

# Pure Plant Oil as local produced renewable energy fuel in Developing Countries – on practical level.

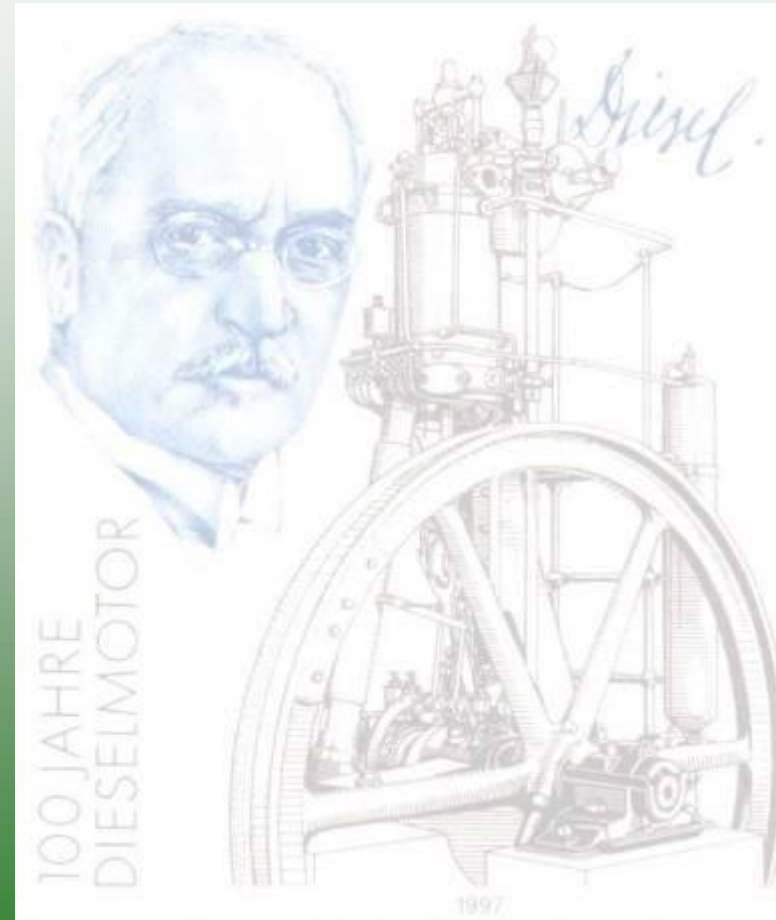
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ICSA 2014  
September 3 – 6, 2014  
@Folkecenter.dk



# Rodulf Diesel used peanut oil in 1912

*"The use of plant oil as fuel may seem insignificant today. But such products can in time become just as important as kerosene and these coal-tar-products of today."*



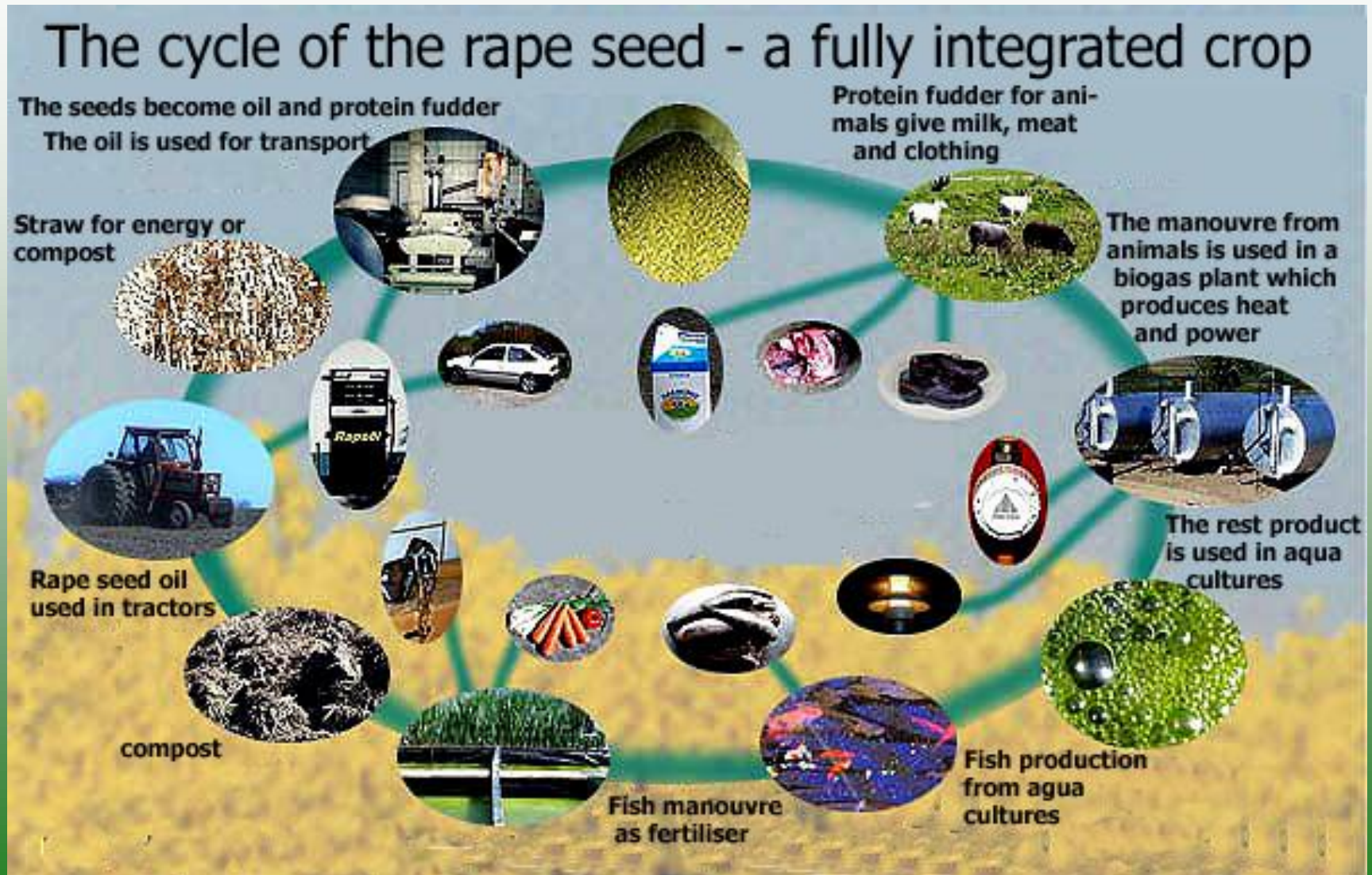
## Plant oil. One of the several solutions

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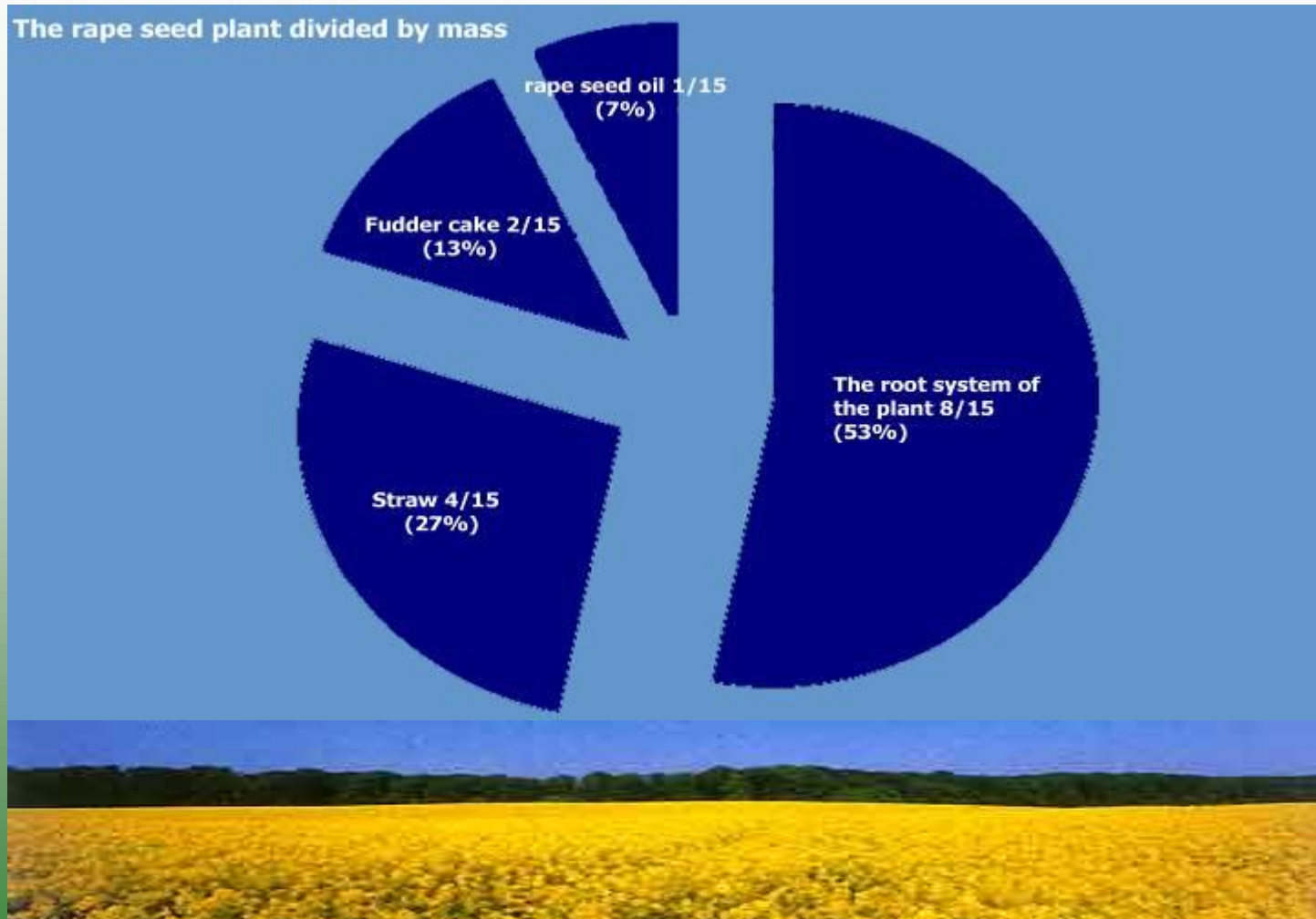
In the future it will be necessary to use a broad range of fuel solutions for transportation:

