APFED II Showcase Site Visits

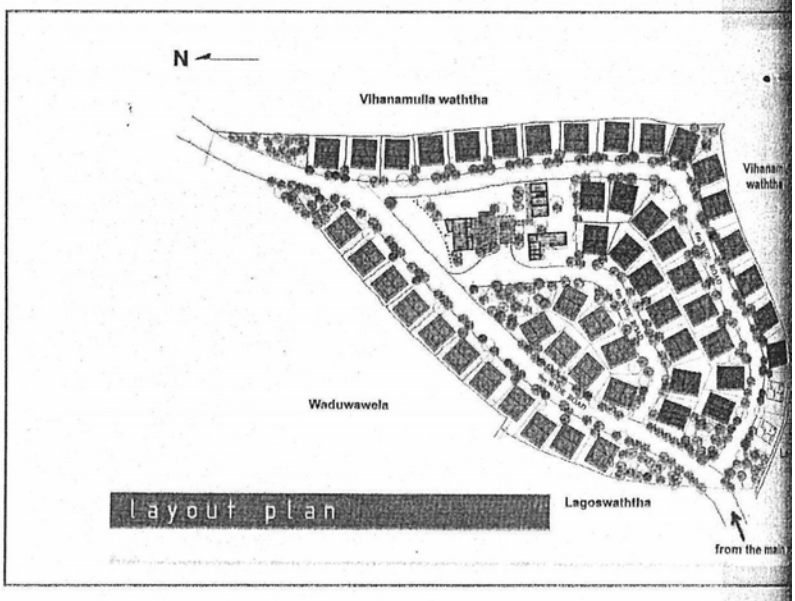
Lagoswatta: The First Eco-Friendly Village in Sri Lanka

Billed as a pilot project in the arena of eco-villages in Asia, Lagoswatta was constructed under the coordination of the SRTS utilizing a total of forty-seven million rupees from the Sarvodaya Tsunami Fund and the AGNTC, APFED, and the UNEP. A total of fifty-six million rupees will be spent by the completion of the project. The village in Kalutara was planned as an innovative model of participatory development to address environmental sustainability. It was designed with the technical advice and guidance of the world renowned Australian permaculture experts, Max Lindegger and Lloyd Williams, who are affiliated with Ecological Solutions Inc. and Global Ecovillage Network (GEN.)

Placed on a gentle eight-acre slope bordering rice fields about four to five kilometers from the sea, the main feature of the village is the fifty-five ecologically friendly houses that were built for families that lost their homes to the tidal wave. The house construction began on 01st May 2005 and the fifty-five families that will eventually settle in them consist of 245 individuals. People engaged in self-employment activities such as fish merchants, carpenters, masons, laborers, and drivers were chosen as the beneficiaries of this program. Fisher families were particularly excluded because the distance of the village from the sea would have been a hindrance to their livelihoods. Each house consists of two bedrooms, a living room, a kitchen, and toilet that encompass a space of 500 square feet. All of the houses are installed with solar panels provided by the UNEP. These ensure an eco-friendly electricity supply.

In addition to the houses, the village includes a multipurpose building, which houses a day-care center that doubles as a preschool, a library, a post office, and other such community facilities. This too, is equipped with solar panels supplied by the UNEP. One of the medium-sized playgrounds under the "Post-Tsunami Healing and Recovery through Recreation and Play" program funded by the AJJDC, USAID, and the Bush-Clinton Tsunami Fund has also been built in this model village.

While the village was mainly constructed to provide permanent shelters to families that lost their homes to the Tsunami its creators concentrated on making it eco-friendly in every possible way. This was sometimes a difficult task since there have never been such villages built previously in Sri Lanka. This meant that the project coordinators had to look at systems and applications used in eco-friendly constructions in foreign climates and geographies as their examples and apply these to circumstances that largely contrasted to these original sites.

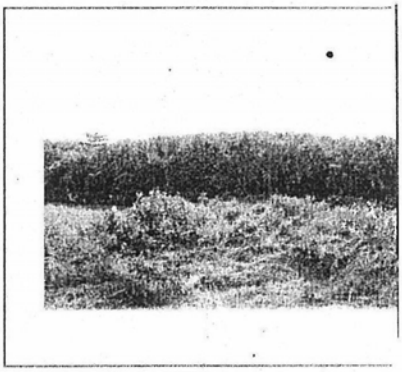


Lagoswatta: The First Eco-Friendly Village in Sri Lanka

The houses and other buildings were erected with special emphasis on ecologically friendly aspects. While usual building construction sees land being cut and leveled to fit the architectural plans of the structure, in this case the designs of the constructions were altered to fit the land. Eco-bricks, a kind of building block that lessens the use of cement, were utilized to erect the multipurpose center while the roofs were completed in Calicut tiles instead of asbestos sheeting. Wood from Kempus trees imported from abroad were utilized, which minimized the use of wood in the constructions. The program coordinators estimate that about eighty percent of the construction material is completely biodegradable and eco-friendly. The houses were also built with very high roof levels that ensure more air circulation and less heat within the homes. Project managers also concentrated on ensuring maximum natural ventilation in the buildings.

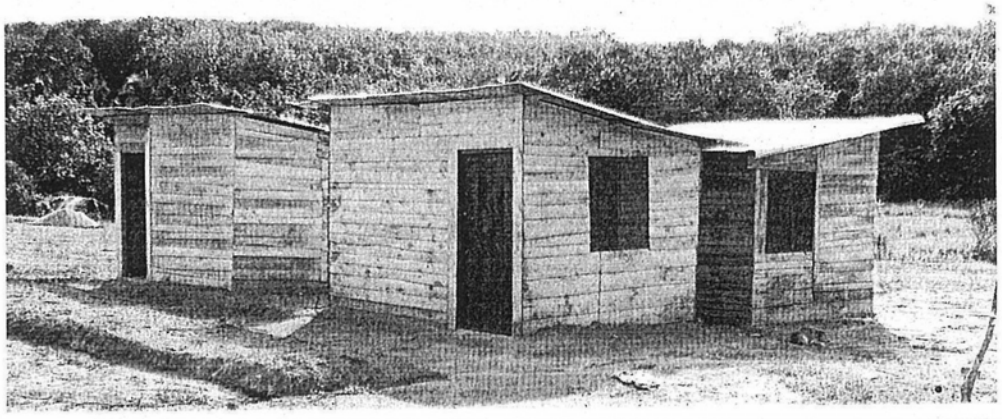
Two major eco-friendly aspects of the village are its electricity and water supply. As stated above all the electricity in the hamlet is provided by a solar system. In the area of water supply, the program established a broad rainwater harvesting system to collect rainwater for domestic purposes. This was done by setting up large tanks in home gardens and roof tops. The project also erected five drinking wells and two bathing wells as additional water supplies to that provided by pipe borne water in the houses. The program coordinators have come to an agreement with local Water Board officials to provide the village along with two neighboring villages with pipe borne water within the first six months of 2006.

Waste management in the village is also looked after in a similar nature-friendly manner. Towards this the project introduced a scheme that has never before been seen in Sri Lanka. Introduced by the UNEP, the Subterra system is a natural method for wastewater treatment, which collects water that accumulates on the ground, storm water or waste water from homes, and treats it so that it can be used for agricultural purposes. It employs existing microorganisms and reed plants and is easy to operate and maintain regardless of seasonal variations. This system also has the advantage of using local resources for construction and since it requires little sludge removal, the running costs are also minimal.



