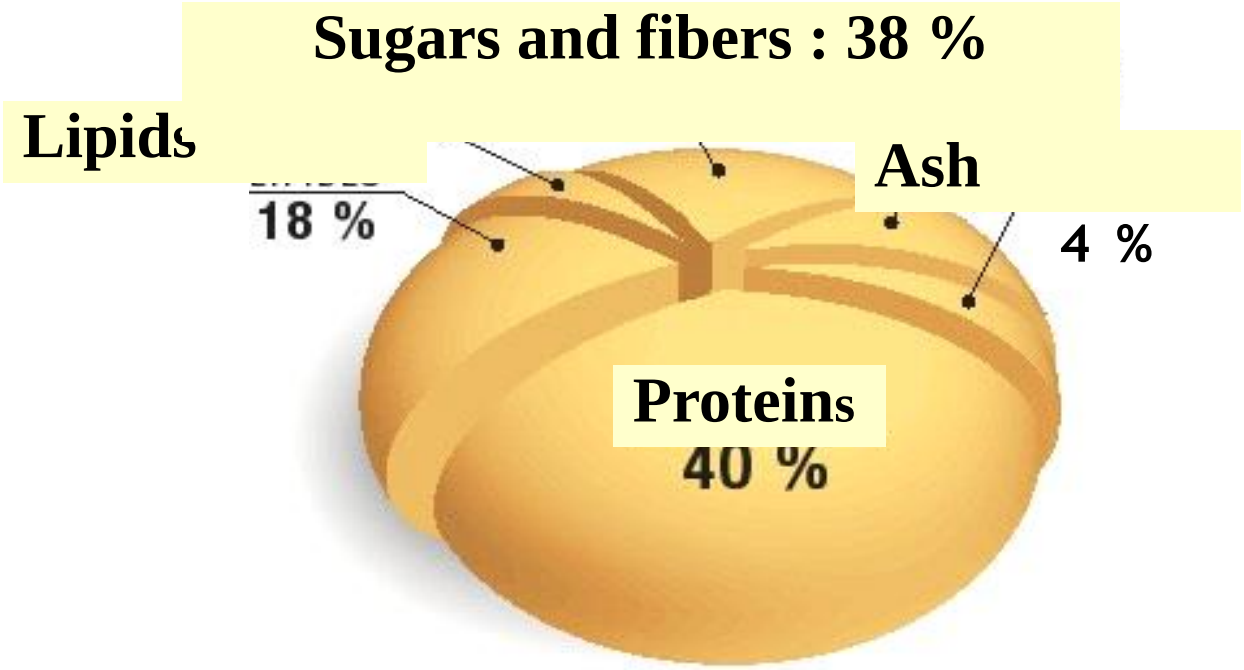
Soybean : main protein source for animal feeding

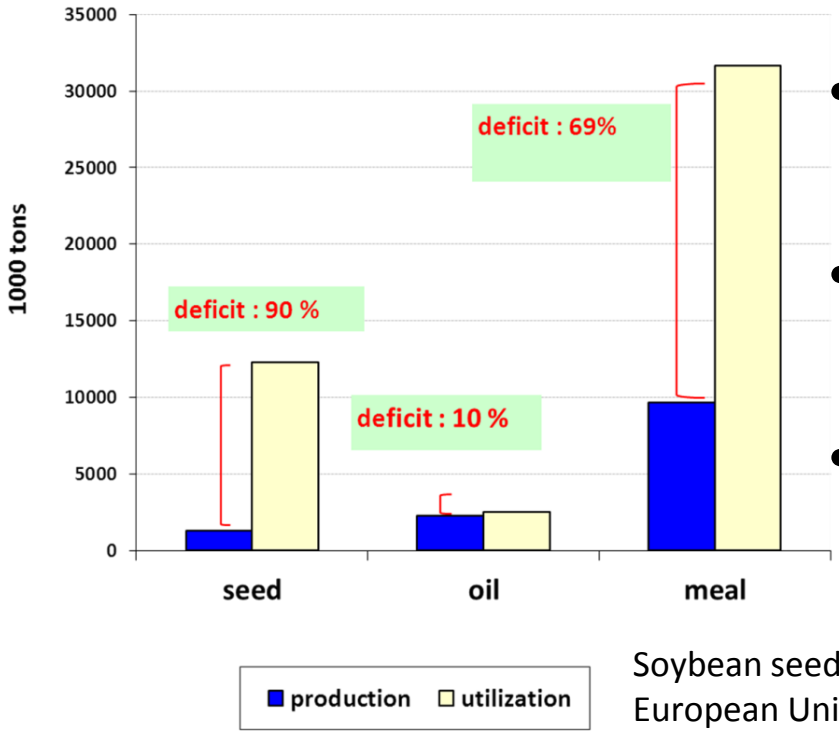


- A high protein content source for human and animals
- Large planting areas in the world
- Two valuable components : oil and protein which could be separated
- Main protein source for feedstoks in the world

