BIOLUBRICANT AND BIOFUEL FROM SUNFLOWER OIL

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SUMMARY

- VEGETABLE OILS
- NEAT VEGETABLE OILS AS FUELS
  - Research work
  - Applied results
- ADAPTATION TO EXISTING HARDWARE
  - Esters
  - Catalytic cracking
  - Blends
- WHICH SOLUTION ?

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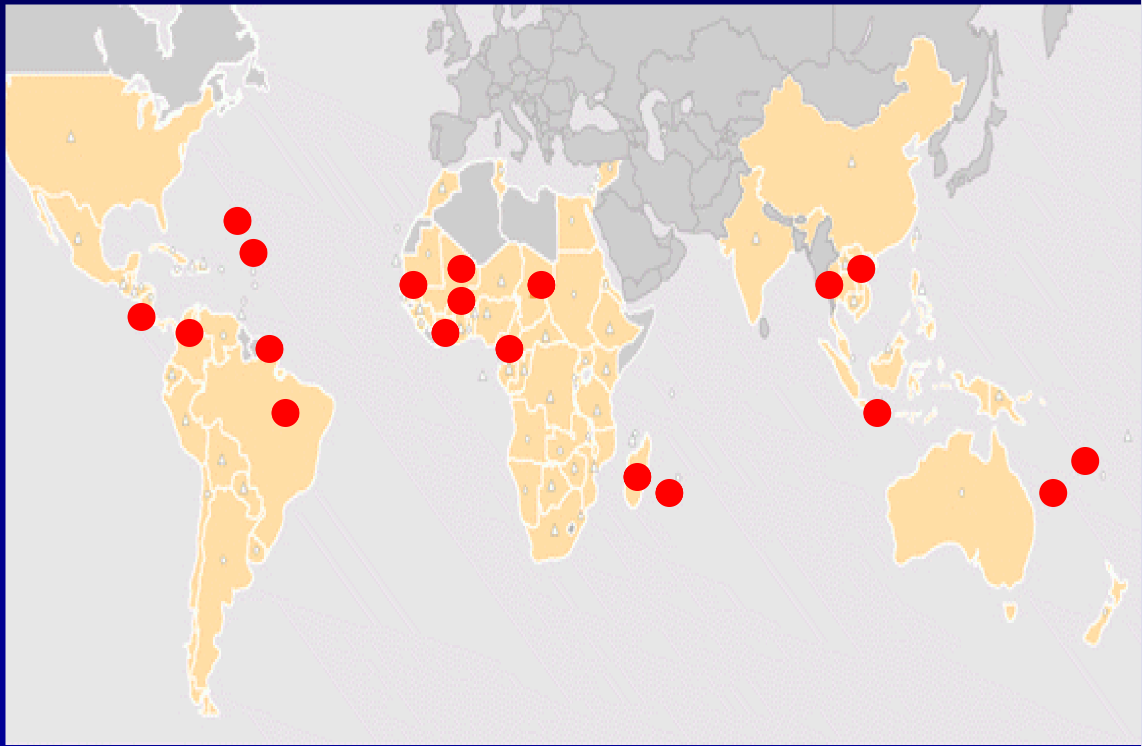
CIRAD PARTNERS

- National, international research & develop. cent.
- Universities
- Farmer's organizations
- Private comp., agricult., forestry manufacture
- N G Os
- Funding agencies



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Centre for International Cooperation in Agricultural Research for Development

- Food security
- Rational natural resources management
- Contribute to rural development tropical and subtropical areas

- R & D projects, experiments
- Training
- Scientific and technical journals

Agronomy, veterinary, forestry, agrifood, economic and social fields.

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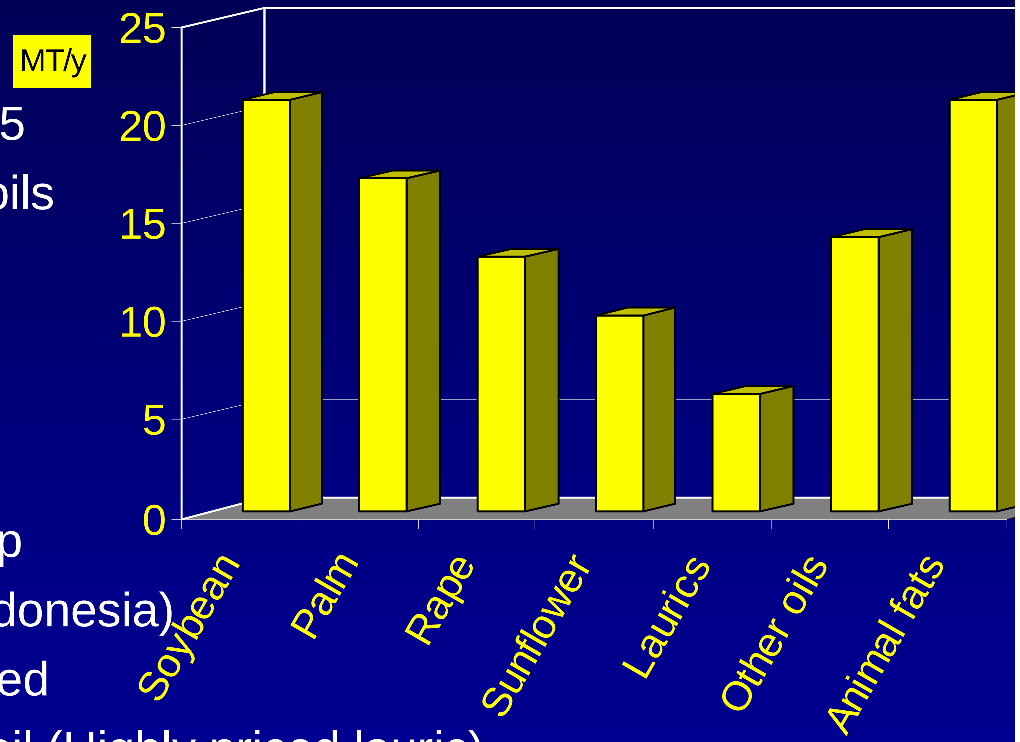
VEGETABLE OILS / WORLD