The land before clearing work began

The construction work is kicked off by building temporary huts for the laborers



Lagoswatta: The First Eco-Friendly Village in Sri Lanka

The program coordinators distributed mud and bamboo compost bins to all the houses in the village and trained the beneficiaries in their use and maintenance. The project also provided facilities for recycling plastic and glass waste material.

Another eco-friendly feature of the village is the landscaping. The establishment of a simple, but comprehensive road network in the village was a priority and all roads were built using the biodegradable material of gravel. The program concentrated on planting trees and building expansive green areas throughout the village. It also distributed plants among the benefiting families and trained them in planting and maintaining these.

These eco-friendly facets are not only beneficial to the environment, but also provide a sight that is pleasing to the eye. Visitors to the building site have commented on how the village seems like a world apart from its surroundings due to its striking beauty and peaceful atmosphere. The Lagoswatta village is also earmarked as one of the main places to introduce the new Disaster Management technology that has been designed by LIRNEasia. Thus the village is a model village from all sides.

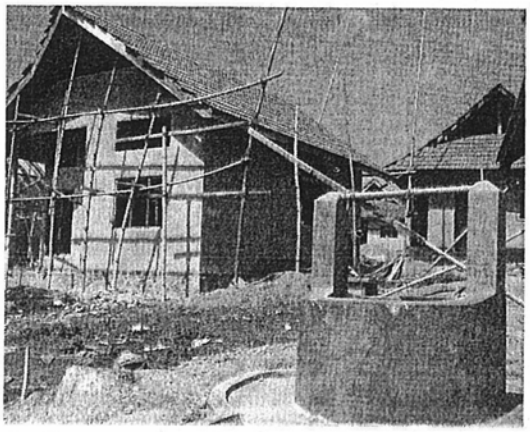
he eco-village will strive to create cooperative lifestyles in harmony with their local environment. Important features are developing and refining social and ecological tools such as consensus decision-making, inter-generational care, alternative economic models, whole systems desing, permaculture practices, renewable energy systems, and alternative modes of education that offer positive visions and real-life solutions for humanity and the planet.

The project was started in May 2005 after initial discussions between Sarvodaya and the UNEP, which provided much of the input and training support for this project. A team of young engineers, architects, and project managers traveled to Bangkok,

Ongoing construction work in December

UNEP Special Envoy, Ms. Tokiko Kato, visited Lagoswatta in September. She was given a grand welcome by the people of village and entertained them to some of her famous Japanese songs

Lagoswatta: The First Eco-Friendly Village in Sri Lanka



Dr. Vandana Shiva, an activist known throughout the world for her fights for the environment in India, visited the site in December. She educated the people of the village on living in harmony with the environment and home-gardening.

Thailand to take part in an eco-friendly training workshop where they learned many of the applications that were utilized in the building of Lagoswatta.

The government gave Sarvodaya the land for the village and it and the local authorities provided full support right from the initiation of construction. The government selected the beneficiaries of the program and if there were masons or skilled laborers among them, they were settled in temporary housing within the building site so that they would not have to face transportation problems from their areas of settlement to the site. Unskilled laborers among the benefiting families were settled thus too, and masons and skilled and unskilled laborers from the surrounding villages were provided with transportation facilities to travel to the sites daily.

Right from the first day of construction there was large and enthusiastic participation in the building efforts by members of the benefiting families. Even women who had no previous experience in such work came to the sites to help out in whatever way they could. Sarvodaya also received substantial support from the Electricity Board, the Water Supply Board, and district engineers.

The major problem that the project coordinators faced was that it was rarely that they could obtain the required construction material such as sand, rubber, and metal in a timely fashion.

While the fifty-five families that are the recipients of these houses are the obvious beneficiaries of the project, it also indirectly benefited a number of people. The skilled and unskilled laborers from the surrounding villages obtained steady employment during the construction period. There were also individuals from the neighboring areas who supplied food and other goods to the 200 or so people

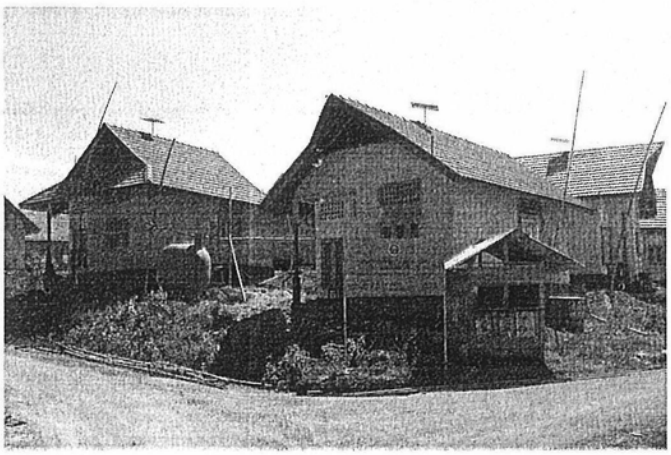
Lagoswatta: The First Eco-Friendly Village in Sri Lanka

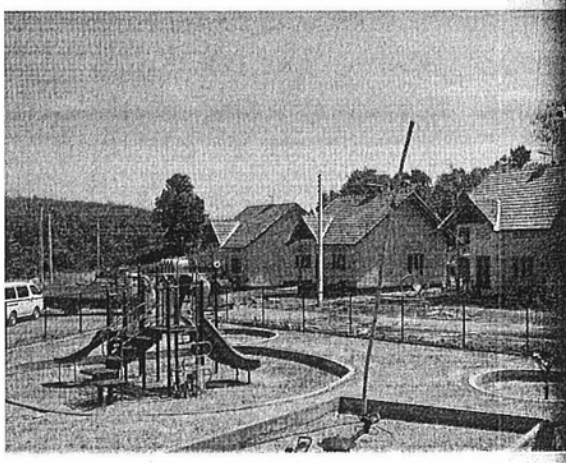
working on the sites and obtained a living through this. Some of these people even put up small stores in the area and it is safe to assume that they will carry on with these even if the construction is now complete. A SSS was newly established in the village and will look after its maintenance. The SSS of the adjacent villages will support this society until it can stand on its own feet. Sarvodaya has placed a special focus on the Lagoswatta program because it is the first time that it received the opportunity to build a housing scheme on government land. Up till this project, all its construction work was limited to land belonging to the direct beneficiaries. The movement has identified the village as one of its new Service Villages within the Grama Swaraj target.

Program coordinators said that eco-friendly aspects are usually introduced to villages long after their construction and since this is the first time in Sri Lanka that anyone has looked at building an entire eco-friendly village from scratch, other organizations have shown a lot of enthusiasm for and interest in it. This maiden aspect itself sometimes made the activation of the project difficult for its coordinators. Nevertheless, it also provided unique problems, which required creative solutions and taught much to the coordinators regarding eco-friendly construction. There is no doubt that this village will provide an example to anyone who hopes to build eco-friendly houses not only in Sri Lanka, but in South Asia, and is probably only the first in a long line of similar projects.

The village will be officially opened in a grand ceremony that is scheduled for late March 2006.