- Ethanol
- Methanol
- Electrical cars
- Hydrogen cars
- **Pure Plant oil (PPO)**
- Biodiesel





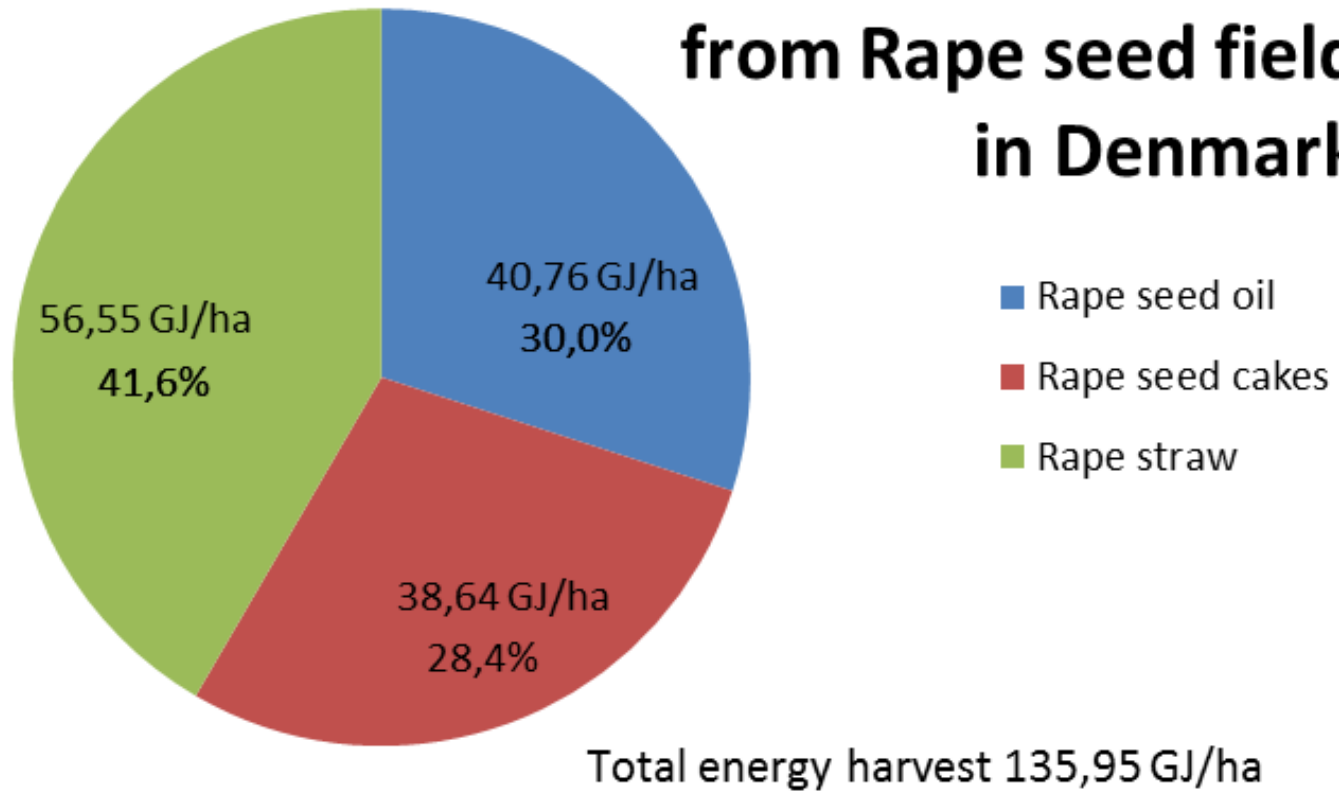
# The Rape seed plant produce oil, protein fodder, straw & roots



**The rape seed oil is only 7% of the total grown biomass.**

# The Rape seed oil just a part of the harvest

## Energy content in harvested biomass from Rape seed field in Denmark



**The rape seed oil contain only 30% of the harvested energy, but often the oil has to "pay" for the production of press cake and straw in energy- and CO<sub>2</sub> balances.**

## BACKGROUND - Grass root activities in Denmark

- Grass root activities created successful bottom up development in Denmark, led by Nordic Folkecenter for Renewable Energy.
- The PPO technology appealed to the people, but constantly met resistance from the Danish government, agencies and institutions.
- The practical experiences gained by the activities in Denmark are important for our current activities in Developing countries.



# Demonstration at Folkecenter since 1992

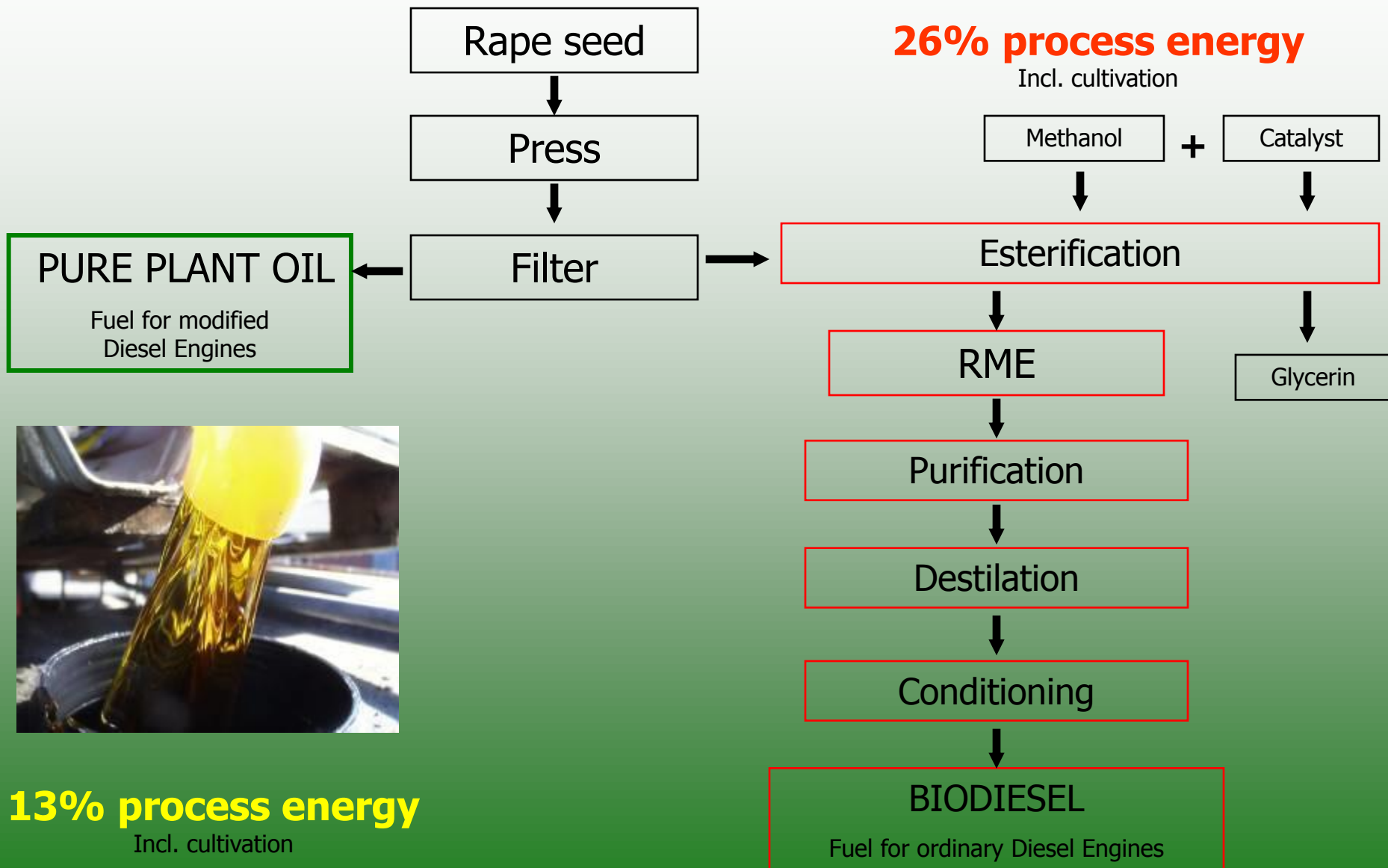




# Example Oil press



# Pure Plant Oil or Biodiesel?



# Production Plant of Pure Plant Oil



**Photo's from farm scale oil mill in Germany**



# Storage and distribution Examples





## Oil from the Supermarket works



# Why plant oil when comparing with other 'green' solutions

- Plant oil is CO<sub>2</sub> neutral.
- Is a well developed, tested technology.
- Available on the market today.
- No danger of fire, can be stored in carports, on the ground, everywhere.
- Will not pollute ground water in case of leakages.
- Can be stored for more than a year; will not deteriorate.

