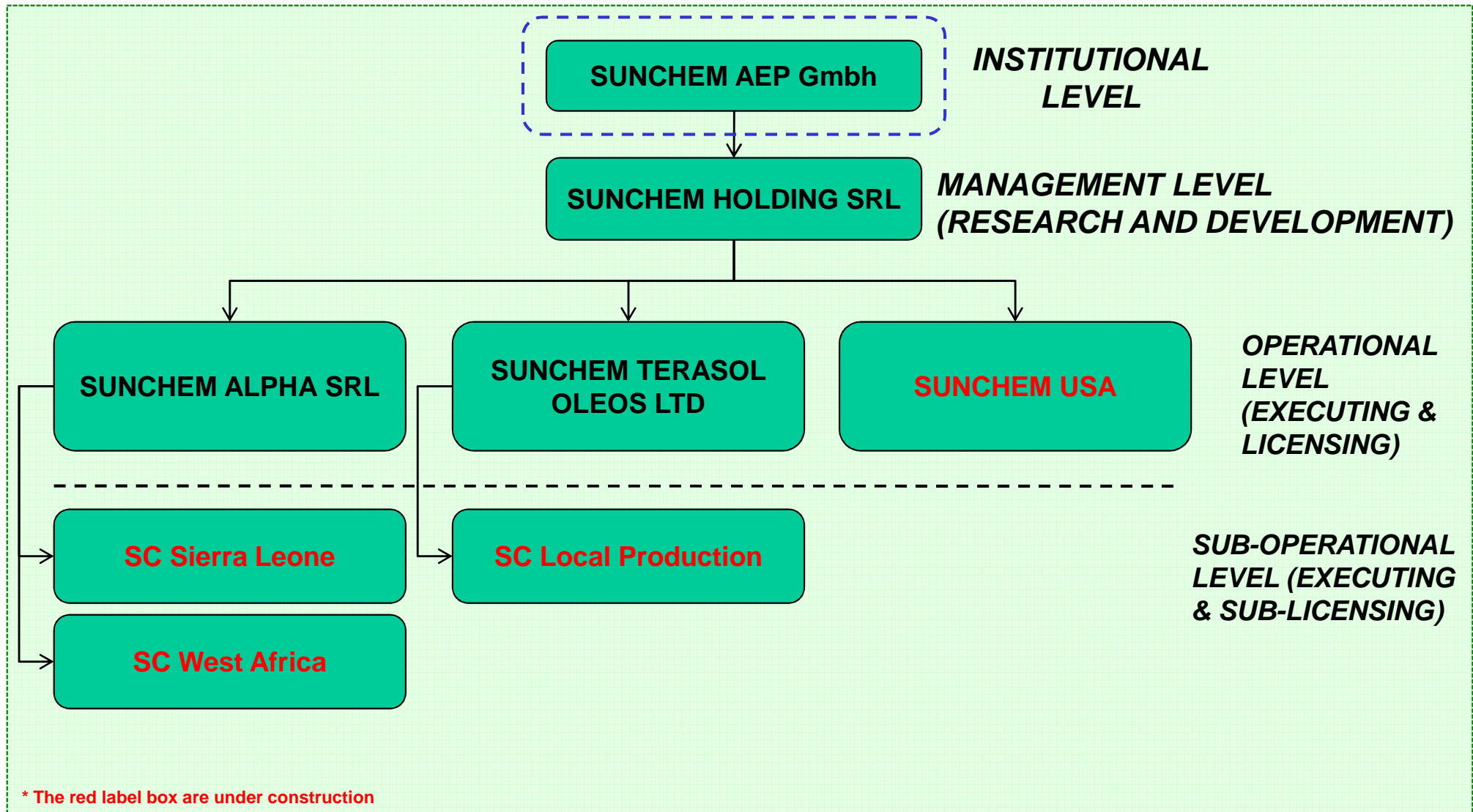




**Development of a High Seed – Yielding Tobacco
Plant Ideotype for Oil Production
Transforming Tobacco into an Oil Crop**

July 2011

Toboil – Energy Tobacco Project: Evolving Legal Structure



Our structure – Sunchem Holding (management level)



Plantechno is a research laboratory specialized in plant genetic improvement and recombinant DNA technology applied to plants. In 10 years of research Plantechno has selected some tobacco varieties for energy applications aimed at the production of seeds rather than leaves



Idroedil is an Italian company operating in the urban waste management and green energy since 1965. They are operating at the industrial level on different sectors: biomass plant for energy production, old tyres recycling plant, co-generation using vegetable oil and biogas