Soybean situation in the European Union (EU)

EU is still dependent on soybean imports for animal feeding

- EU soybean production very low : 1.3 million°tons seeds (M°T) in 2011
- EU soymeal consumption : ≈ 31 M°T in 2011
- EU imports more than 95 % of its soybean needs



- No GM soybean crops allowed in EU
- 10/12 % of imported soymeal in EU : GM free (estimates)
- Higher rate in some countries like in Germany (15/20 %)

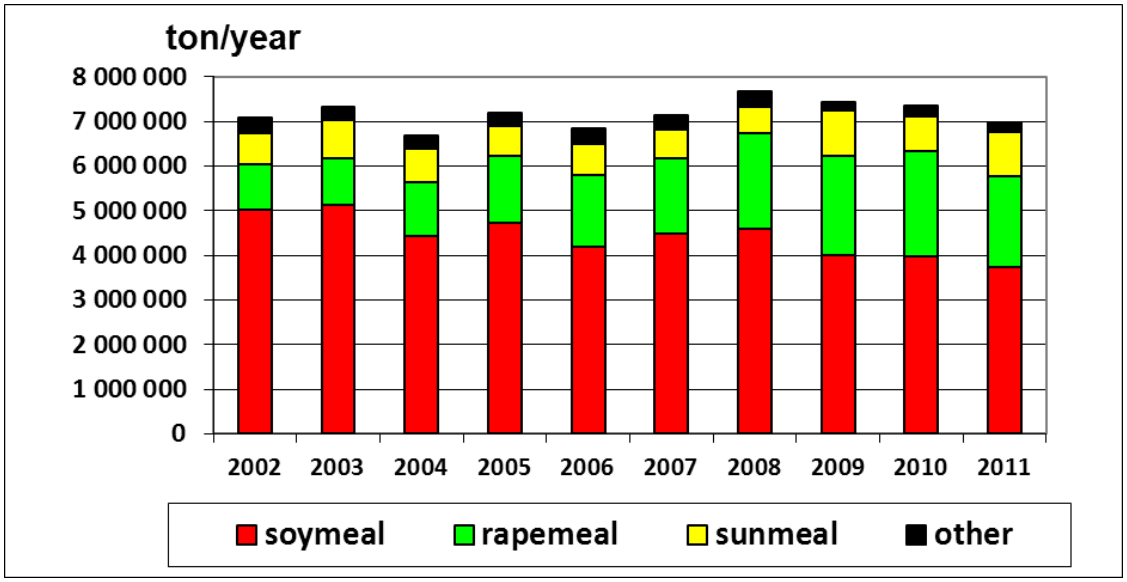
Soybean seeds, oil and meal production and uses in the European Union *(Source: Oil World, 2012 and 2013)*

Soybean situation in France

- Small soybean producing country
- Dramatic decrease of the soybean acreage since the 2000’ :121 000 ha in 2001, 37 500 ha in 2012 (same down trend in EU)
- Challenge : to recover the lost surfaces

Soymeal : first protein source for French animal feeding

- Predominance of imported soymeal despite the increase of local rapeseed meal use
- Significant demand in France for GM free soymeal (≈ 20 % of the soymeal consumption)
- Variable premium (≈ 10% of the regular price market) of the GM free soymeal and increasing threats on the security supply