Construction work almost complete in January





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Community Governance Programme

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Community Bio fuel processing centre

ගුරුගොඩ, රස්නායකපුර

Gurugoda, Rasnayakapura

- **අමුද්‍රව්‍ය**

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දොඹ සහ රබර් ආදිය (ඉඳිකට ආහාරයට නොගන්නා අමුද්‍රව්‍ය)

- **Raw material**

Neem, caster, Jetropa, Karanja, Domda, Rubber etc...
(Non-edible materials)

- **එක් වරකට නිෂ්පාදන ධාරිතාවය ලීටර් 5යි**
- **Production capacity** - 5 liters per batch
- **අපේක්ෂිත ජීව ඉන්ධන භාවිතයන්**

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- **Expected applications**

Transportation
Electricity Generation
Water pumping

- **පාර්ශවකරුවන්**

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NERD මධ්‍යස්ථානය

- **Stakeholders**

Leekolapitiya Praja Sabawa
Universities - Peredeniya,Moratuwa,Ruhuna
NERD Centre
Rasnayakapura Divisional Secretariat office
Nikaweretiya Pradesiya Sabawa

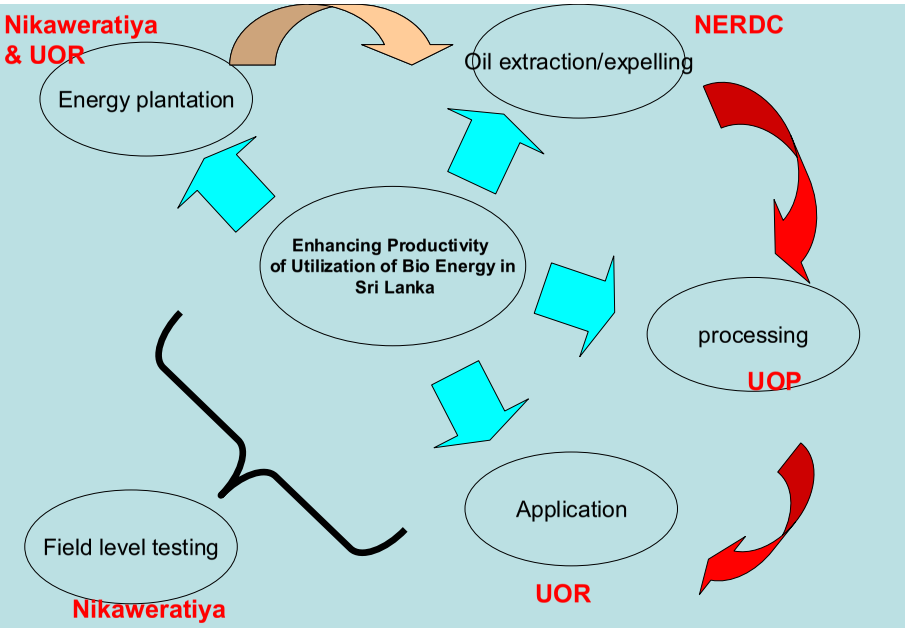
Sangrama
සංග්‍රාම

PRACTICAL ACTION

අරමුදල් දායකත්වය Funded by, APFED - UNEP, DGIS - Netherlands

Commissioned date 13 09 2008

Working group



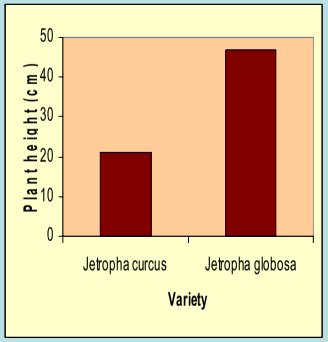
Plantation (Agronomy Study)

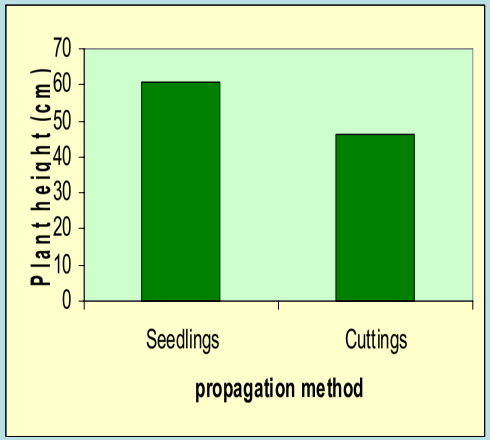
Jathropa green
(*Jatropha curcus*)

Jatropha purple
(*Jathropa globosa*)

Mealy bug pest damage to *Jatropha curcus* Plantation (5 months after planting)

Changes in Plant height and number of leaves





Oil Expelling

Jatropha

Castor

Neem

Rubber

Domba

Oil Filtering

Oil press cake

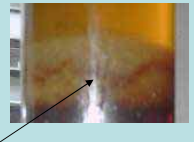
NERDC

Oil Expelling

Oil samples

– Jatropha , castor Neem Rubber

Rubber seed oil biodiesel



Soap layer

Glycerin layer

Heavy impurities

Bio Diesel Processing

Safety First

Wear

- Proper protective gloves
- Apron
- Eye protection and
- Do not inhale any vapours

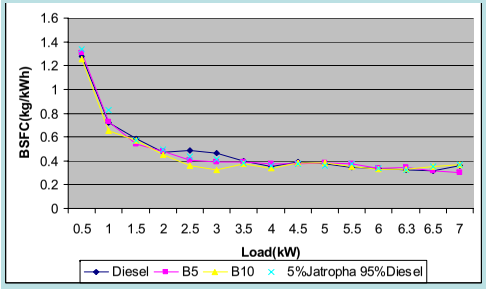
Biodiesel Samples

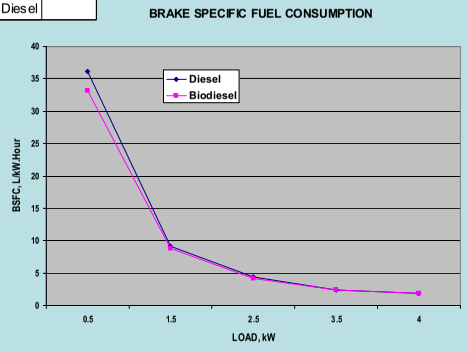
- From left to right
  Jatropha, Castor, Rubber, Neem, Domba and Coconut

Bio diesel Application

Use of Jatropha based biodiesel in a CI engine

D100	**100 % Diesel Oil**
D95J5	**95 % Diesel Oil + Raw Jatropha Oil**
D95B5	**95 % Diesel Oil + 5 % Biodiesel**
D90B10	**90 % Diesel Oil + 10 % Biodiesel**





Knowledge products

- **4 Studies**
  - ***Energy plantation and agronomy study on bio-diesel plantation*** – Prof. S. Subasinghe
  - ***Oil extraction methods from different varieties of oil seed for bio diesel production*** – Eng. Ms. Malani K Ranathunge
  - ***Suitable methods of bio diesel production from row oil and analyze physical and chemical properties*** – Dr. C.S. Kalpage
  - ***Analyze performance of bio diesel driven engine and other applications for rural energy application*** – Dr. Ambawatte

Experience shared in SAARC Bio diesel conference

(4 papers presented by TAB members and PA)