WORLD PRODUCTION (MT/year)

Total oils & fats ~ 110   Veg oils ~ 85

Soybean + palm oils ~ 50% of total oils

Food uses ~ 80%



DIFFERENT CROP SYSTEMS

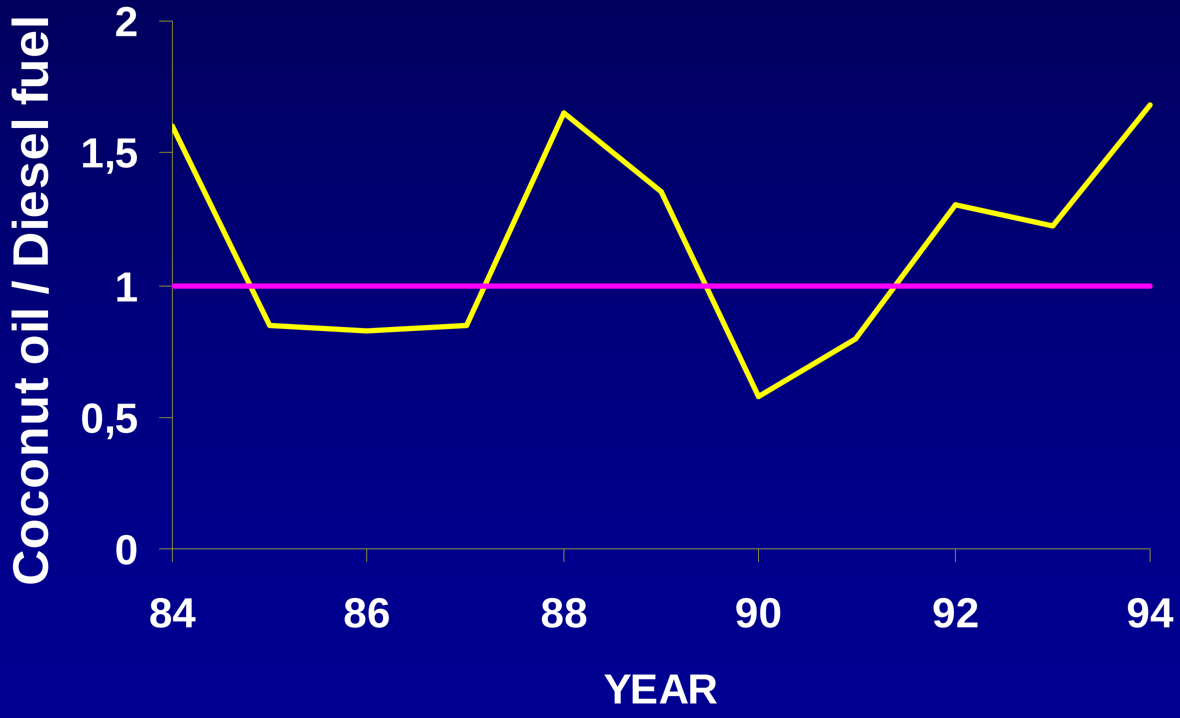
Soybean :	Oil palm :
annual crop	perennial crop
(US, Brazil)	(Malaysia, Indonesia)
highly mechanized	hand harvested
cake (animal feed)	palm kernel oil (Highly priced lauric)

→ **AGRICULT. AND ECONOMIC SPECIFICITY**

PRICES VEG. OILS (WORLD MARKET) > GAS OIL (DIESEL)

STILL POSSIBLE TO COMPET / LOCAL SPECIFIC CONDITIONS

TREND IN RELATIVE WORLD PRICES COCONUT OIL / DIESEL FUEL



V. O. as fuels can compet only under specific local conditions

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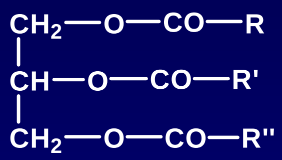
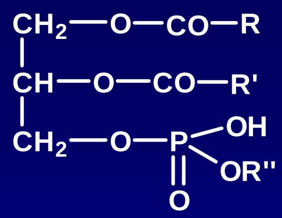
CHEMICAL COMPOSITION OF VEGETABLE OILS



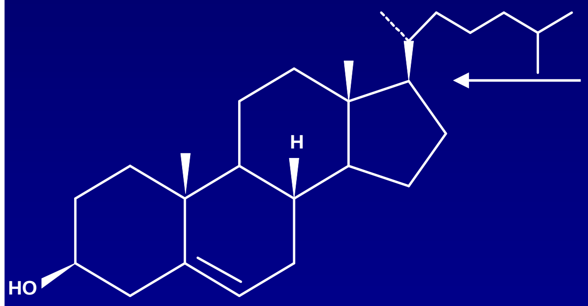
Triglycerides (> 90 % ; C 57 ; gasoil C16)

Phospholipids (0,1- 1 %)



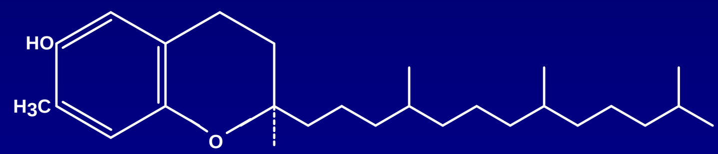
Waxes, Sterol esters

Unsaponifiable materials / Pigments (0,5 - 2 %)