Plantechno & Idroedil are collaborating for the development of the industrial application of this new energy crop. The entrepreneurial group has created **Sunchem Holding Srl** who holds the exclusive rights to use and develop at the international level the new crop, patented as "seed tobacco" (Italian patent RM2007A000129, international patent PCT/IB/2007/053412, national phase in 57 countries, granted already in more than 10 states)



The operational level



Sunchem Alpha Srl is operating in Italy and North Africa to promote the cultivation of Toboil at a large scale basis

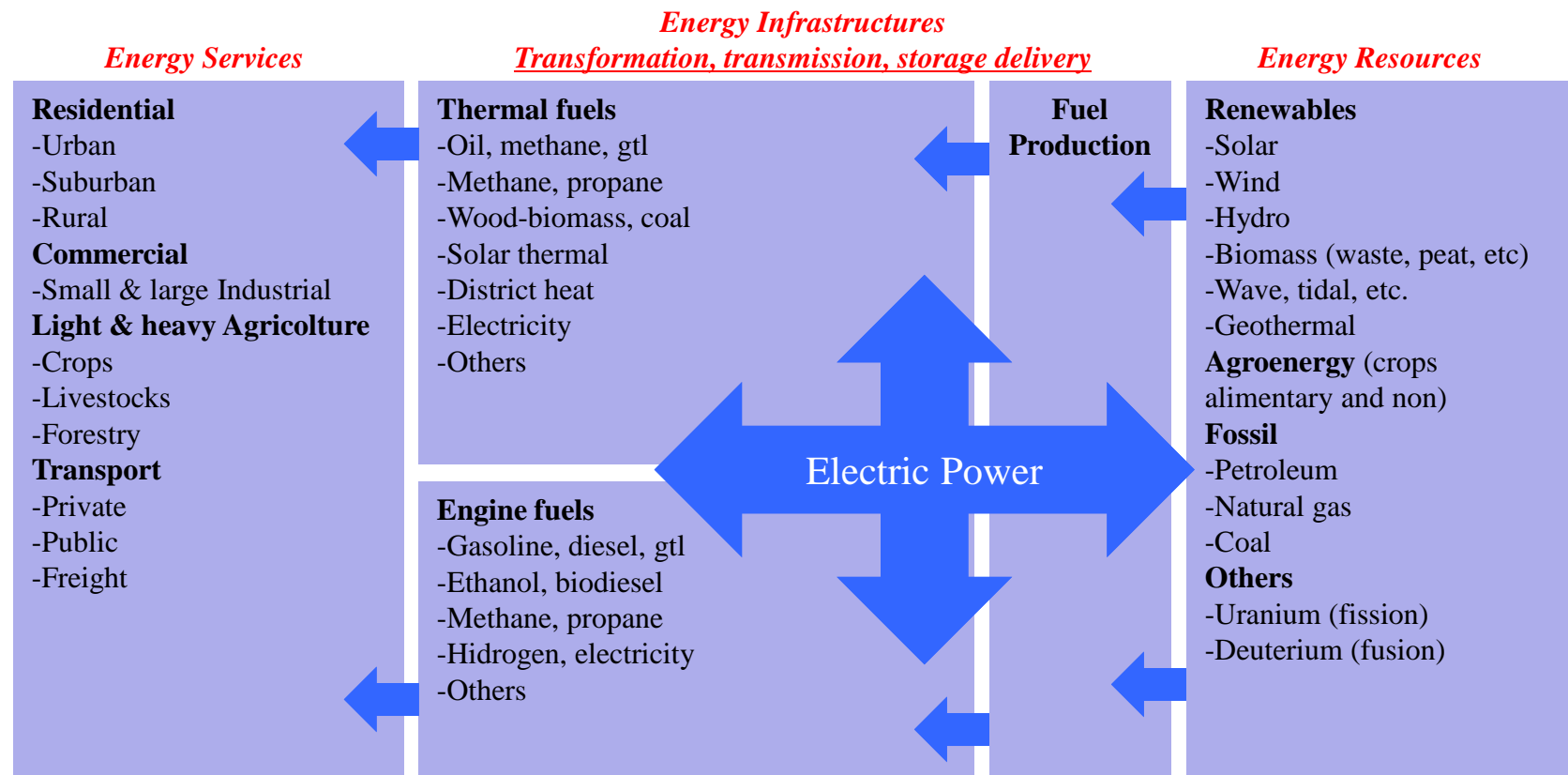


Sunchem Terasol Oleos Ltda is operating in some region of Brazil to promote the cultivation of Toboil at a large scale basis