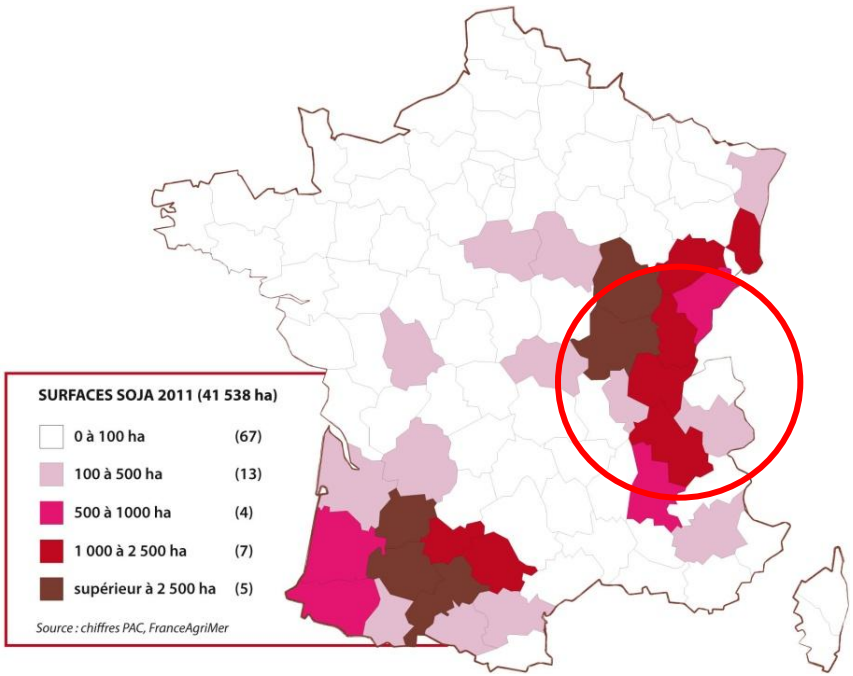


Meal consumption in France

Source : Fed'huile, Onidol

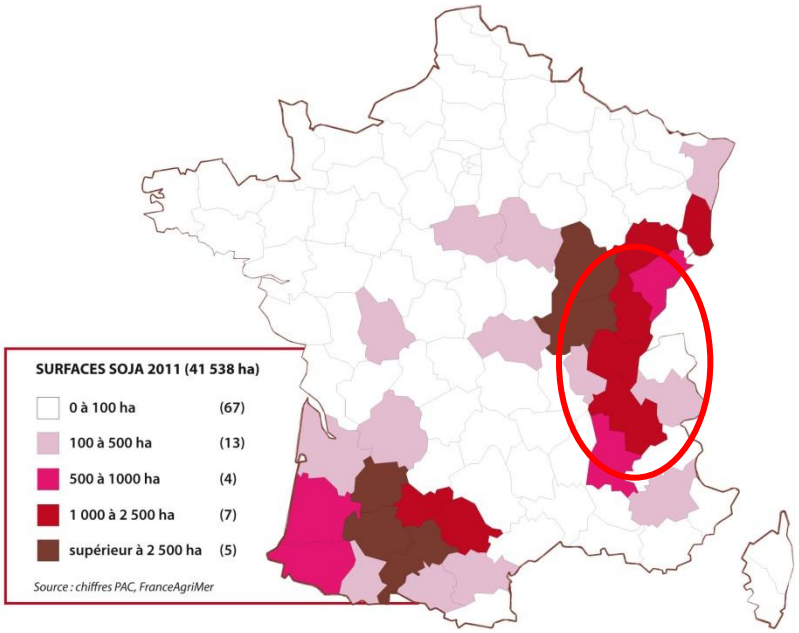
French Eastern area : Suitable context for a local crushing plant

- 2 main soybean production areas in France



- Specificity of the Eastern area (45 % of the French production)
  - Significant livestock in the area
  - Far from the soybean crushing plants and from the importing ports

Suitable soybean context for a local crushing plant



- Rhône-Alpes region : Need of around 30 000 T of identity preserved GM free meal /year
- Local quality food production (poultry and dairy) → switch towards local protein sources if possible

- Existing of local soybean extrusion plants but old equipment and not enough profitable due to the weak valorization of the oil fraction in the extruded whole seed.