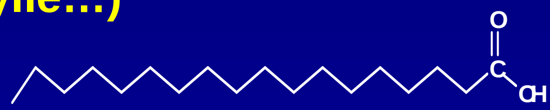
Sterols

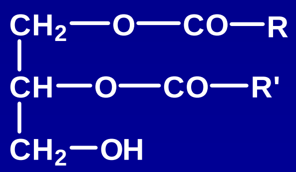
Tocopherols



Pigments (carotène, chlorophylle…)

Free fatty acids (0,5 - 5%)





Partial glycerides (1 - 10 %)

Oxidation products

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Fatty acid composition of triglycerides

Iodine Value (IV) = Total unsaturated fatty acids

COMPOSITION OF TRIGLYCERIDES

C = C

	COCONUT	PALM	COTTON	RAPESEED	SUNFLOW	SOYBEAN
Major Fatty Acids	C12:0 C14:0	C16:0 C18:1	C16:0 C18:2	C18:1	C18:2	C18:2
Saturated Triglycerides (% W)	**96**	59	5	2	**3**	4
Iodine Value	12	50	110	111	132	135

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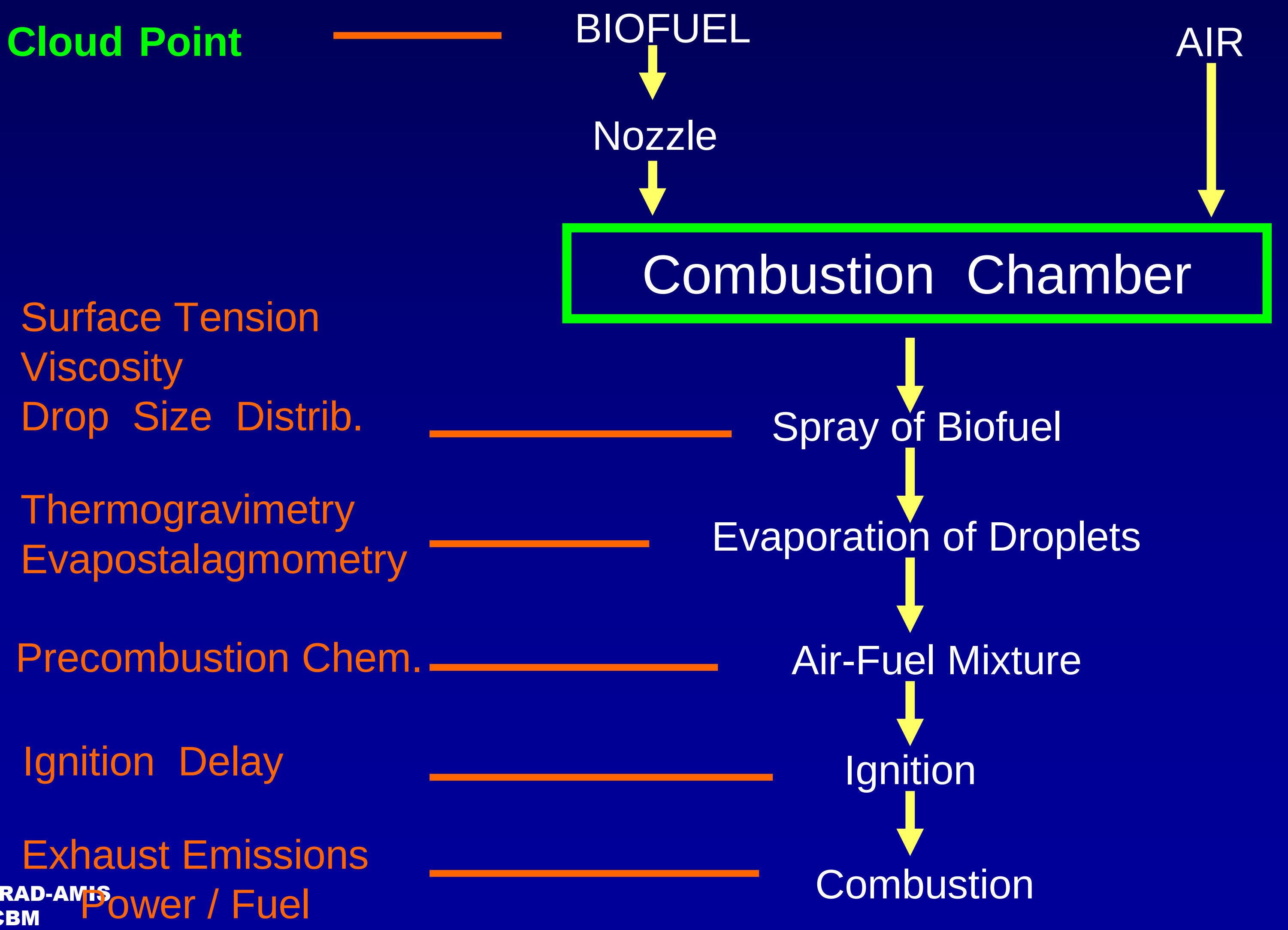
PHYSICO-CHEMICAL PROPERTIES OF DIESEL FUEL AND VEGETABLE OIL

	Diesel Fuel	Sunflower
Hydrocarbons (w%)	≈ 100	0
Glycerides (w%)	0	≈ 100
Oxygen content (w%)	≈ 0	10.8
Temp. Distillation 10% (°C)	205	256
Temp. Distillation 90% (°C)	350	none
Flash point (°C)	52	316
Heat Value (kJ/kg)	42 083	37 750
Ignition Delay (degr)	10.4	11.1
Cetane Number	50	34

VARIOUS PHENOMENA
IN AN ENGINE



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BEHAVIOR OF VEGETABLE OILS AS FUEL

	Coconut	Palm	Sunflower	Linseed
Iodine Value	12	50	130	196
Spray Specific Area (cm^2/ml)	1000	950	890	840
Kevap 450℃ ($10^{-5} mm^2/s$) (Evaporation – Pyrolysis)	245	110	70	55
Ignition Delay (°V)	6.8	7.9	8.6	10.1