Pilot project in Nikaweratiya

Community participation

- Praja Sabawa (Community committee)
- Green movement
  - RE idea came from community
  - Several discussions held and make them aware on LBF
  - Involve in plantation (Nursery management up to plantation)
  - LBF centre establishment
  - Centre construction (labour, material)
  - Seed collection and supply
  - Monitoring (school children)
- Local Authority involvement
  - Land rent for LBF centre
  - Monitoring

Preparation of Polythene bags (Sealing)

Filling of polythene bags for planting

Cuttings and seeds are planted in polythene bags

Jetropha plantation

- Community based Jetropa plantation started at Nikaweratiya as live fence
  - 13 families participated
  - 7800 plants made in nursery
  - 7000 plants field established in live fences
- Pilot jatropha plantation at UOR
  - 300 plants in 0.25 Ackers
  - field established and research going on

Polybag nursery of Jatropha

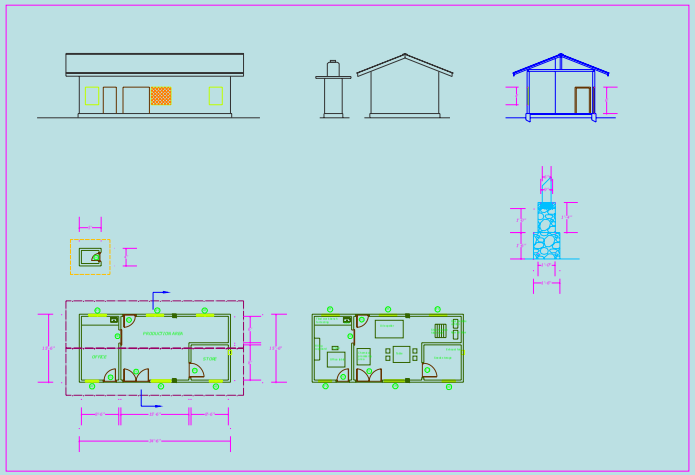
Jatropha Nursery (Well grown Seedlings and poorly grown Cuttings)

Well grown Jatropha seedling ready for planting

Jatropha Seedlings are planted along the fences

Growth performances at 5 months after planting in field at University of Ruhuna

Proposed LBF Processing centre



Seeds- jatropha, Castor, Neem ,Mee

Castor Seeds- sun drying

LBF centre

Oil Expelling

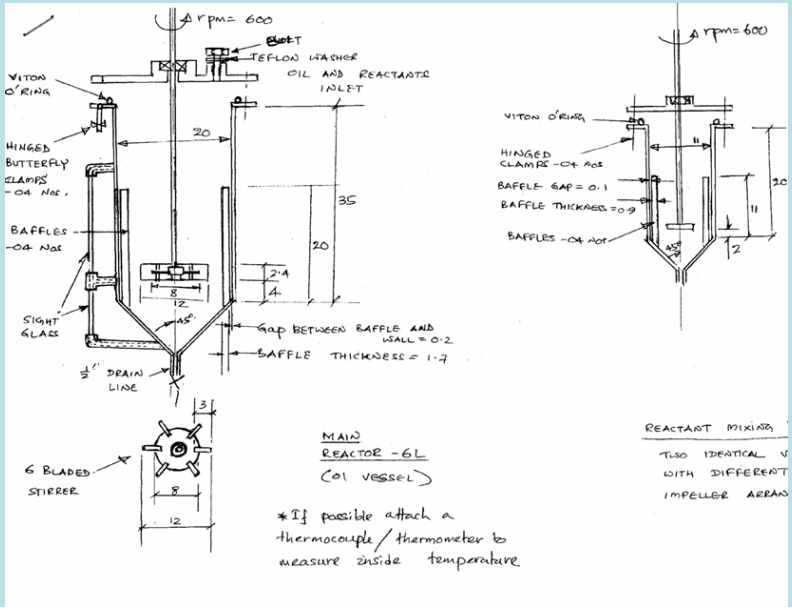
LBF centre oil filter unit

Oil sample

- Jatropha , castor Rubber

Oil Filtering

Bio diesel Processing unit



Bio diesel Processing unit

Bio diesel Processing

Bio diesel Processing

Oil Expelling

Neem oil expelling – Nikaweratiya LBF centre

Jatropa poonac

Neem poonac

Oil press cake

Let’s go and see

Jatropha

A community based home stead energy plantation - Nikaweratiya and Faculty of Agriculture, University of Ruhuna

Jatropha

Family: Euphorbiacea
Genus: Jatropha

- Perennial plant with lifespan of more than 50 years
- Seeds from 2 years
- Maximum yield gives after 4-5 years
- Wide range of soil and climatic adaptability
- Grow very well in waste lands, along the canals, roads, railway tracks, on borders of farmers' field as living fence etc.

Objectives

- Assessing the possibilities of growing Jatropha to address the energy needs of the poor
- To investigate the propagation and cultivation methods to obtain higher yield
- To introduce and promote the Jathropa as commercial cultivation

Jathropa green
(*Jatropha curcus*)

Jatropha purple
(*Jathropa globosa*)

Uses

- Seeds ⟶ oil extraction (3kg of Jatropha seeds ⟶ 1L of bio-diesel)
- Bark ⟶ "Jatropings", anti-cancerous properties
- Roots ⟶ antidote for snake bites
- Leaves ⟶ fumigation of houses against bed bugs
- Glycerin is obtained as a by-product from the plant

Experiments conducted at Faculty of Agriculture- University of Ruhuna

Experiment 1

Find out the most suitable seed treatment for *Jatropha curcus* seeds for germination

Treatments

Hot water treatment

- 50° C for 1 min
- 50° C for 3 min
- 60° C for 1 min
- 60° C for 3 min
- 70° C for 1 min
- 70° C for 3 min

Methodology

- **Experimental sites** - Faculty of Agriculture, University of Ruhuna

- Seed soaking
  - 12 hours
  - 24 hours
- -Seed clipping
- -Seed scarification
- -Control (Normal seeds)

- Design- Factorial CRD
- Replicates-03
- germination was recorded every day

Results

-Seed clipping was the best seed treatment

-Hot water treatment was not affected on seed germination

-No significant difference in water soaking treatments on seed germination.

-Highest root fresh weight was recorded in hard wood cuttings treated with IAA and planted in sand media.

-Higher temperature resulted low viability of the seeds

Results

- Seed germination was decreased with increasing period of storage.

-Storage at cool temperature can longer the seed viability than storing seeds at room temperature

Experiment 2

Germination of Jatropha seeds as affected by storage conditions

Storage conditions

-Room temperature

-Cool temperature (4o C)

- Experimental design -Factorial CRD
- Replicates- 4
- Seed germination % was recorded every day

Experiment 3

***In vivo* propagation of Jatropha through stem cuttings**

Treatments

- Cutting types - Soft wood cuttings (C1)
  - Semi-hard wood cuttings (C2)
  - Hard wood cuttings (C3)
- Rooting media - Sand 1:Compost 0 :Top soil 0 (M1)
  - Sand 1:Compost 0 :Top soil 1 (M2)
  - Sand 1:Compost 1 :Top soil 1 (M3)
- Rooting Hormone - I AA (A)
  - IBA (B)

Results

Rooting media x Hormone

Root vigour

(A) IBA with Sand

(B) IAA with Sand

Hard wood cuttings with IAA

Semi hard wood cuttings with IBA

Shoot vigor

T1 T2 T3 T4 T5

Soft wood cuttings in sand and top soil with IAA significantly increased the shoot vigor (T4) followed bt SHW cuttings with same treatments (T5)