# Why plant oil when comparing with other 'green' solutions

- It is a dual fuel system and the vehicle can still be fueled by diesel with normal efficiency.
- Is economical and can be installed in existing cars.
- High efficiency can be achieved in modern diesel cars; up to 37% (efficiency for gasoline cars is less than 24%).
- You can use it in the salad or on the frying pan.
- Production: locally, with modest investments. Specialized skills not required.

# What can be fueled by rape seed oil

Many vehicles, which today are diesel driven:

- Diesel cars.
- Trucks and busses.
- Tractors.
- Ships.
- Trains.
- Combined heat power systems (for example in German Reichstag by Sir Norman Foster).



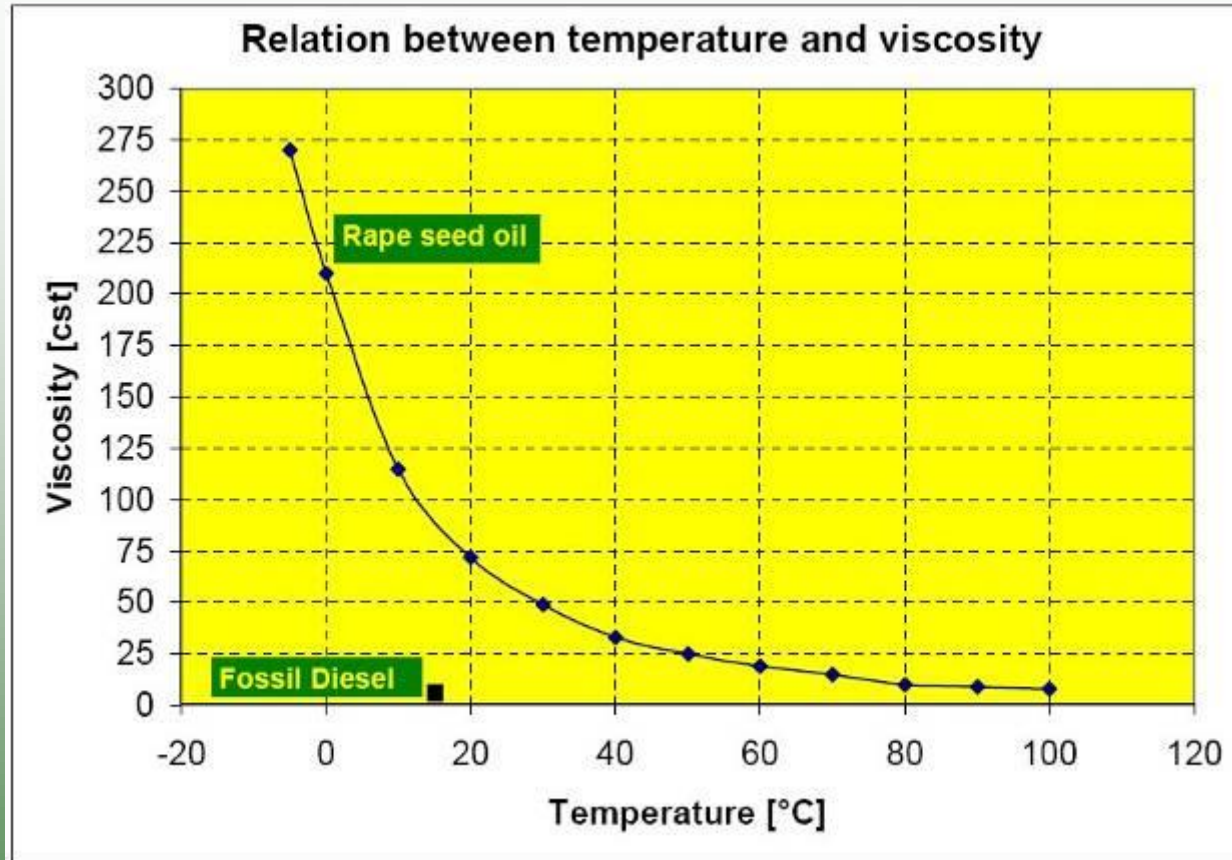
# Examples of Plant oil operation



## 3 main criterias for success with PPO fuel

- 1) Suitable diesel engine and proper conversion.
- 2) Good PPO quality with low content of FFA and low content of natural ash building components (S, P, Ca, Mg)
- 3) Suitable load pattern and good maintenance.