Local demand for a crushing plant

- Local actors (cooperatives, industrial actors, animal livestock actors) asked us for a solution allowing to process local soybean seeds and to deliver soymal offering good nutritional value
- Local actors requirements :
  - Capacity plant : 20 000 tons y^{-1}
  - No solvent extraction
  - Optimized oil extraction

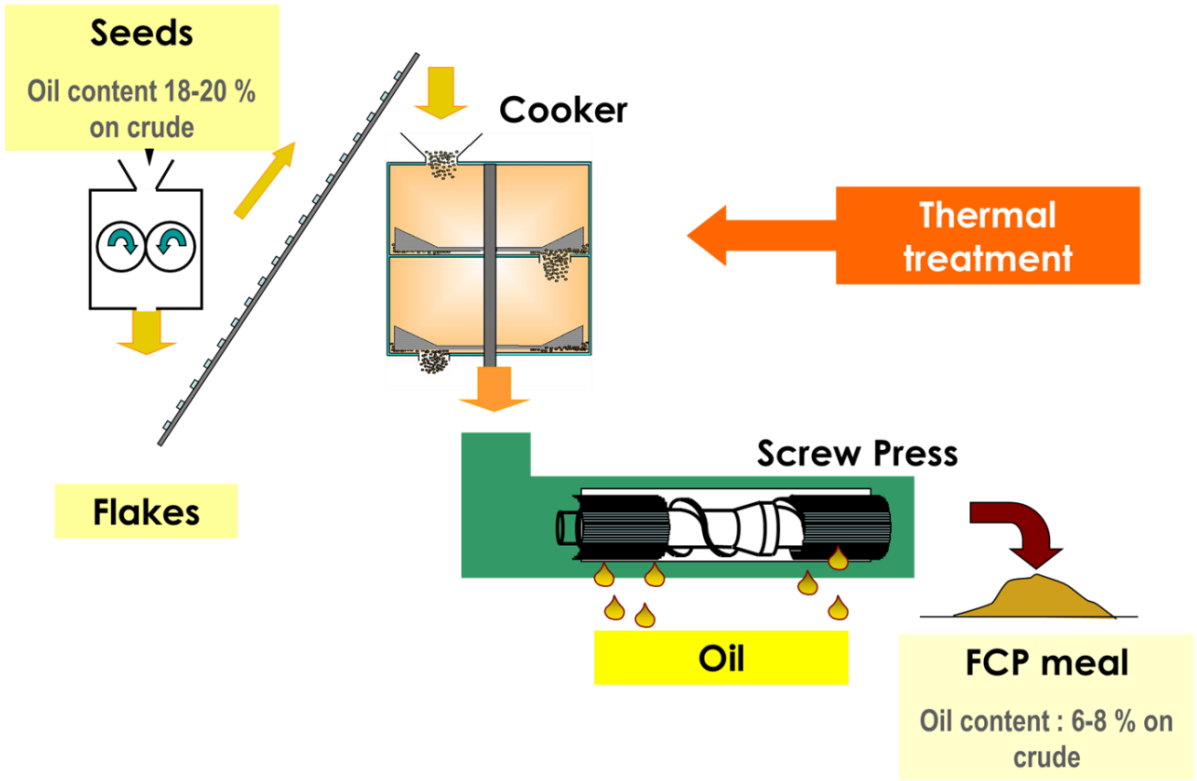
Objectives of the study

- To select the most suitable process for soybean
- To optimize the technical conditions for the selected process
- To assess the quality and economical performances of the process

Flowsheet of the FCP process

- Suitable and specific heat treatment required to reduce trypsine inhibitor activity (TIA) + preference for a versatile process

Selection of the Flaking-Cooking-Pressing (FCP)



METHOD FOR TECHNICAL STUDY

- Lab scale trials (1kg h^{-1}) in CREOL to modelise the hydro-thermal effects of the cooking stage
- Pilot scale up (100 kg h^{-1}) in batch in the Mécanique Moderne facilities to adjust the conditions found out at lab scale and to evaluate the defatting efficiency
- Tests at pilot scale (100 kg h^{-1}) in continue way in CREOL to validate the conditions established in batch and to evaluate the deffating efficiency

RESULTS – MEAL QUALITY

Average of 6 trials

	Water content (% on crude)	Oil content (% on crude)	Proteins (% on crude)	TIA (TIU/mg on crude)	Protein solubility (%)
Seeds	11.8	19.3	34.6	35.5	92
FCP meal (Cooking)	6.7	6.7	44.4	3.8	73
Extraction meal Feedbase	87.7	1.7	43.7		

- Efficient reduction of the Trypsin Inhibitor Activity
- Acceptable oil extraction yield
- Correct level or the protein solubility in soda (73%).