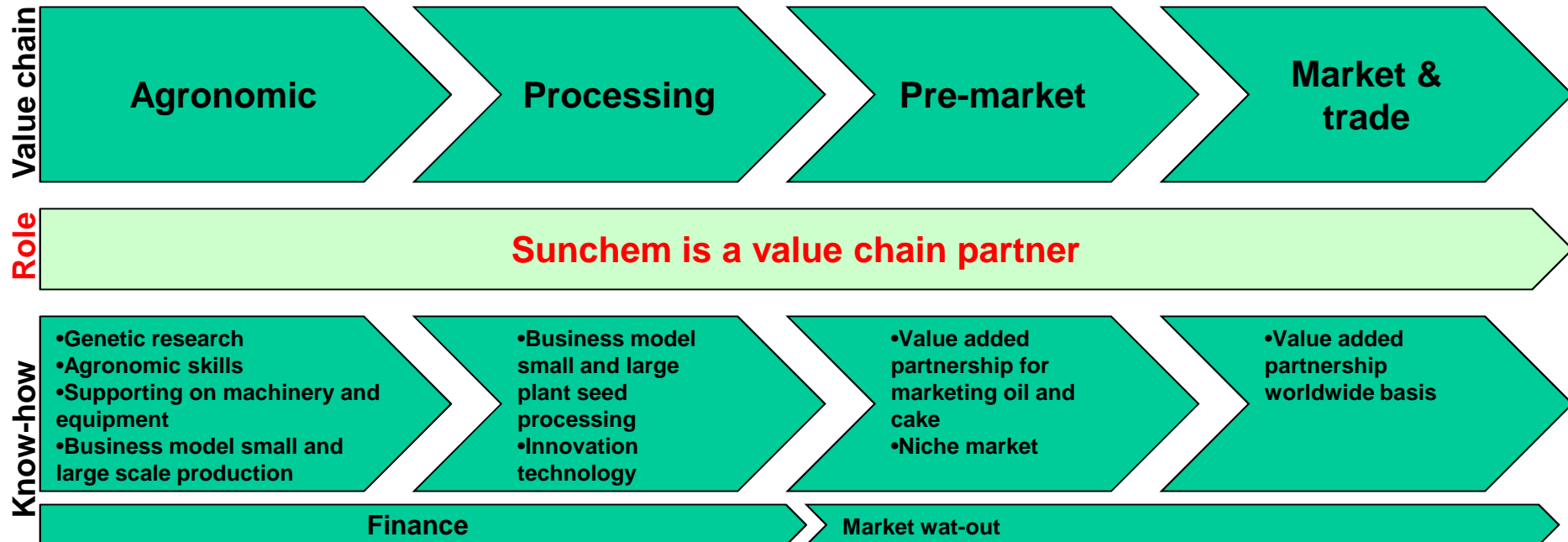
In the following months we are planning to create new scope companies in order to manage West Africa, Bulgaria, Namibia, USA, China



Basic Components of the Energy Sector



Oil Crop Value Chain and Sunchem Holding Market Position



Evolving value chain and Sunchem Position: G2M “from genetic to market”



Tobacco as oil crop: the genesis

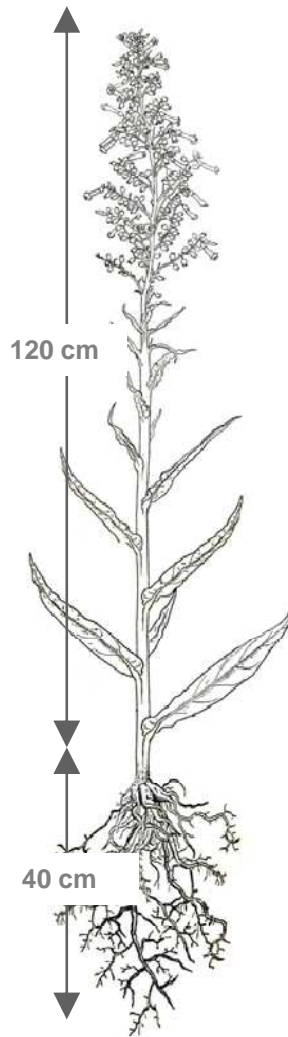
- Surprisingly, tobacco has never been considered an 'oil crop' despite:
 - Having the potential for very high seed production/ha
 - Having seeds with 39-41% oil
 - Being a familiar, widely grown agricultural crop
 - Having the ability to grow on marginal soils



In fact, tobacco has been grown exclusively for leaves, and seed production has been selected ***against***

This means that there is great potential for further improvements through selection for seed yield characteristics