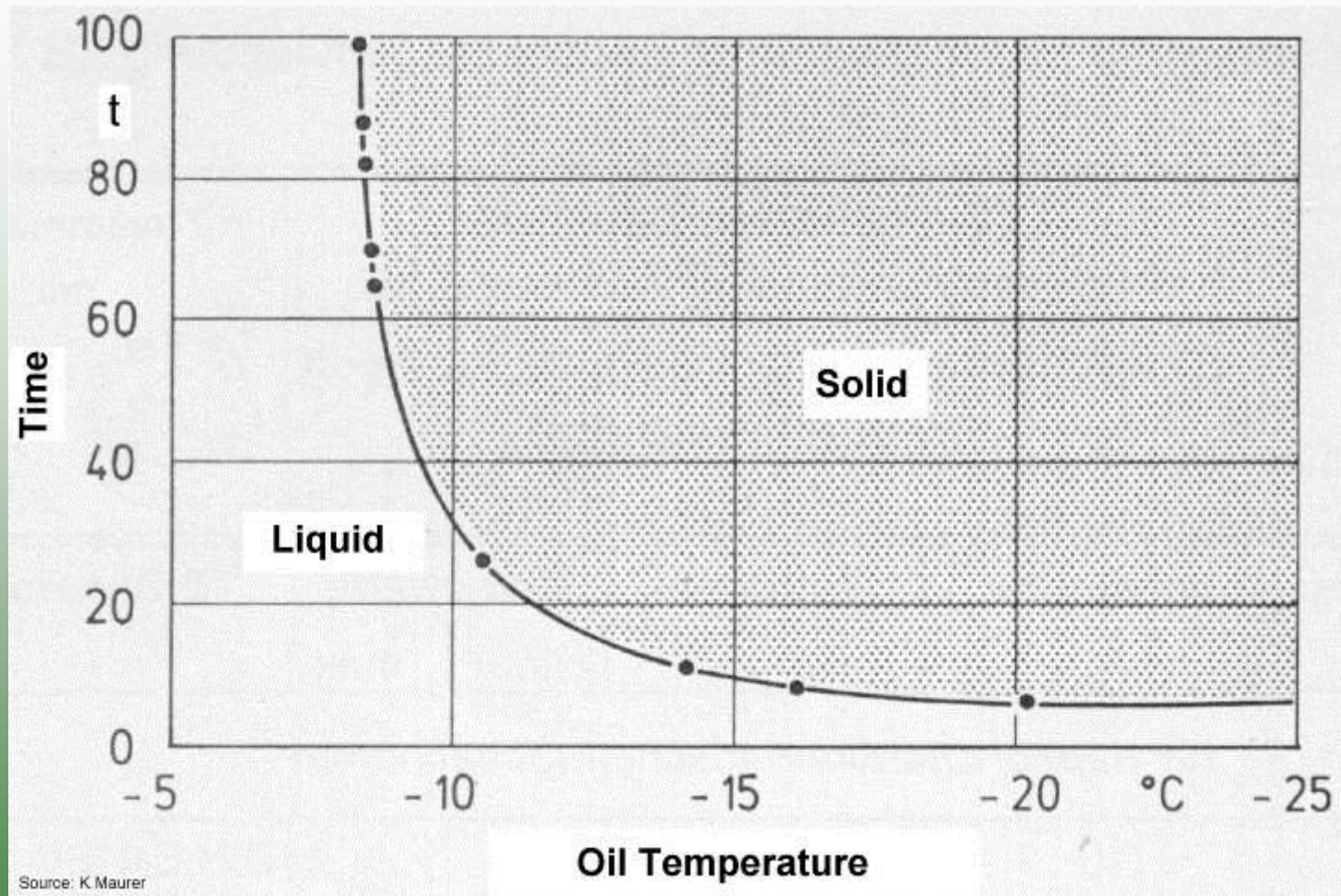
# Viscosity of rape seed oil



**When heated with engine cooling water to 60-70°C the viscosity is reduced considerable.**



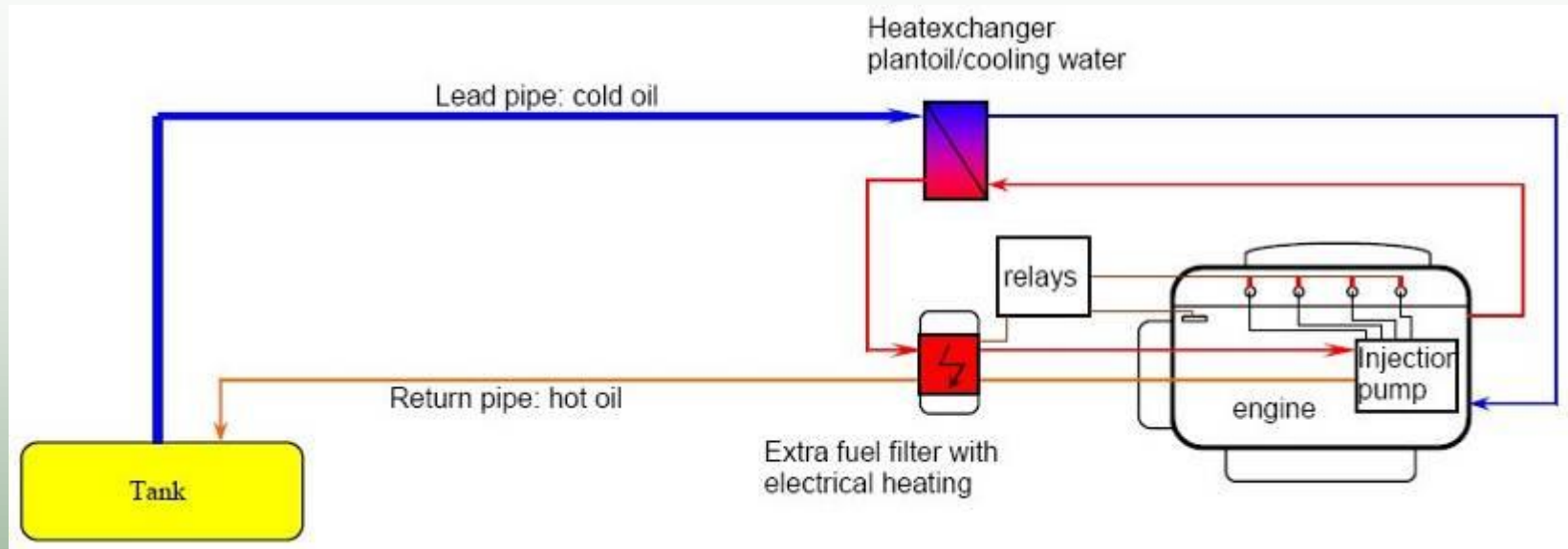
# Rape seed oil at cold conditions



**Other plant oils have similar solidification characteristic, but at different temperatures**



# Modification of Standard diesel engines



- Injection system should be Bosch or similar, but NOT distributor-types manufactured by DELPHI, LUCAS, CAV, Stanadyne and Roto-Diesel
- The engine should be in good condition
- A heat exchanger is installed to heat up the plant oil with hot cooling water
- A larger fuel pipe from tank to engine is installed
- An electrical heater is installed on the fuel filter which heats the first minutes of operation. The old fuel filter remains as extra filter.
- New injectors and adjusted injection pressure.
- New glow plugs which works the first minutes of operation
- 6: Relays for controlling glow plug, filter heater etc.

# Parts for Modification of Standard diesel engines



# Conversion of standard diesel engine

Heat exchanger



Oil heater



Thermostat



Glow plugs and nozzles

# Self-builder workshop at Folkecenter



**Car conversion by car workshops or self builders. Here workshop at Folkecenter in April 2002. About 120 cars has been converted at 9 workshops (until nov. 2005)**



# Self-builder workshop at Folkecenter



# Hosted by Technical School for car mechanics





# Local authorities trust & believe



**New VW T4 modified for Vejle Amt, environmental department.**

# Every self-builder-workshop a musician



**An enthusiastic musician & his practical car mechanic.**

# Modification package – safety in the supply



**New plantoil drivers usually buys complete package including modification, quality plantoil, and filling equipment.**



# Large engagement – fuel for local development



**Enthusiastic self-builder(DIY) develop small oil press.**

# Local development creates new products and jobs

Nyhed!!



KSM-Multistoker med indbygget rapsoliepresser.

Patenteret konstruktion



**Enthusiastic self-builder becomes professional.**

**Local development creates new products and jobs**

**Danish developed oil expeller from SWEA**





**Local development creates new products and jobs**

**Danish developed oil expeller from  
BT Maskinfabrik**





## Reliable technology – personal experiences



**VW Touran TDI  
Particulate filter  
4½ year – 155.000km**



**VW Golf with >10 years on  
100% plant-oil. On the photo  
in the Austrian Alps and  
about -13°C**

**We drove >800.000km on PPO with 4 cars during 15 years**

## How do the vehicles drive

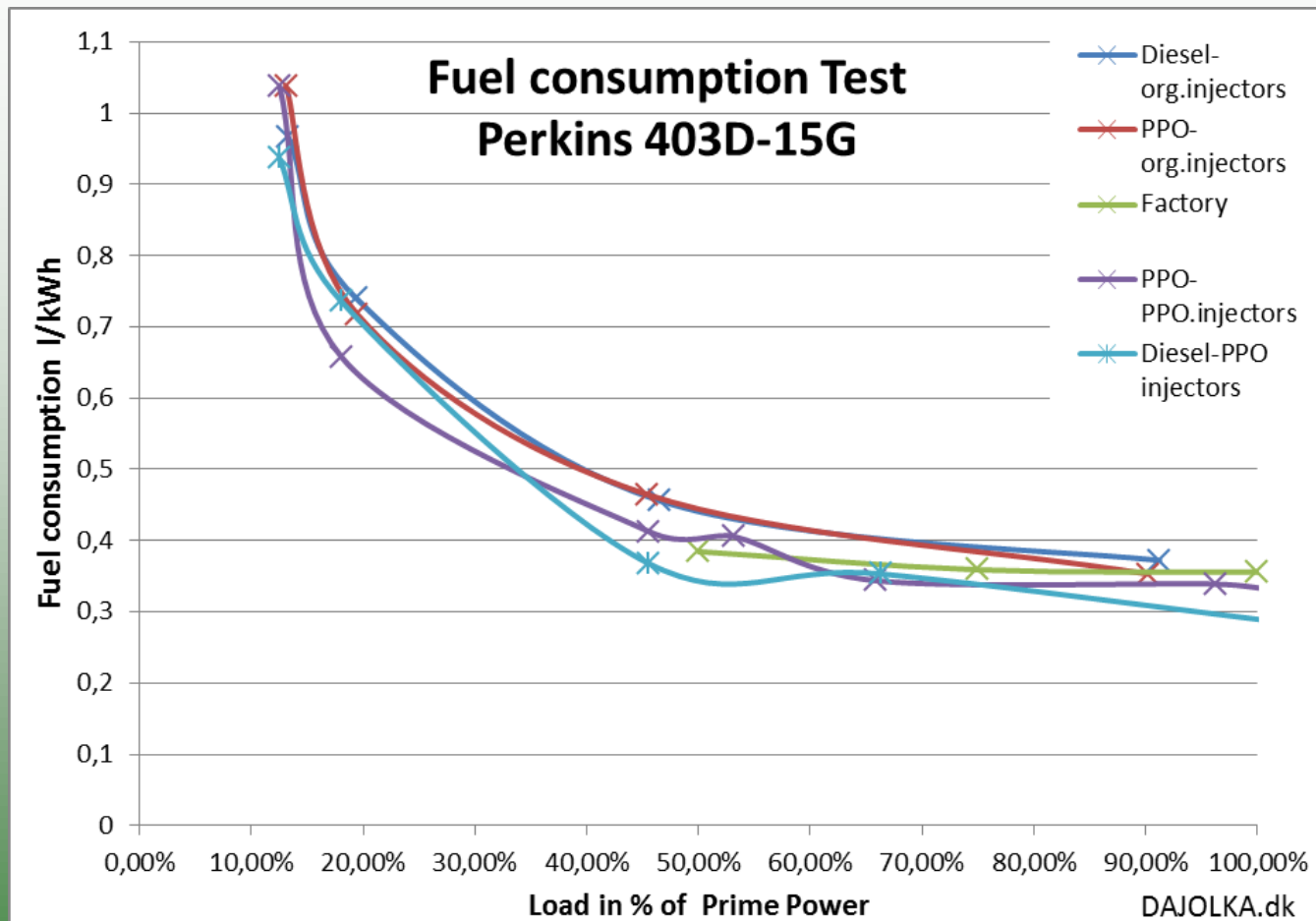
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- The noise is slightly reduced. Plant oil is a “softer” fuel than diesel and the engine runs more smoothly.
- The consumption is comparable to diesel.
- Performance and torque are unchanged