⟹ High saturated FA content

↳ Low Iodine Value ⟶ better quality

Coconut > Palm > Cotton > Sunflower > Peanut > Soybean > Rapeseed > Linseed

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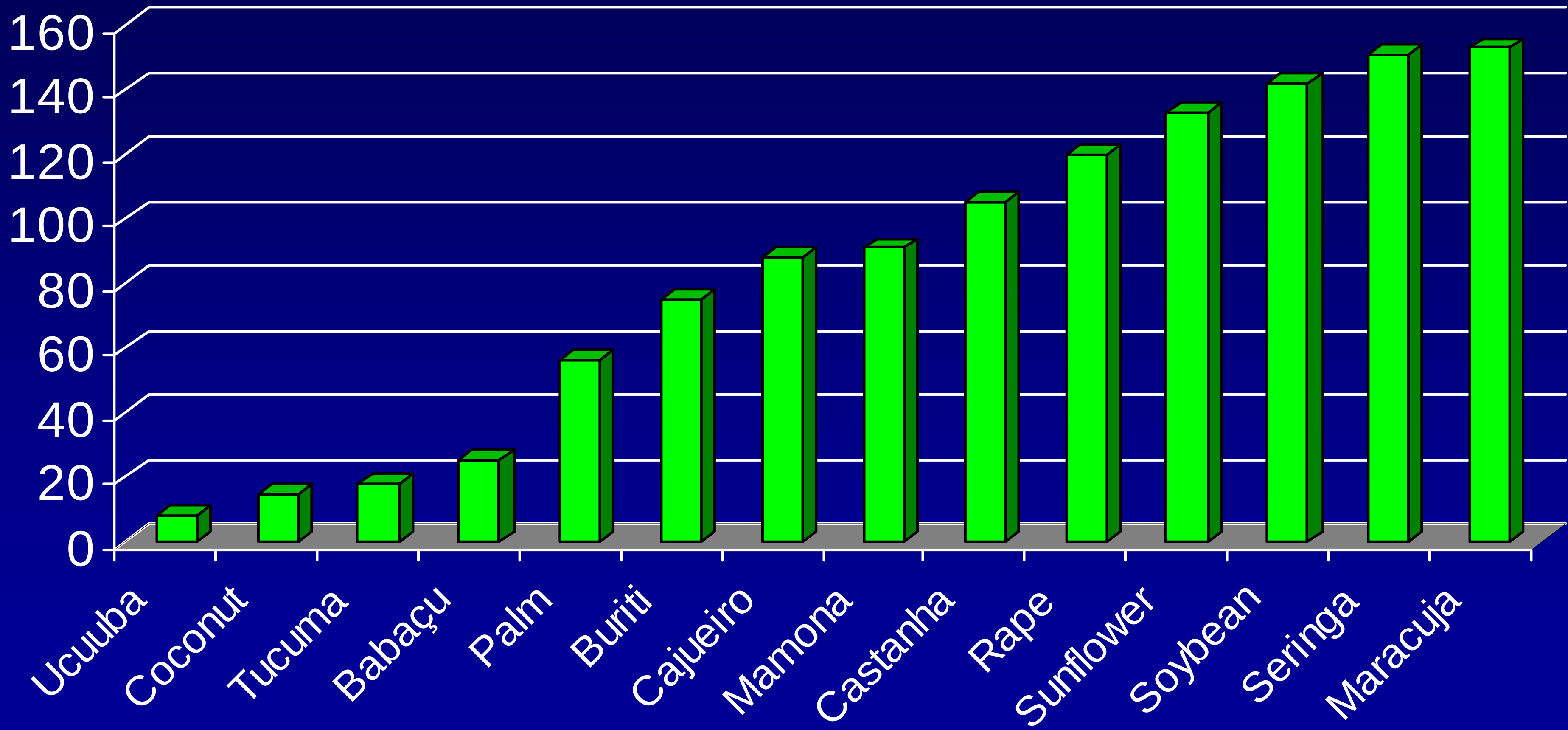
UNSATURATION OF OILS (IODINE VALUE)



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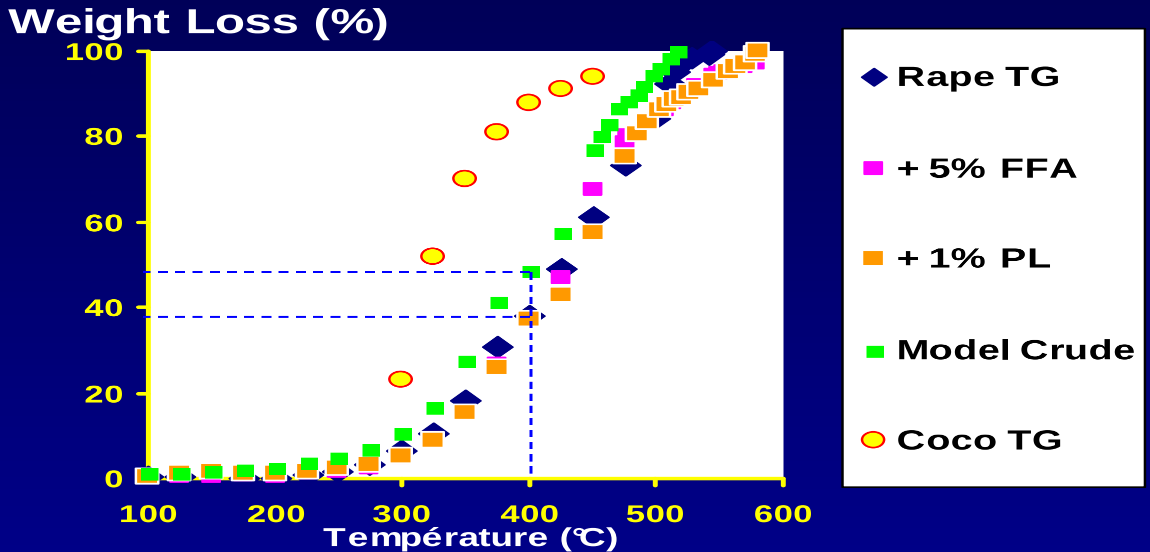
MAJOR DRAWBACKS OF VEG. OILS AS FUELS