Our Plant of Seed Tobacco



- The plant of tobacco for energy applications, contrary to the tobacco for the cigarettes industry, maximizes the production of flowers and seeds to the detriment of the leaves production and quality
- Its tobacco seed has a diameter of about 0.6 mm and is produced by the inflorescence in capsules 1.5 cm long, each capsule holds 0.5 g of seeds and each inflorescence more than 100 capsules
- The plant is extremely robust, able to grow in various climates and soils, as a matter of fact it can be cultivated on marginal lands which cannot be used for food production
- It is an annual plant, with the harvest in the same year of the sow, allowing farmers to plan every year the size of dedicated fields
- Sunchem has available both non GMO varieties as well as GM varieties for resistance to herbicide and insects

Our Plant of Seed Tobacco (2)



- The cultivation techniques are more economical than the ones of other traditional oil seeds and they include:
 - transplanting or direct seeding
 - few irrigations during the first phases of growth
 - low level of fertilization
- Production yields per hectare (average):
 - Density: from 60.000 to 90.000 plants/ha
 - 10 ton/ha of seeds – 2 Harvest (7% humidity - 40% oil content)
 - Biomass - 15 ton/ha of leaves and stems (80% humidity)
- Test field results obtained this year show that 2 harvest are feasible in north Mediterranean countries like Italy, Spain, Bulgaria, Romania
 - Sunchem believes that in southern Mediterranean countries the tobacco plant would be bi-annual allowing up to 4 harvest per year with a total annual production of 20 ton/ha
- Using a screw press loaded with tobacco seeds we have obtained:
 - 33% of tobacco oil (yield per hectare 3.3 ton of oil) – the oil is very clear and with low density; and
 - a residual oil cake with an 8% oil content, calorific value of 4,618 Kcal/kg and a high content of omega 6 (linoleic acid) that makes it particularly interesting for the preparation of animal feed

Key characteristics of Sunchem tobacco oil (raw oil)

Property
Acid value and FFA (free fatty acid) content (it would be useful to have the ffa profile)
Moisture content
Viscosity (dynamic and kinematic)
Suspended solids
Density/ average molecular weight
Sulphur
Metals (ca + mg)
Flash point
Cloud point
Pour point
Net Calorific value
Breakdown of the various acid components

Italy	Brazil	Egypt
1,2	1,5	1,8
0,1	0,12	0,09
30,6	32	30,2
nd	nd	nd
926	925	926,8
<3	<3	3,7
28	26	24
258	260	254
-3,8	-3,9	-4
-18	-21	-17
8920	8920	8920
Average data		



Applications:

- Biodiesel Production
- Cogeneration of electrical power and heat
- Industrial, chemical and cosmetic applications

Fatty acids content:

- 75%-77% linoleic acid
- 11%-12% oleic acid
- 8%-10% palmitic acid
- 2%-3% stearic acid

(1) Test performed by Stazione Sperimentale per i Combustibili – 2008, 2009, 2010, 2011 San Donato Milanese Milano ITALY

Key characteristics of Sunchem tobacco oil (biodiesel)

INPUT: refined and bleached TOBOIL (neutralized by NaOH - bleading 1% Tonsil optimum)

Property	Units	lower limit	upper limit	Test-Method	DATA
FAME content	% (m/m)	96,5	-	EN 14103	98,3
Density at 15°C	kg/m³	860	900	EN ISO 3675 / EN ISO 12185.	884
Viscosity at 40°C	mm²/s	3,5	5	EN ISO 3104	4,5
Flash point	°C	> 101	-	EN ISO 2719 / EN ISO 3679.	>158
Sulfur content	mg/kg	-	10	ISO 20846 / EN ISO 20884.	<3
Carbon residue remnant (at 10% distillation remnant)	% (m/m)	-	0,3	EN ISO 10370	0,13
Cetane number	-	51	-	EN ISO 5165	53,8
Sulfated ash content	% (m/m)	-	0,02	ISO 3987	<0,01
Water content	mg/kg	-	500	EN ISO 12937	185
Total contamination	mg/kg	-	24	EN 12662	20
Copper band corrosion (3 hours at 50 °C)	rating	Class 1	Class 1	EN ISO 2160	1
Oxidation stability, 110°C	hours	6	-	pr EN 15751 / EN 14112	2,1
Acid value	mg KOH/g	-	0,5	EN 14104	0,12
Iodine value	-	-	120	EN 14111	138
Linolenic Acid Methylester	% (m/m)	-	12	EN 14103	0,83
Polyunsaturated (>= 4 Double bonds) Methylester	% (m/m)	-	1	EN 14103	nd
Methanol content	% (m/m)	-	0,2	EN 14110	0,03
Monoglyceride content	% (m/m)	-	0,8	EN 14105	0,45
Diglyceride content	% (m/m)	-	0,2	EN 14105	0,1
Triglyceride content	% (m/m)	-	0,2	EN 14105	0,04
Free Glycerine	% (m/m)	-	0,02	EN 14105 / EN 14106	<0,01
Total Glycerine	% (m/m)	-	0,25	EN 14105	0,16
Group I metals (Na+K)	mg/kg	-	5	EN 14108 / EN 14109 / EN 14538	2
Group II metals (Ca+Mg)	mg/kg	-	5	EN 14538	2
Phosphorus content	mg/kg	-	4	EN14107	nd