RESULTS - PREDICTIVE MEAL COMPOSITION

Predictive composition of meal obtained with FCP process applied to a 20 000 T y^{-1} plant

Process	Water content (% on crude)	Oil content (% on crude)	Proteins (% on crude)	TIA (TIU/mg on crude)	Protein solubility (%)
Seeds	12	19,3	34,6	> 35	> 80
FCP meal (Cooking)	4.5	7.2	44.5	< 8	> 70

RESULTS / CRUSHING COST PRODUCTION FOR THE CPP

- 20,000 t year^{-1}
- 7 years for depreciation
- 4% of interests
- steam cost: 0,059 US $/kWh
- electricity cost : 0,0760 US $/kWh
- Other costs provided by the industrial and process supplier partners

Cost (US $/t)	FCP process
Damping	9.8
Financial expenses	1.5
Insurances, cash-flow	3.1
Maintenance	1.0
Thermal energy *Electrical energy*	*8.9* *5.5*
Total energy	14.4
Labor	13.8
Total (US $/T crushed seeds)	43.6

RESULTS : ASUMPTIONS FOR MARGINS CALCULATION

Gross margin = value of outputs (oil and meal)– value of the inputs (seeds)

Net margin = value of outputs (oil and meal)– value of the inputs – processing cost

Divided by the quantity of crushed seeds per year to get the margin/T

Market prices used for the study (ref 2011)

	Seeds	Meal	Oil
US $/T	460	409	1197

RESULTS : ASUMPTIONS FOR MARGINS CALCULATION (1/2)

Three set of hypotheses :

- **Optimistic :** the best we can expect for oil extraction yield (6.4% residual fat in meal) and products quality valorization (oil and meal)
- **Intermediate :** the realistic medium value for oil extraction yield (7.2% residual fat in meal) and products quality valorization
- **Pessimistic :** the realistic medium value for oil extraction yield (7.2%) and poor valorization of the products quality

RESULTS : ASUMPTION SET FOR GROSS MARGIN CALCULATION (2/2)

Assumptions for soymeal local trade price in relation to the quality traits of the delivered products (in US $/T crushed seeds)

Hypothesis	Valorization	Protein in Meal	Oil	Identity Preserv.	Logistic gain	Total outputs
Optimistic	Level	PROFAT	100%	100%	100%	537
	Value ($)	347	173	10.1	7.1	
Intermediate	Level	PROFAT	100%	67%	67%	530
	Value ($)	353	165	6.8	4.8	
Pessimistic	Level	PRO	95%	33%	33%	479
	Value ($)	316	157	3.4	2.4	

RESULTS : NET MARGINS

Net margin according to 3 sets of valorization hypotheses of the delivered meal and oil (in US $/T of crushed seeds)

Hypothesis	Inputs (seeds)	Outputs (meal, oil)	Gross margin	Processing costs	Net Margin
Optimistic	461	537	**76,9**	43,6	**33,3**
Intermediate	461	530	**69,3**	43,6	**25,7**
Pessimistic	461	479	**18,8**	43,6	**-24,8**

RESULTS : ASUMPTION SET FOR MARGIN CALCULATION

Assumptions for premium level with additional GMO free premium in relation to specific quality traits of the delivered products

Hypothesis	Valorization	Protein in Meal	Oil	GMO free	Identity Preserv.	Logistic gain	Total
Optimistic	Level	PROFAT	100 %	100%	100%	100%	575
	Value ($)	347	173	38	10.1	7.1	
Intermediate	Level	PROFAT	100 %	67%	67%	67%	555
	Value ($)	353	165	25.7	6.8	4.8	
Pessimistic	Level	PRO	95%	33%	33%	33%	492
	Value ($)	316	157	12.6	3.4	2.4	

RESULTS : NET MARGINS

Net margin according to 3 sets of valorization hypotheses

with GMO free premium

Hypothesis	Inputs (seeds)	Outputs (meal, oil)	Gross margin	Processing costs	Net Margin
Optimistic	461	**575**	114,9	43,6	**71,3**
Intermediate	461	**555**	95,0	43,6	**51,4**
Pessimistic	461	**492**	31,5	43,6	**-12,1**

CONCLUSION

- Processing conditions of a small/medium scale crushing plant (20 000 T y^{-1}) based on flaking-cooking- pressing have been established at pilot level

- Quality of the delivered soymeal is good and meets the requirements of livestock actors

- Real chain value based on the FCP crushing process depends on the premium that livestock actors will accept to pay for local protein source, identity preserved management and GM free soymeal

Thank you for your attention ！