- SLOW EVAPORATION - PYROLYSIS
  - High molecular weight TG
  - Lower ID / Gasoil
  - ➔ **INDIRECT INJECTION**
  - ➔ **HIGER TEMPERATURE IN COMB. CHAMBER**
- COKING
  - Slow evaporation
  - Phospholipids ?
  - ➔ **HIGHER TEMPERATURE IN COMBUST. CHAMBER**
- LOW TEMPERATURE PROPERTIES
  - Storage, cold start, filter, pump
  - High viscosity, phospholipids
  - ➔ **DEGUMMING STEP NECESSARY**

MINOR COMPONENTS / THERMOGRAVIMETRY



- In the Model Crude Oil, all together the 3 minor components have no adverse effect
- On the contrary at 400°C, weight loss is +25% / TG
- High Specific Area, High Evaporation Rate

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EXAMPLE OF SUNFLOWER OIL

- INDIRECT INJECTION ENGINE

(NOT ADAPTED)

	CO g/kWh	HC. g/kWh	NO_x g/kWh
Diesel fuel	2.3	0.6	6.6
Sunflower	1.9	0.5	6.4
EUR oct 98l			
ISO 8178 C1	6.5	1.3	9.2

LONG TERM TEST (1000 h)

Wear, Crankcase Lubricant

Drainage as for gasoil

- DIRECT INJECTION ENGINE

(ADAPTATED)

New design of combustion chamber

Thermal insulation of piston and liner

New injector type

	Torque 1500 rpm (Nm)	SP. Fuel consum. (g/KMh)	Efficiency (%)
Sunflower	410	247	39
Gasoil	403	217	38

FULL WARRANTY FROM ENGINE MANUFACTURER

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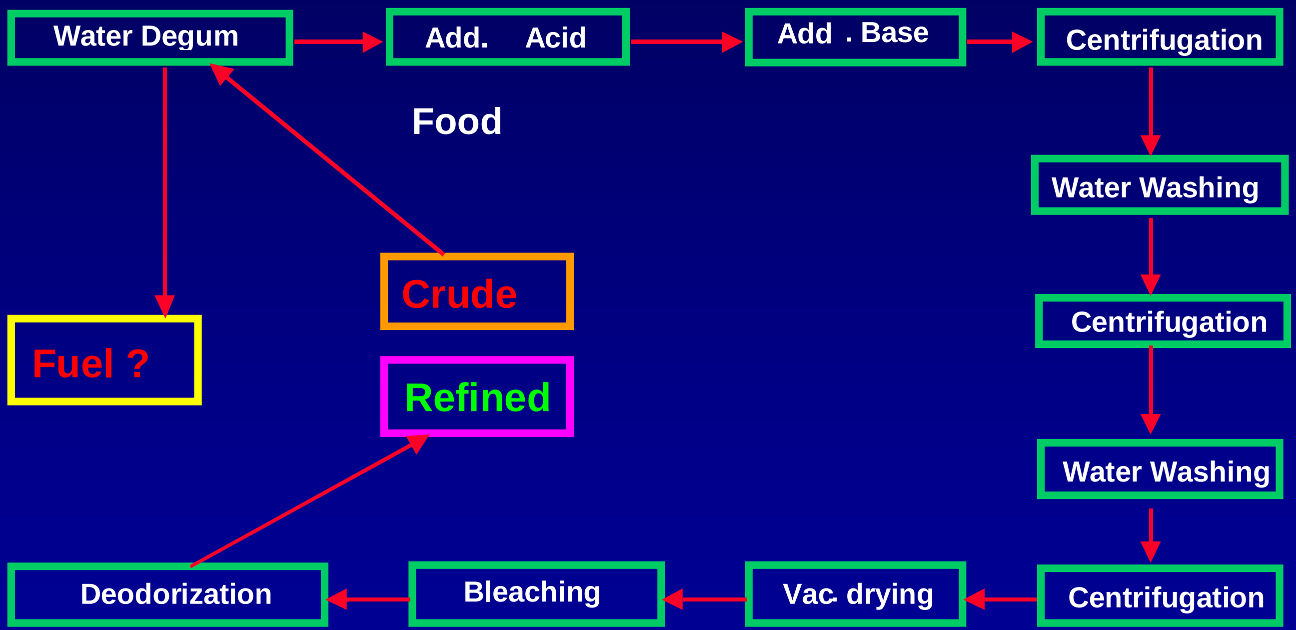
FLOW SHEET DIAGRAM FOR VEGETABLE OIL REFINING



WAYS FOR USING VEGETABLE OILS AS FUELS : ADVANTAGES AND DRAWBACKS

Biomass Available	Technical way	Number of components required	ADAPTATION OF ENGINE Spark ign.	Diesel direct inject.	Diesel indirect inj.	Best uses
Veg. Oil only	Veg. oil	1	/	Heavy	Light	A few big diesel engines, cars
	Cracking	1	No	No	No	All engines
	Blend	2 or more	/	Upon/case	Upon/case	All diesel
Veg. Oil + Alcohol	Ester	2	/	Light	Light	All diesel