Benchmark oil crops

Crop	kg oil/ha	L oil/ha
maize	145	172
cashew	148	176
oats	183	217
lupine	195	232
kenaf	230	273
calendula	256	305
cotton	273	325
hemp	305	363
soybean	375	446
coffee	386	459
linseed	402	478
hazelnuts	405	482
euphorbia	440	524
pumpkin	449	534
coriander	450	536
mustard	481	572
camelina	490	583
sesame	585	696

Crop	kg oil/ha	L oil/ha
safflower	655	779
rice	696	828
tung oil tree	790	940
sunflowers	800	952
cocoa	863	1026
peanuts	890	1059
poppy	978	1163
rapeseed	1000	1190
olives	1019	1212
castor beans	1188	1413
pecan	1505	1791
jojoba	1528	1818
jatropha	1590	1892
macadamia	1887	2246
brazil	2010	2392
avocado	2217	2638
coconut	2260	2689
palm oil	5000	5950

Comparison only on 1 harvest. Toboil could give more cut a year.
It is going to become the most productive oil crop worldwide.

Benchmark oil crops (based on 1 cut per year)

Comparison of European Energy Crops

	Rapeseed	Sunflower	Soybean	Tobacco
Seed Yield (MT/ha)	3.3 ^a	1.9 ^a	1.5-3.3 ^a	5.7 ^b
% Oil Content of Seeds	33.2-47.6 %	32-45 %	21-22 %	39-41 %
Oil Production (MT/ha) ^c	0.88-1.14	0.49-0.68	0.25-0.58	1.77-1.87
Density (kg/L)	0.9115	0.9161	0.9138	0.9175
Volume of extracted oil (L/ha)	965-1,250	534-742	274-635	1,930-2,038

^a Based on 2004 average EU-25 production (from “Agriculture in the European Union - Statistical and economic information 2005”)

^b Based on field trials of improved high-yielding tobacco varieties in Italy.

^c Assuming 80% extraction efficiency

Benchmark on fatty acid specs

FA name	FA struc	Tobacco Oil	Rapeseed Oil	Sunflower Oil	Soybean Oil
caproic acid	C6:0	ND	ND	ND	ND
caprylic acid	C8:0	ND	ND	ND	ND
capric acid	C10:0	ND	ND	ND	ND
Lauric acid	C12:0	ND	ND	ND-0.1	ND-0.1
myristic acid	C14:0	ND	ND-0.2	ND-0.2	ND-0.2
Palmitic acid	C16:0	8.0-9.7	1.5-6.0	5.0-7.6	8.0-13.5
Palmitoleic acid	C16:1	0.1-0.2	ND-3.0	ND-0.3	ND-0.2
margaric acid	C17:0	ND	ND-0.1	ND-0.2	ND-0.1
Margaroleic acid	C17:1	ND	ND-0.1	ND-0.1	ND-0.1
Stearic acid	C18:0	2.4-3.2	0.5-3.1	2.7-6.5	2.0-5.4
Oleic acid	C18:1	10.6-12.1	8.0-60.0	14.0-39.4	17.0-30.0
Linoleic acid	C18:2	75.0-76.8	11.0-23.0	48.3-74.0	48.0-59.0
Linolenic acid	C18:3	0.9-1.4	5.0-13.0	ND-0.3	4.5-11.0
Arachidic acid	C20:0	0.1	ND-3.0	0.1-0.5	0.1-0.6
Eicosenoic acid	C20:1	0.2	3.0-15.0	ND-0.3	ND-0.5
Eicosadienoic acid	C20:2	ND	ND-1.0	ND	ND-0.1
Behenic acid	C22:0	ND	ND-2.0	0.3-1.5	ND-0.7
Erucic acid	C22:1	ND	2.0-60.0	ND-0.3	ND-0.3
Lignoceric acid	C24:0	ND	ND-2.0	ND-0.5	ND-0.5

0 to 5%
5 to 10%
10 to 30%
30 to 50%
50 to 75%
75 to 85%

Data for rapeseed, sunflower, and soybean derived from Codex Standard for Named Veg. Oils, Codex-Stan 210
 Data for tobacco generated from analysis of 6 tobacco seed lots by Stazione Sperimentale per le Industrie degli Oli e Grassi (Milano, Italy).