## Energy content

Energy content in rape seed oil And fossil diesel	Rape seed oil	Diesel
Energy content [MJ/kg]	36,5	42,7
Density [kg/l]	0,92	0,84
Energy content [MJ/l]	33,6	35,9
Comparison energy / litre in %	93,6	100
Difference in %	-6,4	0

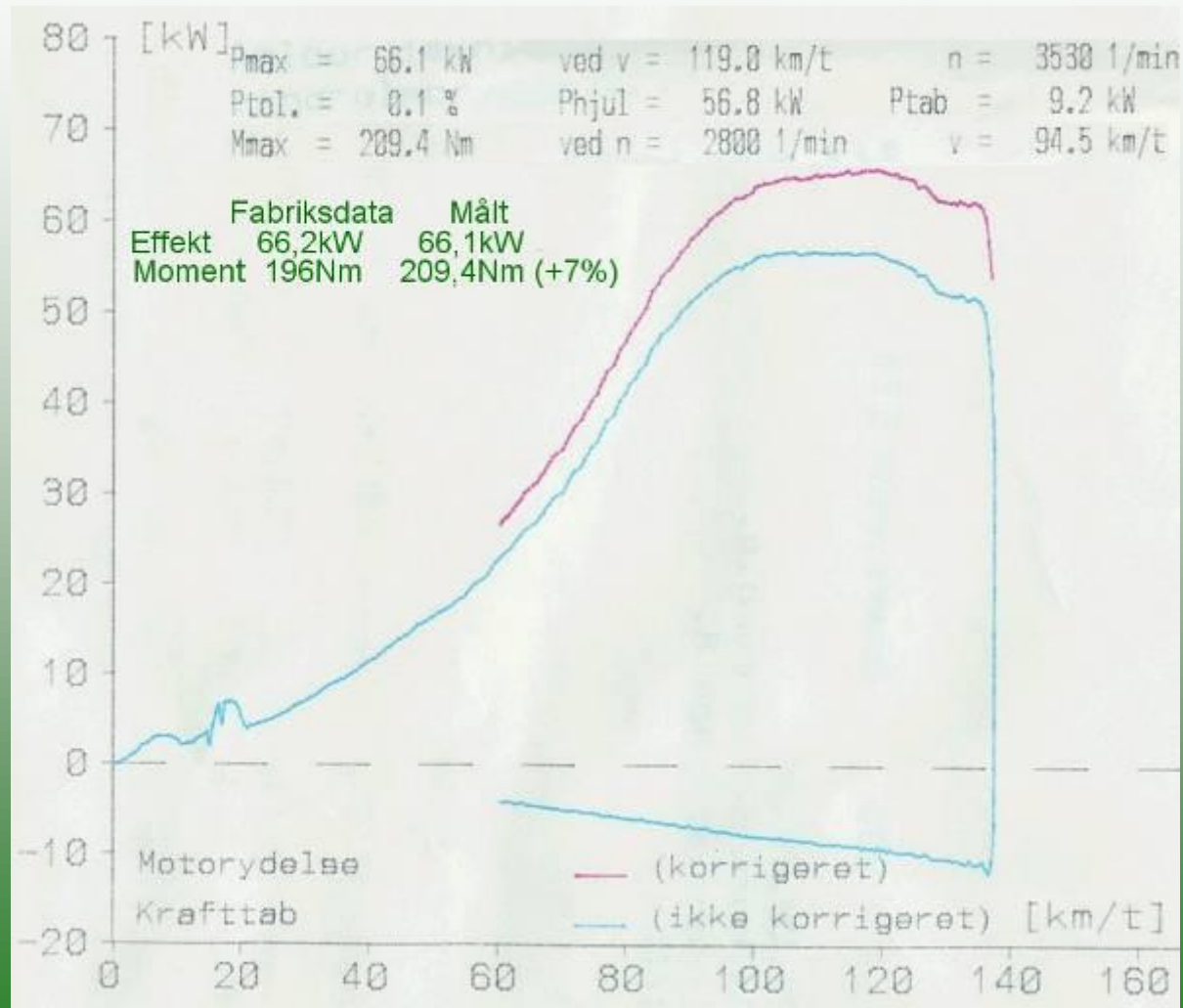
Energy content of PPO is a little less than for diesel, but same power and consumption for an engine due to higher efficiency caused by a natural content of  $\sim 11-12\%$   $O_2$  in PPO



## Test of fuel consumption PPO $\Leftrightarrow$ Diesel



# Power and Torque unchanged



# World Wide PPO activities benefit from German research

## DIN V 51605(2011)<sup>3)</sup> – Quality Standard for Rape Seed Oil as engine fuel

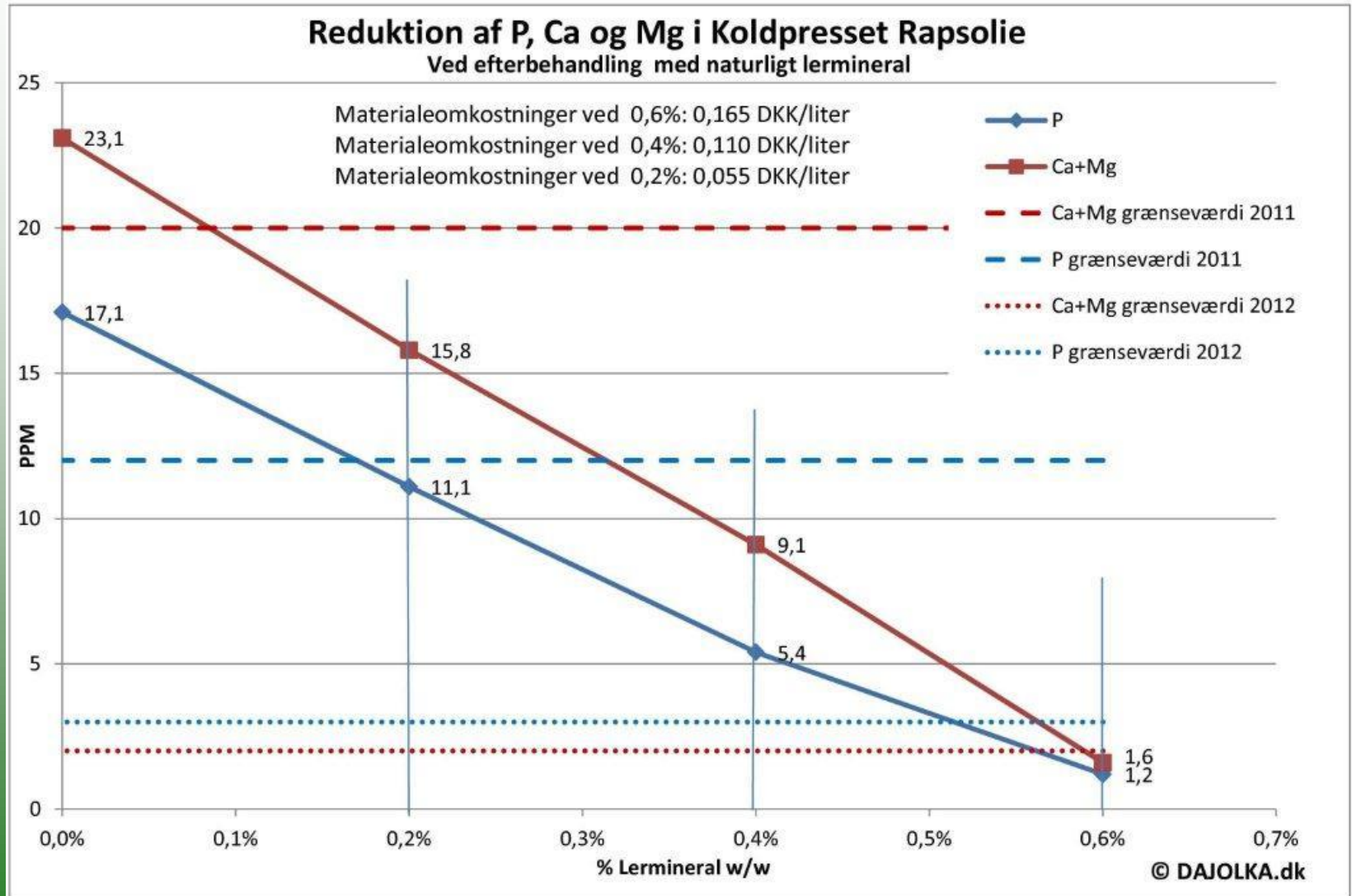
Parameter	Limit	Unit
<i>Characteristic/natural properties</i> <sup>1)</sup>		
Density at 15 °C	900 - 930	kg/m <sup>3</sup>
Flashpoint Pensky- Martens	min. 101	°C
Kinematic viscosity at 40 °C	max. 36,0	mm <sup>2</sup> /s
Calorific value (incl. H <sub>2</sub> O –Correction)	min. 36.000	kJ/kg
Cetane number	min. 40	-
Carbon residue CCR (from Original)	max. 0,40	% (m/m)
Iodine number	95 - 125	g Jod/100 g
Sulfur content	max. 10	mg/kg
<i>Variable properties</i> <sup>2)</sup>		
Total contamination	max. 24	mg/kg
Acid number	max. 2,0	mg KOH/g
Oxidation stability	min. 6,0	h
Phosphorus content	max. 12	mg/kg
Earth alkali content (Ca + Mg)	max. 20	mg/kg
Ash content	max. 0,01	% (m/m)
Water content	max. 0,075	% (m/m)

1) The natural properties which are independent from the process, handling and storing.