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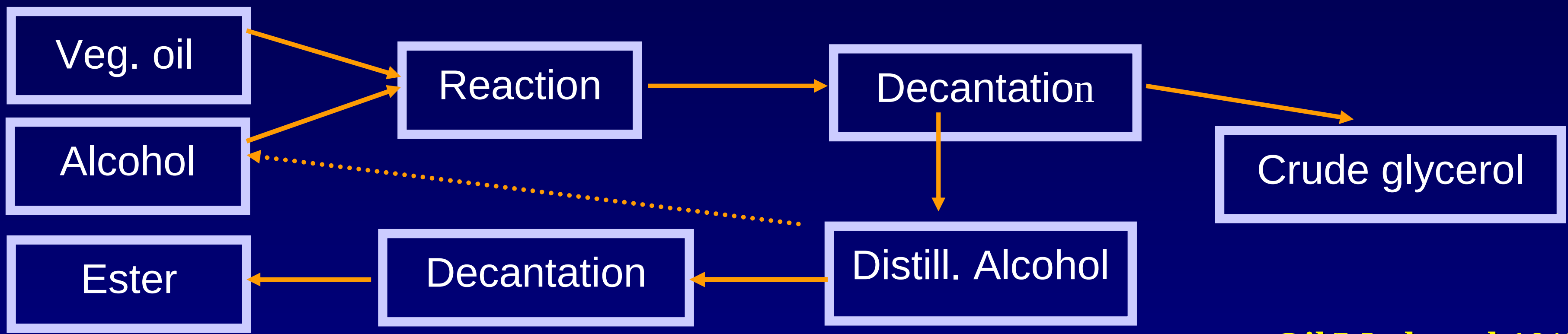
ESTERS FROM VEG. OILS

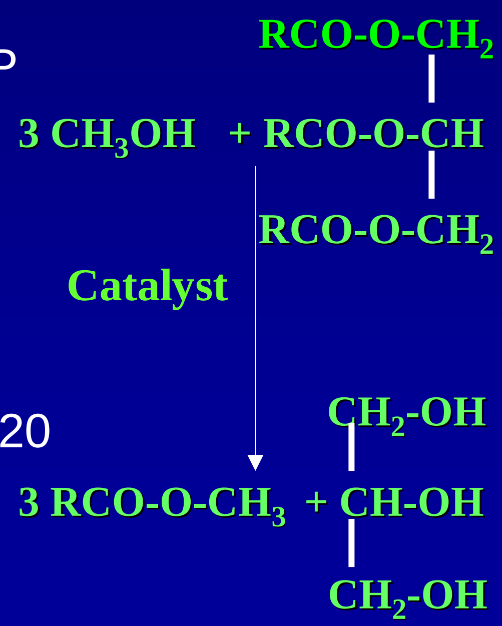


- Chemical Composition : Standard for Ester purity, Mono- Di- Triglyc., Glycerol, Methanol, Water, Soap, P
- Europe Leads the way (kt / y ; 1997-1999))

World	EU 15	France	Italy	USA
700	590	280	125	50

- RME : F 3-5% everywhere ; up to 30% city bus
  D, A 100% lake, skiing, pump, bus; USA 20% B20
- Lubricant additive + lower emissions (CO, NO_x)

Oil/Methanol 10/1



Ester/Glycerol 10/1

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HYDROCARBONS FROM VEGETABLE OILS

One step process

Less than 1/4 of gas to run the process

Neat Energy yield (3 fuels) 86%

Various catalyst available (easy reactivation)

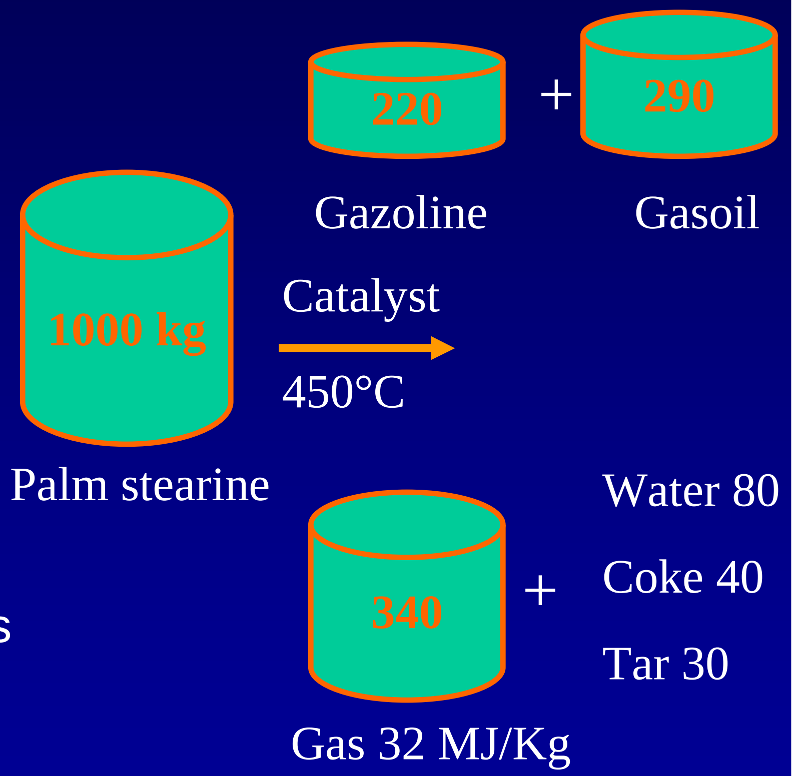
No hydrogen needed

Feed all types of engines for transportation

Electric power from gases (plant, village)