Key characteristics of the residual oil cake

Key Characteristics of Tobacco Residual Cake			
Humidity	ASTM D 5142-04	8.0	%
Ashes	"	5.5	%
Carbon	ASTM D 5373-07	47.6	% m/m
Hydrogen	"	6.1	% m/m
Nitrogen	"	5.8	% m/m
Net Calorific Value	ASTM D 5865-07	4618	kcal/kg
Macroelements			
Calcium	UNI CEN/TS 15290	2450	mg/kg
Magnesium	"	6287	mg/kg
Potassium	"	15594	mg/kg
Sodium	"	25	mg/kg
Ashes			
Softening Temperature	DIN 51730	1065	°C
Melting Point	"	1290	°C

In term of pro-fat mix % our product achieves a real market value

Applications:

- Animal feed:
 - oil cake with a protein content of 35%;
 - absence of nicotin and high content of omega 6 (linoleic acid);
 - characteristics that make it useful as an integrator in the preparation of animal feed
- Cogeneration of electrical power and heat



(1) Test performed by Stazione Sperimentale per i Combustibili – 2010 San Donato Milanese Milano ITALY

How many products we get from tobacco seed?



By cold press

From 1 TN of seed

**670 kg
Oilcake**

**330 kg
Oil**



Production for a 100,000 hectares cultivation



**Total seed production
1,000,000 TN**

**OilCake
670,000 TN**

**330,000 TN
Oil**



If we are going to manage
the oil for Energetic use
(based on our experience)
1 liter Toboil = 3,8 kwe

$330,000 \times 1000 \times 3,8 =$
1 billion 254 mln Kwe

Hypothesis for the engine
8000 hours/year

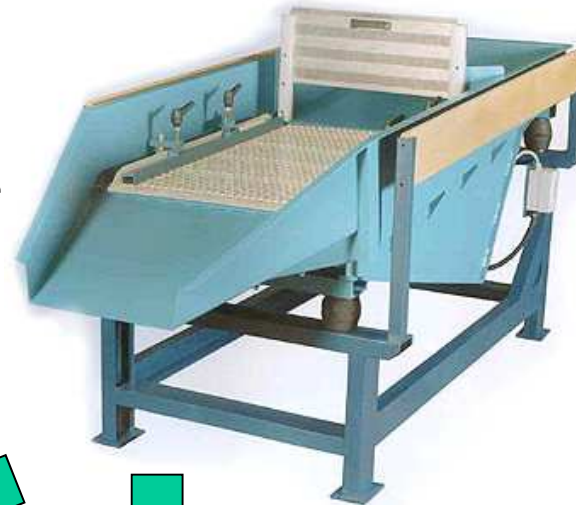
$156,750 \text{ Kwe} = 156.75 \text{ Mwe/H}$

$156,75 \times 8000 = 1248 \text{ Gwe}$
+ add termic power
+ add biomass power

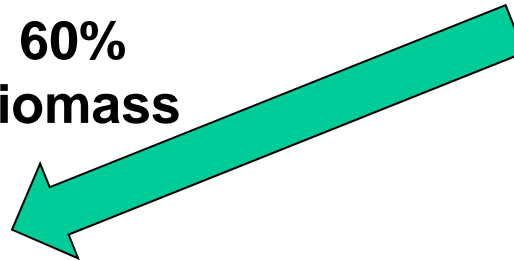
We don't have to forget the biomass !!



**From 1 TN of
dry inflorescence**



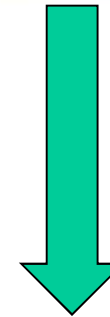
**60%
biomass**



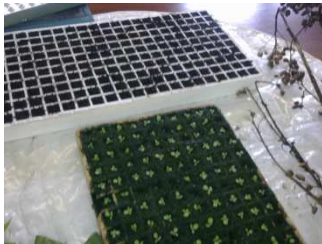
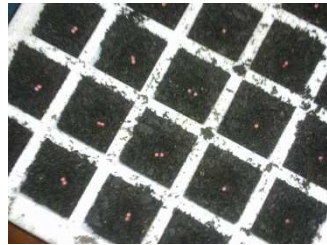
Residual biomass could be used:

- as organic fertilizer
- transform in pellet
- calorific power 3,800 kcal/kg

**40%
seed**



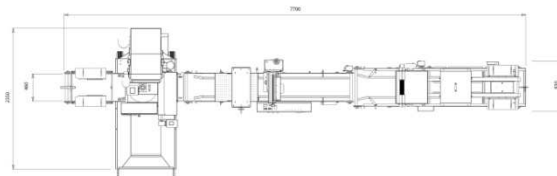
Toboil: greenhouse (1)