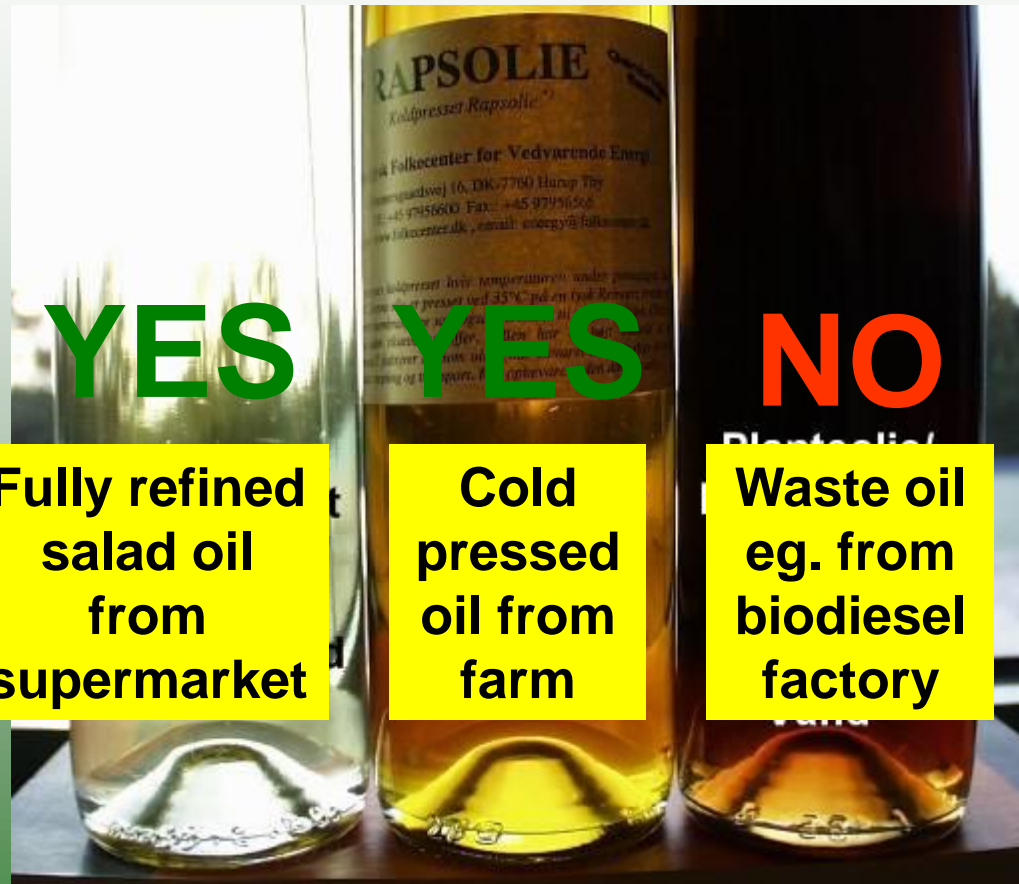
2) The variable properties which are influenced by the process, handling and storing

3) A final version of DIN 51605, with reduced limits for ash building components, were introduced by January 1.st 2012, especially to meet requirements for the newest type diesel engines with particulate filter installed, meeting the newest emission standard on the European market. The limits in the table above are from the DIN norm before January 1<sup>st</sup>, and are suitable for diesel engines without particulate filter, which applies to most engines in developing countries as well.

# Improve quality by semi-refining



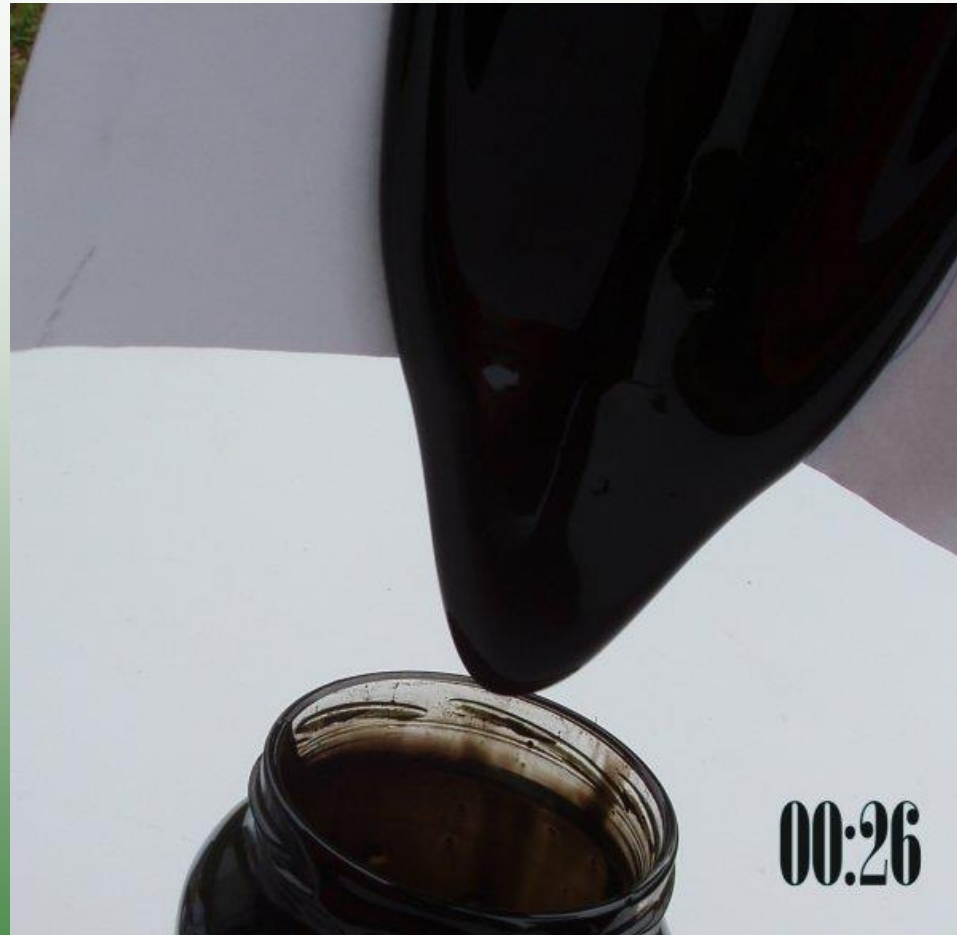
# Quality of the Plantoil



**Take care for bad quality plantoil on the heating oil market.**



# Damages coursed by bad fuel / maintenance



## Polymerisation of lubrication oil.

## Damages coursed by waste oils



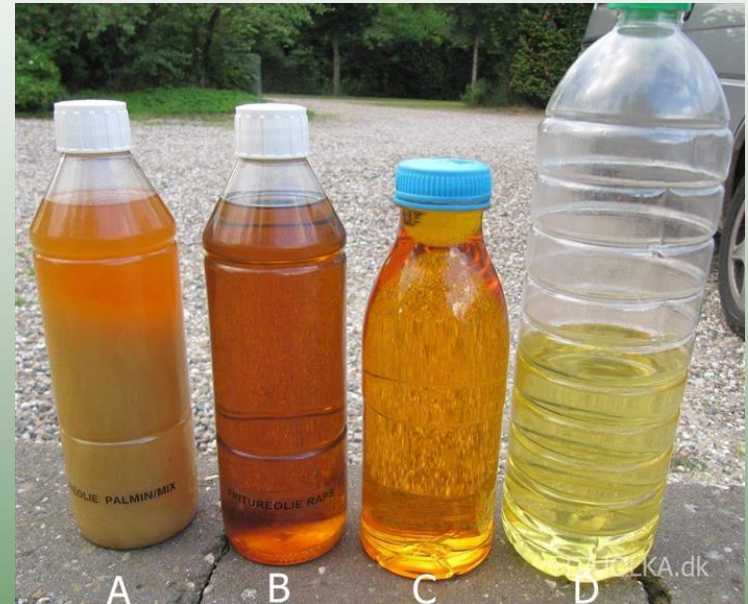
**WORTH CASE:** Piston from broken injection pump after only 20 litres use of waste oil from biodiesel factory.  
(The oil was intended and sold for heating purpose)

# How does the exhaust smell

- The exhaust smells of fried oil.
- If the engine burns the fuel efficiently, car exhaust smell is limited.
- Catalysator will reduce exhaust smell.