In many places :

price of Bio HC < price of Petro HC+Taxes



AUTARCIC SOLUTION FOR ISOLATED AREAS

SAVING ON TRANSPORTATION COST

PARTNER FOR PILOTE AND LONG TERM ENG. TEST

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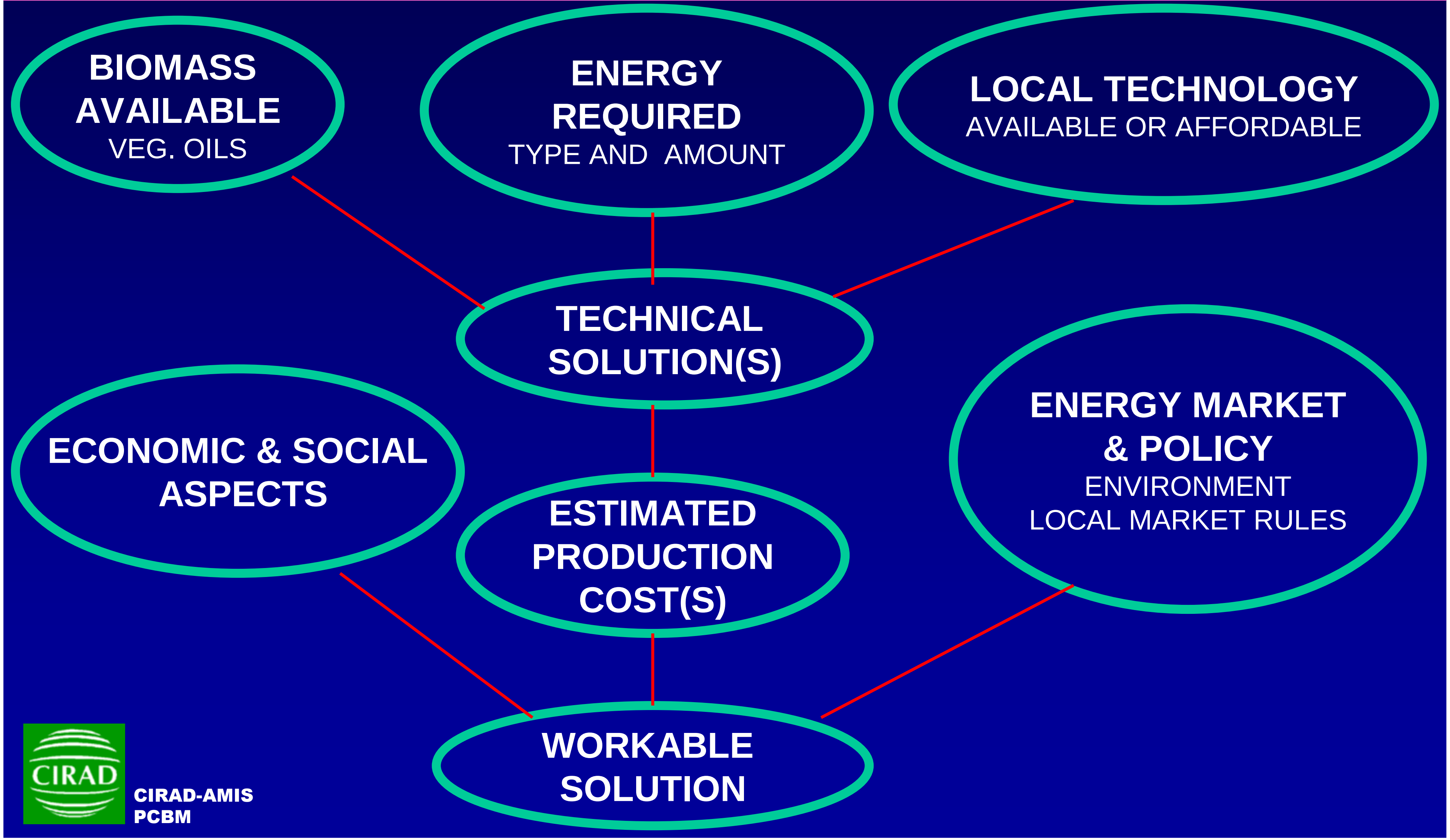
VEGETABLE OILS AS FUELS ; WHICH SOLUTION ?



PROSPECT

- Wide panel of Technical solutions
- Vegetable oils are and will be available
  - World market (demand for cake encreases)
  - Local oils to be valorized as well as used oils
- Economic side (cost)
  - macro : policy/tax cut (world price too high)
  - micro : can be profitable isolated regions (carriage x2)
    - village, plant, island
- Environment : positive effect on $C0_2$ reduction
  - Global impact to be estimated/each case
  - Land management
- Rural development : Definitely very positive
  - Employment, self sustainable

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RESEARCH TEAMS INVOLVED IN THE PROJECT

CIRAD - Physico-Chemistry-Bioenergy Team	Montpellier
Dr N.Chirat, Dr D.Pioch, Dr G.Vaitilingom	France
P.Lozano, A.Liennard	
USDA - ARS Oil Chemical Research	Peoria
Dr G.Knothe	USA
SWRI - Engine & Vehicule Research Div.	San Antonio
Dr T.Ryan	USA
Ecole Supérieure d'Energie et des Matériaux	Orléans
Prof. J.Andrzejewski	France
Université Catholique Louvain	Louvain La Neuve
Unité de Thermodynamique et Turbomachines	Belgium
Prof. J.L Martin, Dr J.L Vanhemelryck	

→ Special thanks to **ADEME** (French Agency for Energy) for funding the CIRAD work

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OIL PRESS 25 KG/H

+ DIESEL. ENGINE

(COCONUT OIL)

PUMP 9KW

IRRIGATION 50 M^3/H, OUVEA

(FUELED WHITH COCONUT OIL)

HATZ ENGINE

TO BE COUPLED

TO 7 KVA

GENERATOR

(FUELED WITH

COCONUT OIL, FIDJI)

EL. GENERATOR 80 KVA

(COCONUT OIL, OUVEA)

CARS AND TRACTORS

RENAULT 21 250.10^{3} KM

(SUNFLOWER OIL : STANDARD IDI ENGINE)