Plateau and
Seed/pellet



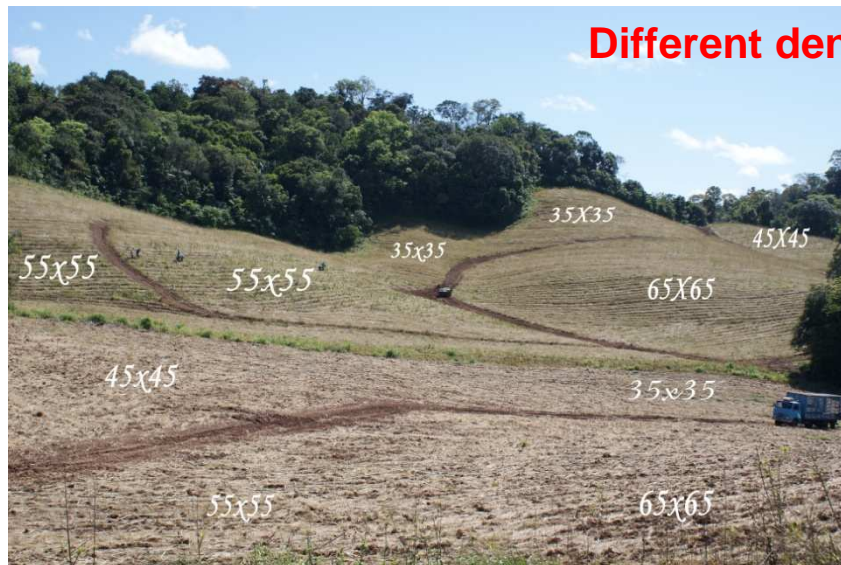
Greenhouse
Float system



**Greenhouse in going to take
40-45 days before transplanting**

Tobacco: transplanting (2a)

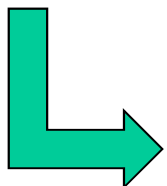
Different density



Bioplastic



**Manual or
Semi-automatic**



Macchine trapiantatrici automatiche e semiautomatiche



Tobool: direct seeding (2b)

Free Seeding



Direct Seeding Row 40-50

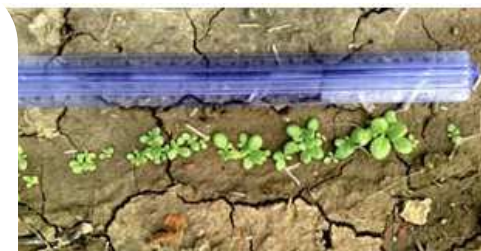


30 gr per hectar plus
zeolite or other mix



7 days germination

20 days germination



Direct Seeding in Brasil



Tobacco: growth, mechanical and manual harvest (3)