Experiment 4

Field establishment to find a suitable spacing

Treatments (Spacings)

- 3' x 2'
- 3' x 3'
- 3' x 4'

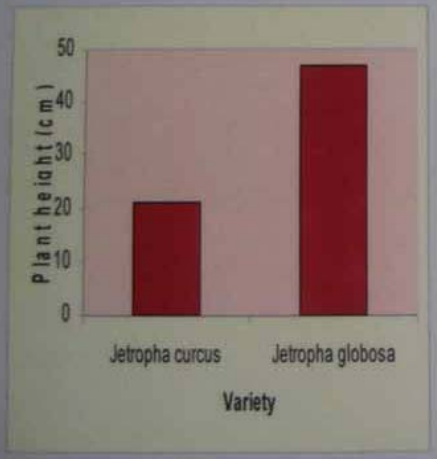
Parameters

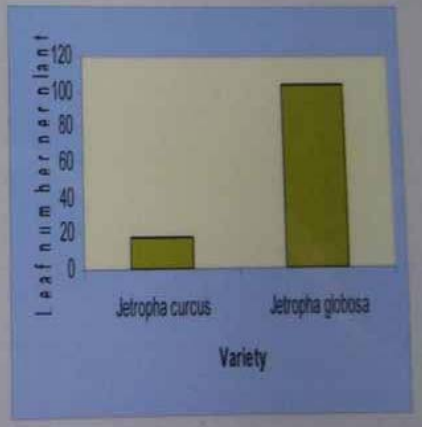
- Number of shoots
- Number of leaves
- Shoot height
- Time taken for flowering

-**Experiments are still going on and 1st and 2nd data set on growth and yield were collected**

Jetropha – 1 month after planting at Ruhuna

Changes in Plant height and number of leaves





Jatropha Plantation at Field (5 months after planting)-Jathropa globosa at Ruhuna

Jatropha Plantation at Field (5 months after planting)-Jathropa curcus at Ruhuna

Observations

Disease caused by Jetropha curcus at field (5 months after planting)

Growth performances at 5 months after planting in field at University of Ruhuna

Mealy bug pest damage to *Jatropha curcus* Plantation in Ruhuna (5 months after planting)

Plantation at Ruhuna (5MAP)




Filling of polythene bags for planting

Preperation of Polythene bags (Sealing)

Cuttings and seeds are planted in polythene bags

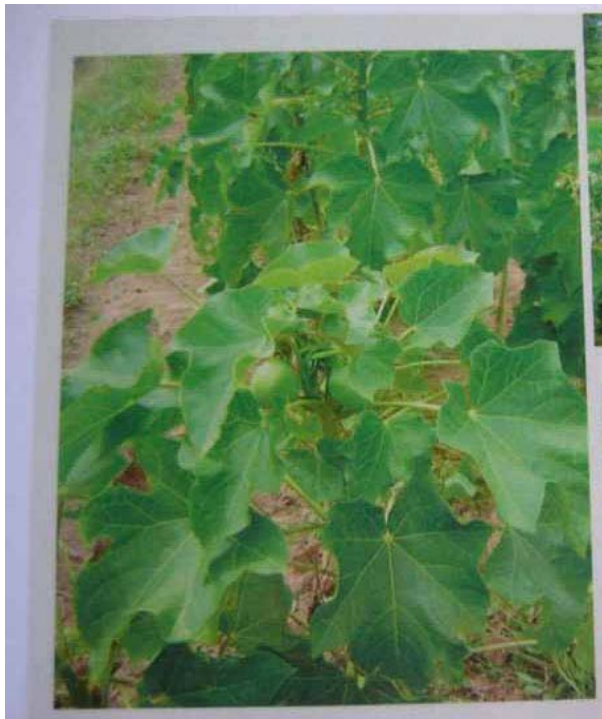
Progress at Nikaweratiya

Polybag nursery of Jatropha

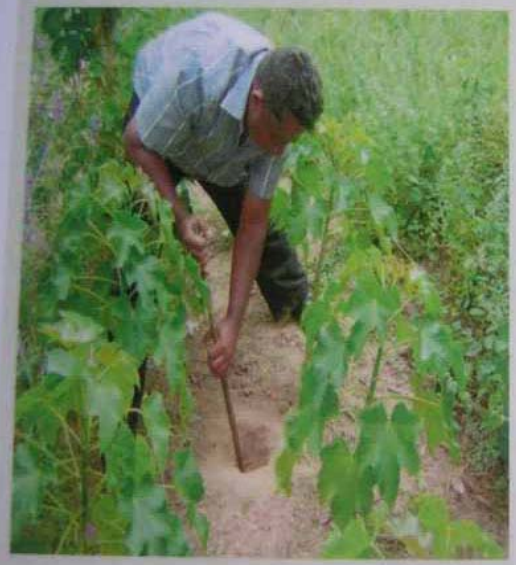
Jatropha Nursery (Well grown Seedlings and poorly grown Cuttings)

Well grown Jatropha seedling ready for planting

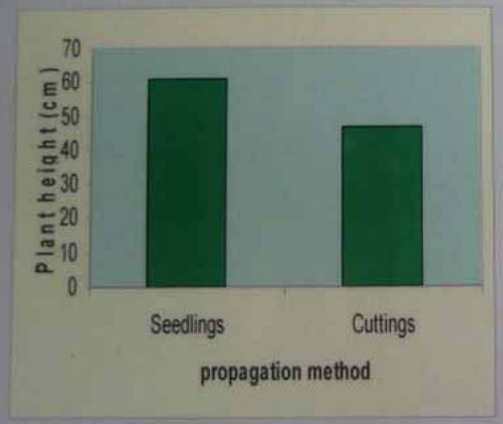
Jatropha Seedlings are planted along the fences

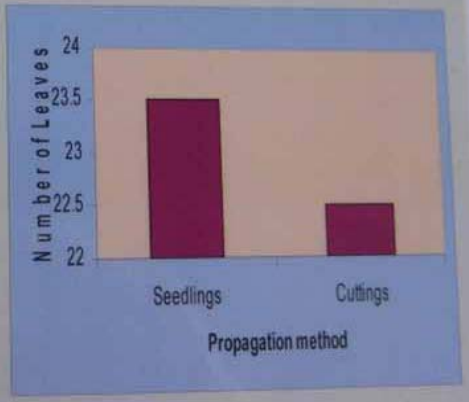


Jatropha at Nikavaratiya

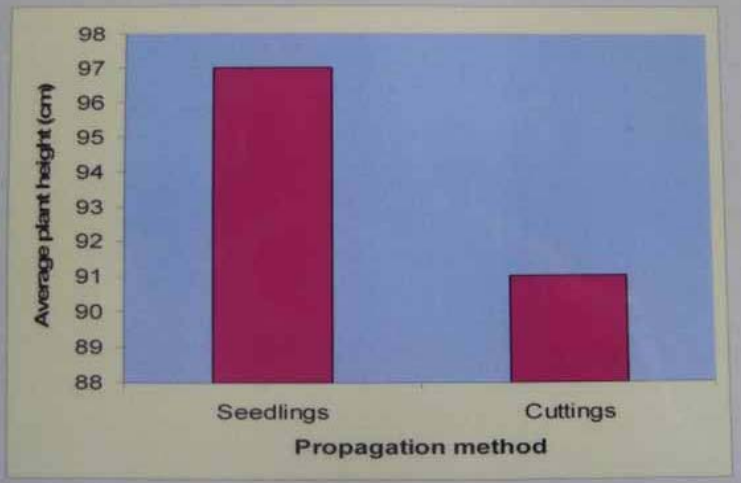


Growth parameters at 5 months after planting in field at Nikaweratiya





Growth parameters at 3 months after planting in field at Nikaweratiya



Pest attack of Jatropha Plants at Nikaweratiya (3 months after planting)