MASSEY-FERGUSSON

SUNFLOWER OIL

MODIFIED DI ENGINE

TOYOTA PICKUP

(COCONUT OIL)

BEFORE

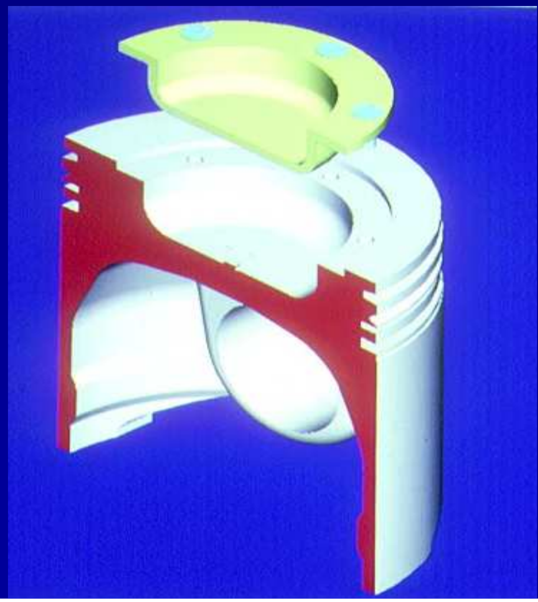
ADAPTATION

PISTON

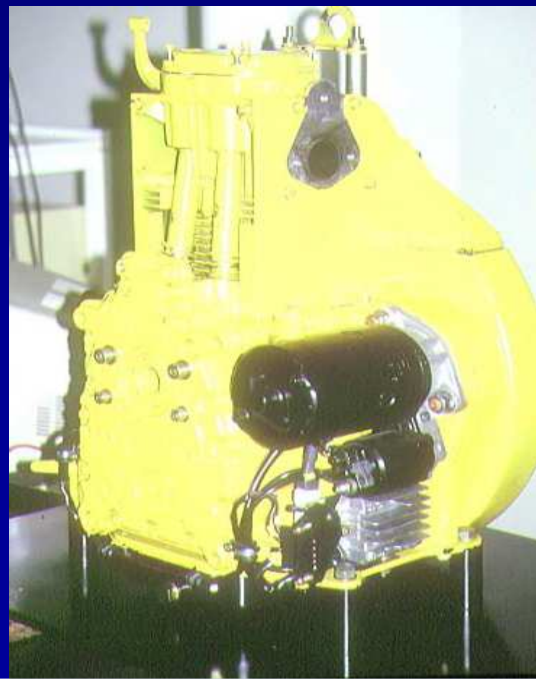
NOZZLE

AFTER ADAPTATION

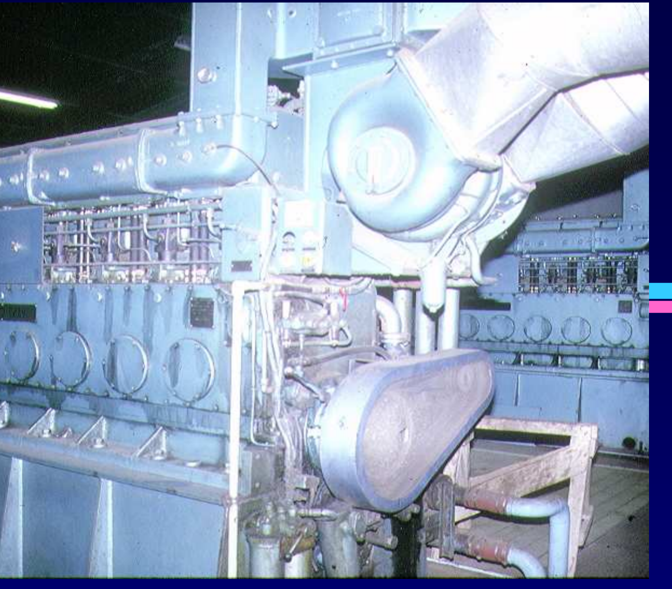
PISTON DESIGN
(DIRECT INJECTION)



HATZ ENGINE
(DIRECT INJECTION)



EL. POWER PLANT 600 KVA
(COTON OIL, MALI)



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EL. POWER PLANT 200KVA
(CRUDE COCONUT OIL ; SEA WATER DESALTING, OUVEA)

BOILER - DRYIER ; SUGAR BEET, PLANT

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BIOLUBRICANT FROM OLEIC SUNFLOWER OIL

	CONVENTIONAL PETROLEUM MOTOR OIL				BIOLUBRICANT HELIANTHE			
vehicle/engine	**CLIO/F8Q**	**CLIO/F8Q**	**R19/F8Q**	**R19/F8Q**	**CLIO / F8Q**			
Vehicle mileage	33395	38270	51098	65646	74691	79290	83797	88318
Drain oil	4828	4875	4401	4700	4599	4507	7251	4521
WEAR (ppm)								
Iron	35	43	24	18	37	28	25	30
Lead	1	5	2	18	4	2	3	4
Copper	1	1	1	2	3	2	1	2
Tin	2	2	2	2	8	6	6	5
Chromium	4	6	3	2	7	4	4	5
Aluminium	10	11	7	10	13	11	10	11
Nickel	1	2	1	1	2	2	1	3
Molybdenum	79	77	8	3	5	4	3	3
POLLUTION								
Silicium (ppm)	12	13	7	15	12	11	10	12
Water (%)	0.09	<0.02	<0.02	<0.02	0	0	0	0
CARACTERISTIQUES DU PRODUIT								
Visco. @ 100 °C	14.70	14.60	14.00	14.10				
Visco. @ 40 °C	107.00	104.90	106.50	102.20	101	93	94	103
V.I.	140	142	131	139				
T.B.N.	9.00	9.20	8.40	12.50				

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