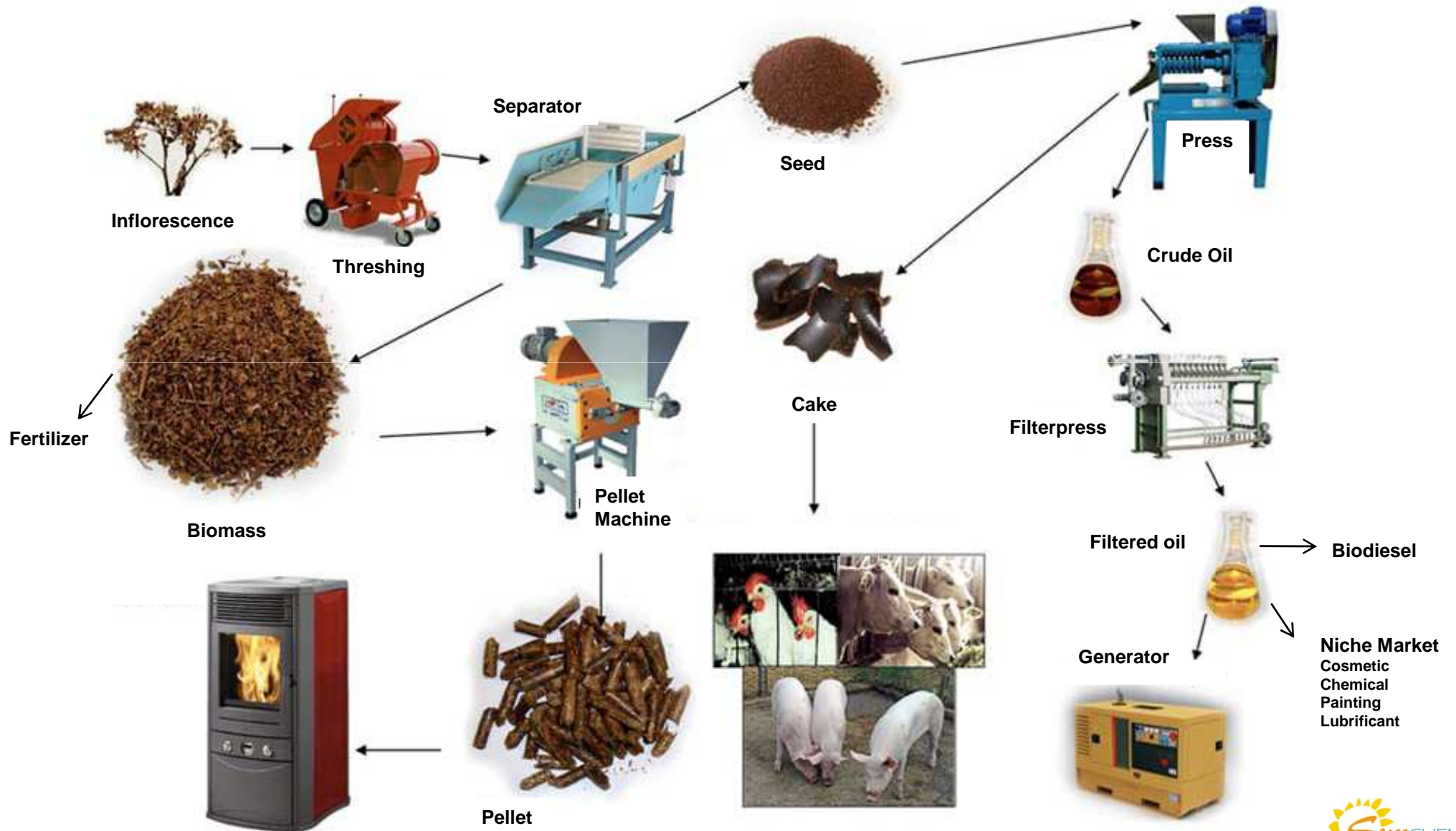
**105 days
first harvest**



**After first harvest
& regarding the climate
we can think about an harvest
every 40-45 days**



Full Process



Nicotine content

The work team carried out a series of certified analyses on the plant material (leaves and seed) and on the oil obtained from pressing the seed of the Solaris energy tobacco variety (PLT 103), obtained for selection by Sunchem as the enjoyment right of the variety, and the following nicotine contents were found:

Seed	< 5 ug/kg
Oil	= 3 ug/kg
Oil cake	< 2 ug/kg
Leaves	0.02% fresh weight

The above analyses imply that this variety of energy tobacco does not contain significant levels of nicotine.

Our Industrial Patent

The new agricultural species is patented as "seed tobacco" : Italian patent RM2007A000129 - International patent PCT/IB/2007/053412)

The patent claims are as follows:

- A group covers the mutagenised tobacco plant characterised in that it has a much higher seed production than the average seed production of the currently existing tobacco plants. The claimed plants, therefore, are plants that, for the same amount of sowed soil and seeds planted, produce a much higher quantity of seeds than any other tobacco plant currently on the market. The plants of the invention, can also be further genetically modified to provide resistance against the various pathogenic agents
- A second group claims the use of the plants for the production of seeds for the production of the products indicated in the patent: fuel, supplements, oil, oil cakes, etc.
- A third group claims the production method of the plant, therefore they also protect the necessary procedure to create the desired plants, at least in the methods indicated in the claims
- A fourth group protects the seeds of the plant, their use for producing tobacco oil, fuel oils, biodiesel, animal food supplements, solid fuels and dietary supplements for humans
- A fifth group protects the oil extraction method from tobacco seeds wherein the oil yield is equal to between 70 and 95% of the oil through the pressing step and any other steps
- A sixth group covers the tobacco seed oil that can be obtained with the extraction method according to previous claims characterized in that it has an iodine level of less than or equal to 120.

The patent claims extend to an international level and are currently undergoing negotiations with the different countries

Some Test Field - worldwide



Our results: Toscana Italy 2010 – Univ. of Bologna



**Cultivation Time
April – October**



Bio Plastic

No irrigation



2 Harvest

9,3 TN Seed



Our results: Bologna Italy 2010 – Univ. of Bologna



**Cultivation Time
April – October**

Transplant

No irrigation

2 Harvest

7,2 TN Seed



Our results: Egypt Cairo 2010 – Minister of Agriculture



**Cultivation Time
All Year**



Irrigated



5 Harvest



19 TN Seed



Our results: Egypt El Bostan 2010 - Minister of Agriculture



**Cultivation Time
All Year**

Irrigated

5 Harvest

17 TN Seed



Our results: Brasil Uberlandia 2010 – Private Partner



**Cultivation Time
Sept – May**

**Direct seedling
Large scale**

Irrigated & no

3 Harvest

11 TN Seed



Information Sheet

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