Conclusions

Propagation studies

- Seed clipping is the best seed treatment to achieve the highest seed germination.
- Seed viability is decreased with increasing seed storage period.
- Storage in cool temperature can extend the seed viability than storage in room temperature.
- The best potting media is either Sand :Top soil-1:1 or Sand :Top Soil:Compost-1:1:1 for both seed and vegetative propagation.
- The best cutting type is semi-hard wood cuttings but soft wood cuttings (top cuttings) also gave good results
- Best rooting hormone is IBA

Field studies

- Seedlings are the best planting material for field planting in both Wet Zone as well as Dry Zone
- *Jetropha curcus* seedlings are well grown in Dry zone (Nikaweratitiya)
- *Jetropha globosa* seems to be promising variety as far as growth performances considered for wet zone with compared to *Jetropha curcus*, which are poorly grown in the university plot

- Some pest problems occurred at field plants in Ruhuna (Severe attack by mealy bugs)
- 50% of the *Jetropha curcus* plants at Ruhuna were dead, may be due to water logging during heavy rains for several months continuously. Therefore it is clear that Ja*tropha curcus* seedlings seems to be not so tolerant for water lodging specially during the early stage of the growth.
- Jetropha purple variety start fruiting early (5 months after planting) and now started harvesting

- When considered income generation and other socio-economic factors, Jatropha mixed cropping, may be more viable option for large scale planting.
- Growing plants along the fence, road sides, and along the canals etc. may be other options for growing Jatropha for large scale plantating.

Biodiesel Production

What is Biodiesel ?

- Biodiesel is the name of a clean burning alternative fuel, produced from renewable resources
  - can be blended at any level with petroleum diesel to create biodiesel blends
  - can be used in compression-ignition (diesel) engines with little or no modifications
- Biodiesel is simple to use, biodegradable, nontoxic, and essentially free of sulfur and aromatics.

Outline

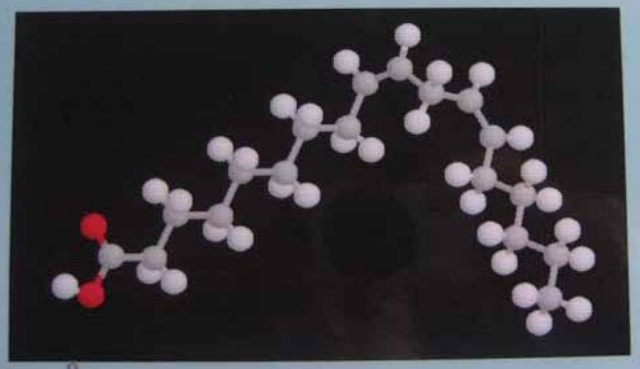
- Introduction to Biodiesel
- Biodiesel Standards
- Biodiesel Processing

How to Make it ?

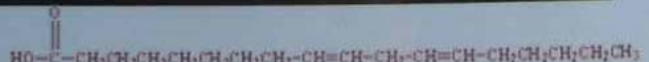
- Biodiesel is made through a chemical process called transesterification whereby the glycerin is separated from the fat or vegetable oil
- The process leaves behind two products
  - methyl esters and
  - glycerin

Oil Chemistry

- Vegetable oils and animal fat contains TAGs of Fatty Acids

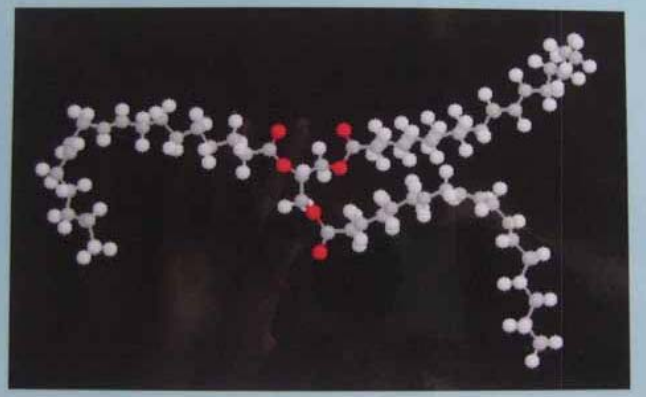


Linoleic Acid, a common component of vegetable oils

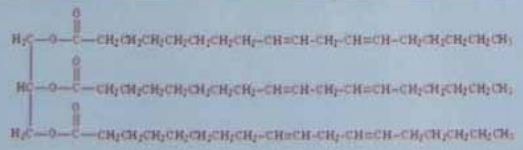


Oil Chemistry

Cont…

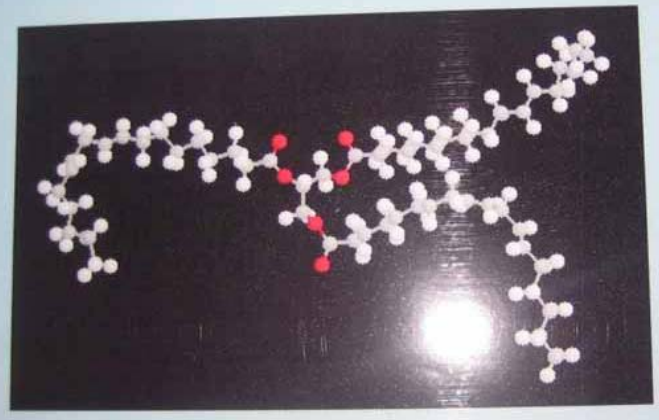


Typical Oil: Trilinoleic Ester of Glyceride

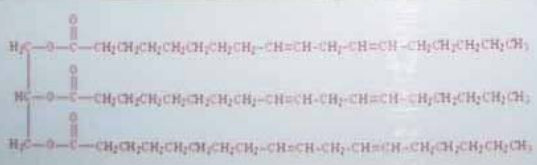


Oil Chemistry

Cont…



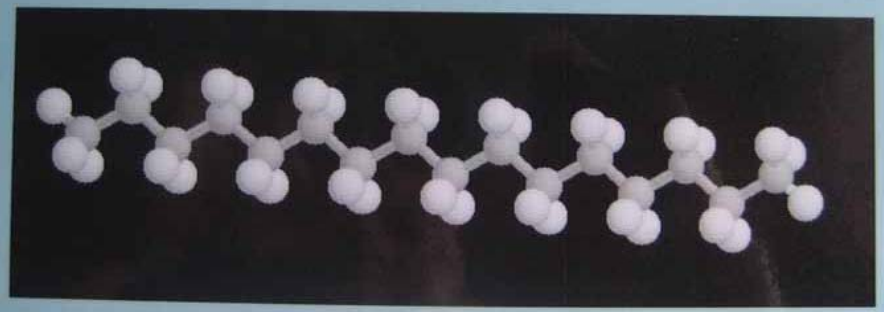
Typical Oil: Trilinoleic Ester of Glyceride