# Using waste cooking oil, Denmark 2014



2 modern vans were converted in September 2013, to operate on waste cooking oil. One van belongs to a company selling new cooking oil(D) for the restaurants, and the other to a company collecting the used oil(B).



# Plant oil as a fuel in developing countries

PPO has has very high potential for Developing Countries

- Simple technology
- Low investment
- No need for highly educated personal
- Implementet decentralised where the resources are available (sunshine->biomass)
- Implemented where fossil fuel is relatively more expensive and need to be transported long distance under difficult conditions

# Plant oil as a fuel in developing countries - SENEGAL

- PPO powered off-road transport vehicles for Senegal for sustainable char coal production



# Plant oil as a fuel in developing countries – HONDURAS



Castor (*Ricinus communis*)



Jatropha (*Jatropha curcas*)



Sunflower (*Helianthus annuus*)



Tijgernoot (*Cyperus esculentus*)



**Nabo Forrageiro**  
(*Raphanus sativus* L.)





# Plant oil as a fuel in developing countries – HONDURAS



**Around 45 car mechanics were trained during 1 week training course in Yoro, Honduras.**



# Jatropha oil project Mali



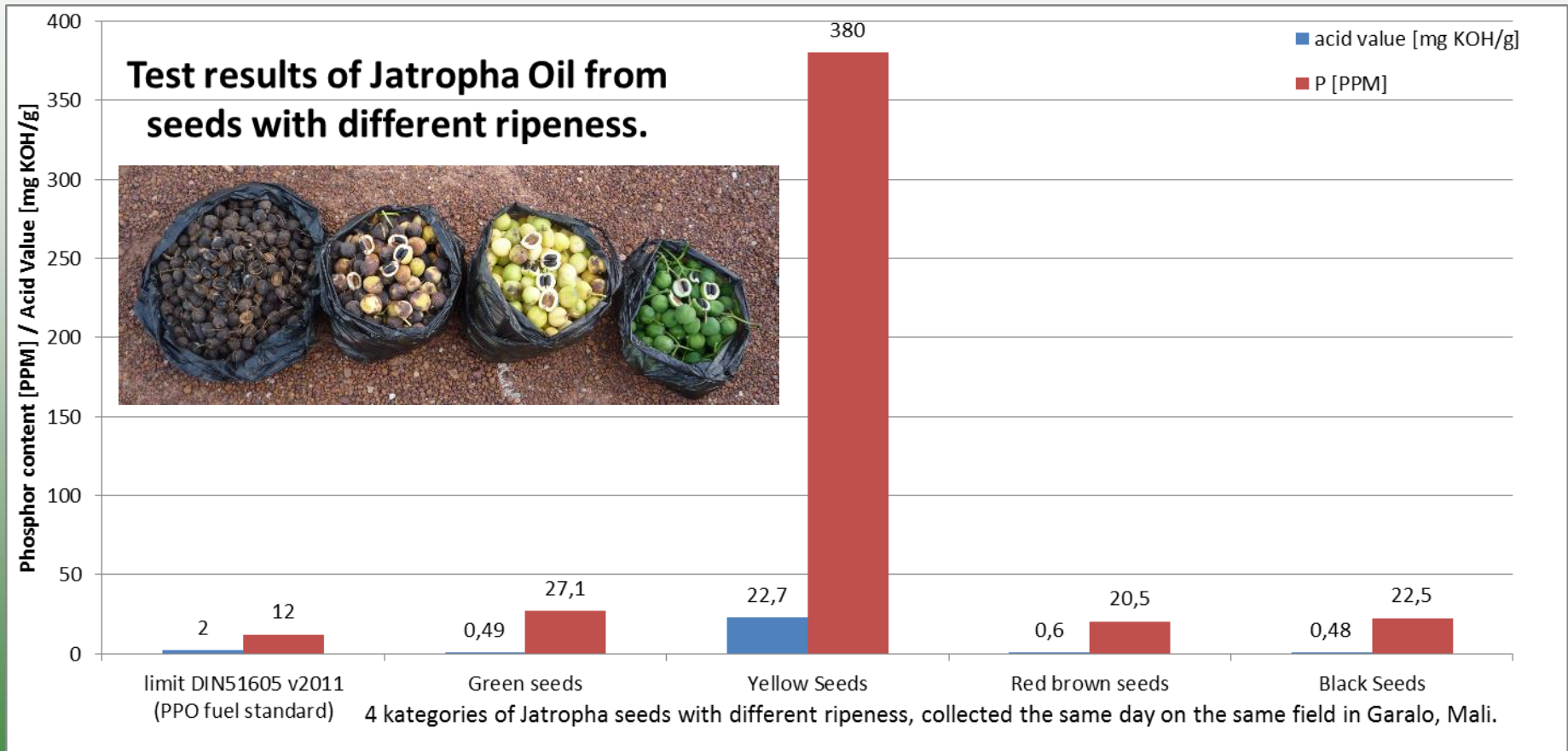
**Semi industrial oil pressing facility in Mali, supplied with power from a PPO powered genset.**

# Jatropha oil project Mali



**Converting gensets in Mali. We trained the local mechanics**

# Jatropha oil project Mali



**Testing Jatropha oil quality depending on seed ripeness.**



# Jatropha oil project Mali



**Building up small factory for producing steel tanks for fuel.**



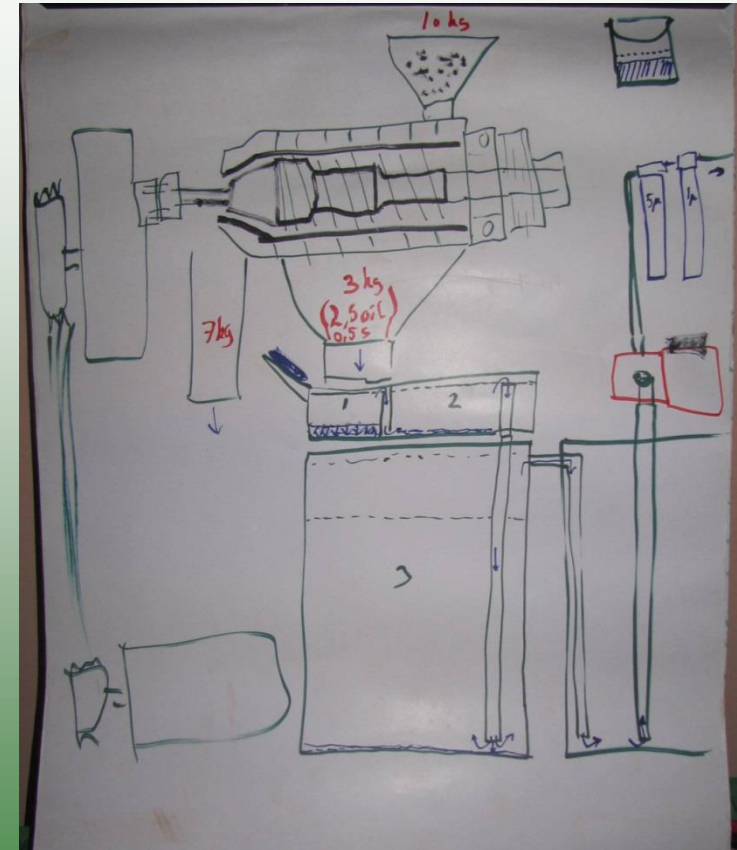
# Jatropha oil project Guinea Bissau

Workshop training in converting gensets  
in August 2013



Participants with certificates

# Jatropha oil project Guinea Bissau



**Workshop training in PPO production  
in March 2014**



# Jatropha oil project Guinea Bissau



**Workshop training in PPO production in March 2014. Oil expeller from local market**



# Jatropha oil project Guinea Bissau



**Workshop training in PPO production in March 2014. Constructing sedimentation system for 1<sup>st</sup> filtration.**



# Jatropha oil project Guinea Bissau



**Workshop training in PPO production in March 2014.  
Constructing pump filtration system for 2<sup>nd</sup> filtration.**