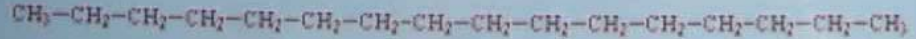


Oil Chemistry

Cont…

Reference: Cetane, typical of petro-diesel

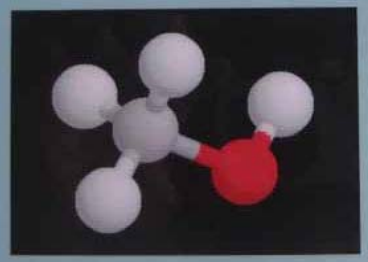




Oil Chemistry

Cont…

Break down the giant TAG by **an alcohol**



$H_3C—OH$

Oil Chemistry

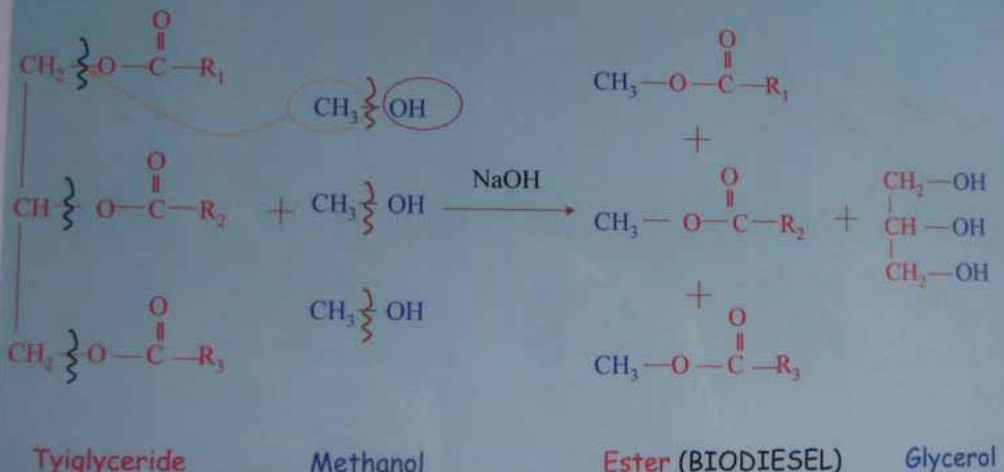
Cont…

Biodiesel ($R\text{-}COO\text{-}CH_3$)

Glycerene ($CH_2OH\text{-}CHOH\text{-}CH_2OH$)

Oil Chemistry

Cont…



Biodiesel Standards

Country	Standard / Specification
Europe	EN 14214
Austria	ON C1191
Czech Republic	CSN 65 6507
Germany	DIN V 51606
Italy	UNI 10635
Sweden	SS 155436
USA	ASTM D-6751

ASTM D 6751– Biodiesel Specifications

Property	Method	Limits	Units
Flash point, closed cup	D 93	130 min	° C
Water and sediment	D 2709	0.050 max	% volume
Kinematic viscosity, 40 ° C	D 445	1.9 – 6.0	mm2/s
Sulfated ash	D 874	0.020 max	wt. %
Total Sulfur	D 5453	0.05 max	wt. %
Copper strip corrosion	D 130	No. 3 max	
Cetane number	D 613	47 min	
Cloud point	D 2500	Report	° C
Carbon residue	D 4530	0.05 max	wt. %
Acid number	D 664	0.8 max	mg KOH/g
Free glycerin	D 6584	0.02	wt. %
Total glycerin	D 6584	0.24	wt. %
Phosphorus	D 4951	10	ppm
Vacuum distillation end point	D 1160	360 °C max. at T-90	
Storage stability	To be determined		

Wear

- Proper protective gloves
- Apron
- Eye protection and
- Do not inhale any vapours

Biodiesel Processing

- Raw Materials
  - Vegetable oil or animal Fat (free from suspended matter, impurities and moisture)
  - Methanol (moisture content should not exceed 0.5%)
  - NaOH
  - H_2SO_4

Biodiesel Processing

Cont…

Procedure

- Measure the acid value using 0.1% NaOH
- Perform a suitable Transesterification method (1-step or 2-step)
- Check the unreacted oil content by methanol test
- Check the biodiesel quality by wash test
- If both tests are ok, do washing
- Separate water and impurities, dry and use as refined biodiesel

1-Step Method
(Base Catalyzed Transesterification)

A general procedure for processing 1L of oil:

- Accurately measure 1L of the oil into the reactor
- Heat the oil to 55 ^{0}C
- Dissolve 3.5 g of NaOH in 200 ml of CH_3OH to prepare CH_3ONa
- Add CH_3ONa into the oil and stir for 1 hour at 600 rpm. (Keep the temperature at a constant level throughout)
- Transfer the product mixture into a settling tank and allow settling for 24 hours
- Carefully drained-off the bottom layer
- Store the top layer as crude biodiesel

Main Reactor

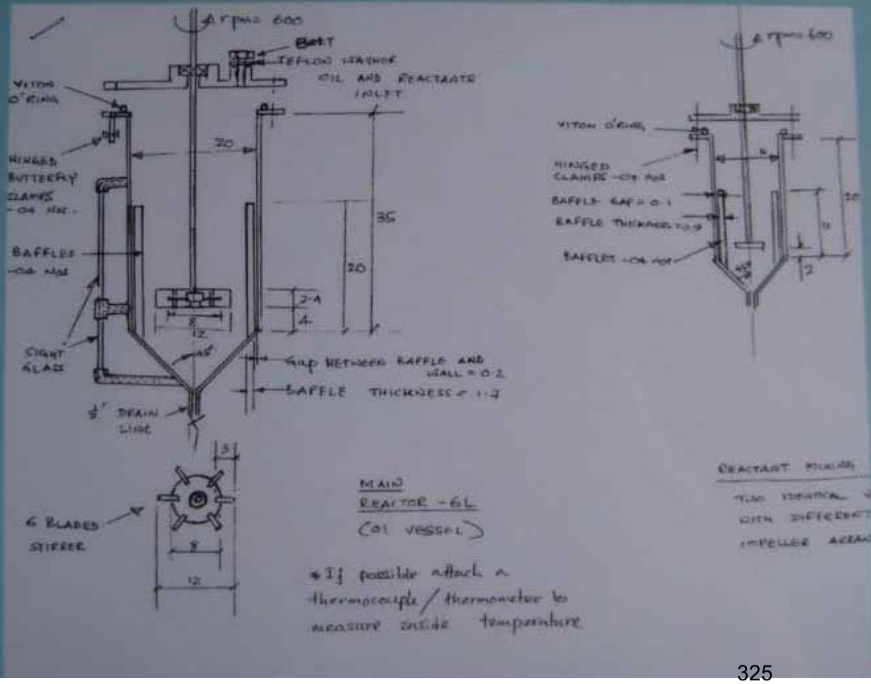
- 5 L Batch Reactor used by Gram Vikas-CTxGreEn Biodiesel Project at Orissa (India)

2-Step Method
(Acid Catalyzed Esterification followed by Base Catalyzed Transesterification)