# Jatropha oil project Guinea Bissau



**Removing bad quality seeds**

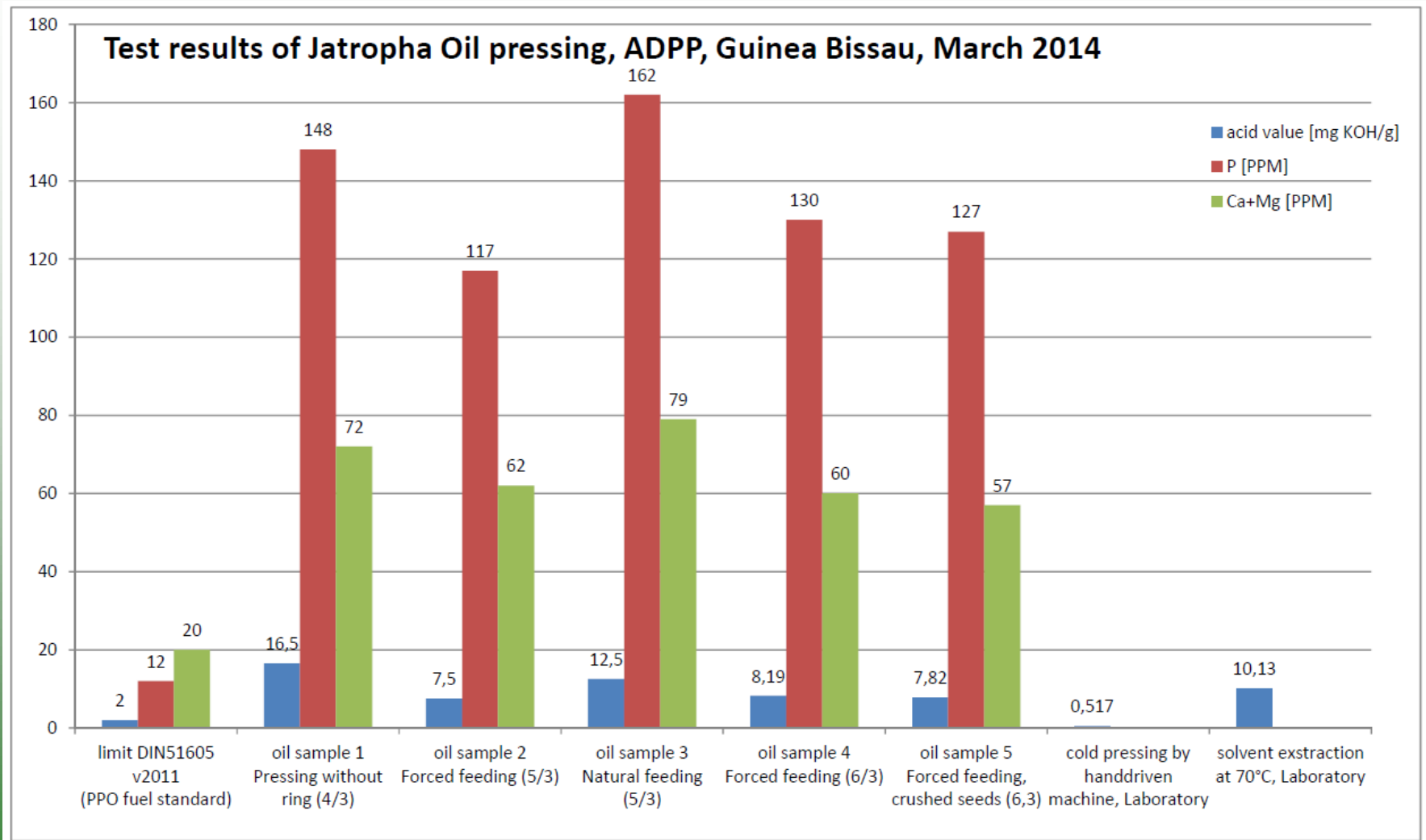


# Jatropha oil project Guinea Bissau



**Testing PPO  
quality**

# Jatropha oil project Guinea Bissau



**Concluding that seed quality was fine, but oil expeller produce bad quality oil caused by too high temperature**

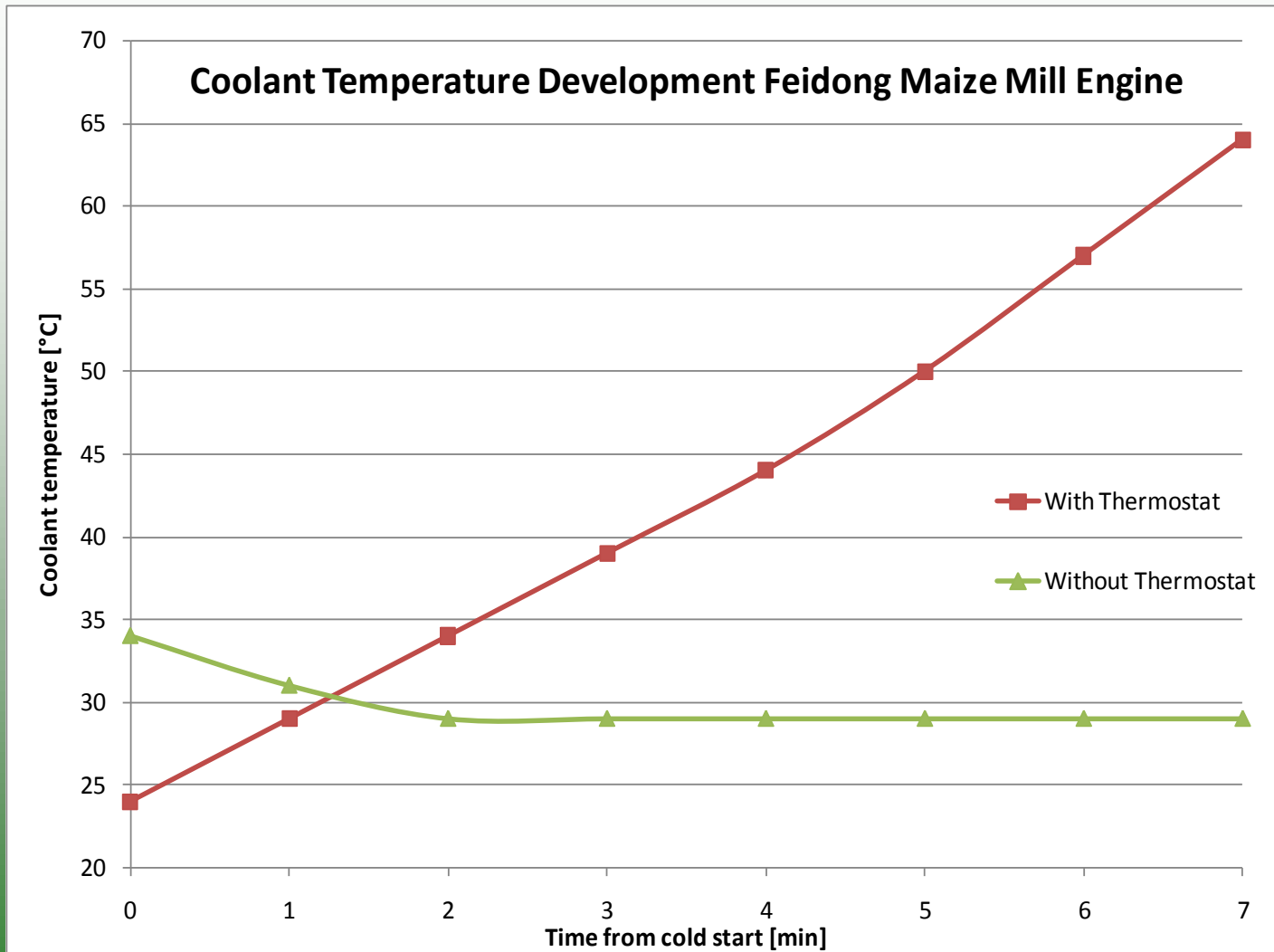


# Jatropha oil project Mozambique



Installing coolant thermostat to ensure safe operation on PPO

# Jatropha oil project Mozambique



**Installing coolant thermostat to ensure safe operation on PPO**



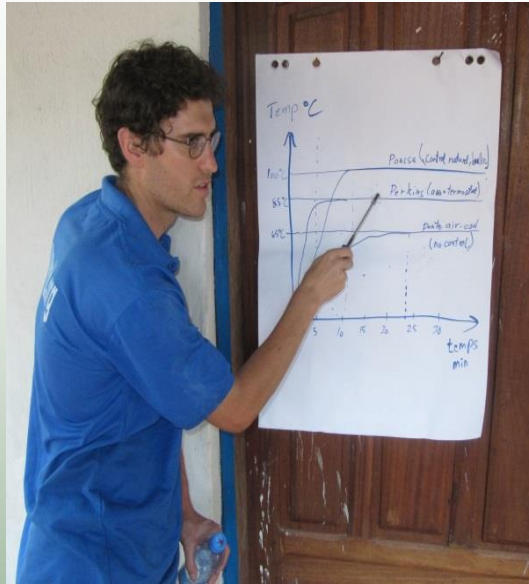
# Jatropha oil project India – January 2014



**Jatropha plants along the roads.**



# Small scale palm oil project in DRC





# Fossil oil create conflicts



# Pure Plantoil for Peace !