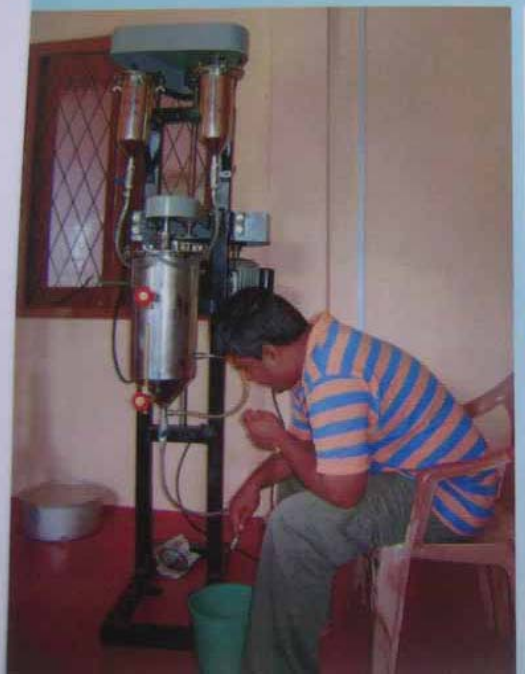
A general procedure for processing 1L of raw oil :

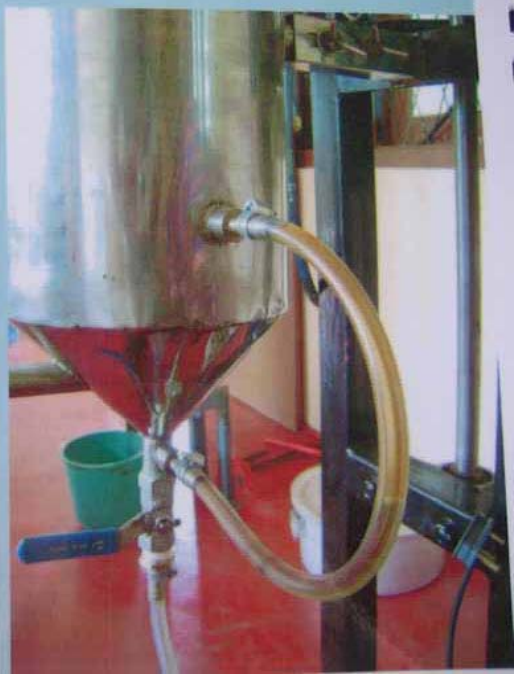
- Accurately measure 1L of the oil into the reactor and heat to 55 ^{0}C
- Mix 1% (by volume) H_2SO_4 acid in 250 ml CH_3OH solution
- Add the mixture into heated oil and stir at 600 rpm for 1 hour (Keep the temperature at a constant level (55 ^{0}C) throughout)
- Allow settling for 24 hours
- Separate the impurity layer and quantify the acid value (A)
- Dissolve (3.5+A) g of NaOH in 200 ml of CH_3OH to prepare CH_3ONa solution
- Continue the transesterification as explained in 1-step method
- Store the top layer as crude biodiesel

Bio diesel Processing unit



Bio diesel Processing unit





Fatty Acid Composition of Coconut Oil

Name	Composition	Mean %
Caprolic acid	C 6:0	0.44
Caprylic acid	C 8:0	7.05
Capric acid	C 10:0	6.59
Lauric acid	C 12:0	50.63
Myristic acid	C 14:0	18.10
Palmitic acid	C 16:0	8.26
Stearic acid	C 18:0	3.07
Oleic acid	C 18:1	4.65
Linoleic acid	C 18:2	0.8
Other	C 18:3 to C 24:1	0.31

Medium Chain TAG (65 %)

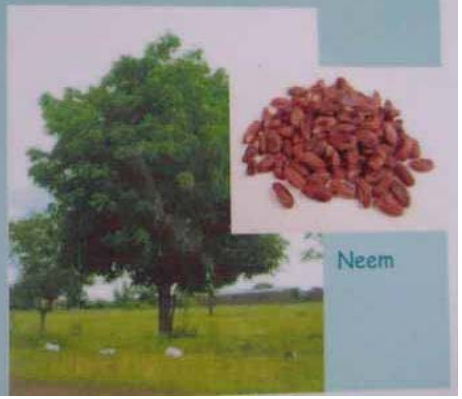
Totol Saturated Fat (94 %)

Options for Sri Lanka

Jatropha curcus

Rubber

Castor Beans



Neem

Fatty Acid Composition of Jatropha Oil

Name	Composition	Mean %
Palmitic acid	C 16:0	14.7
Stearic acid	C 18:0	6.9
Oleic acid	C 18:1	42.4
Linoleic acid	C 18:2	35.2
Other	C 18:3 C 24:1	0.8

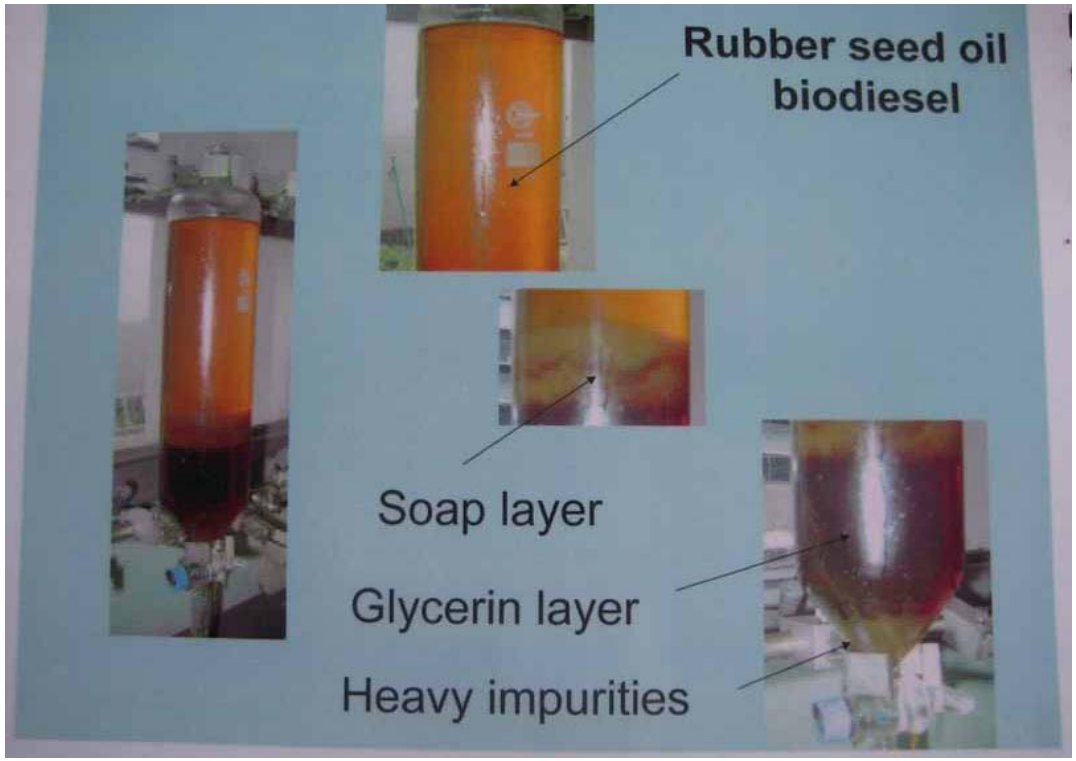
Total Saturated Fat (21.7%)

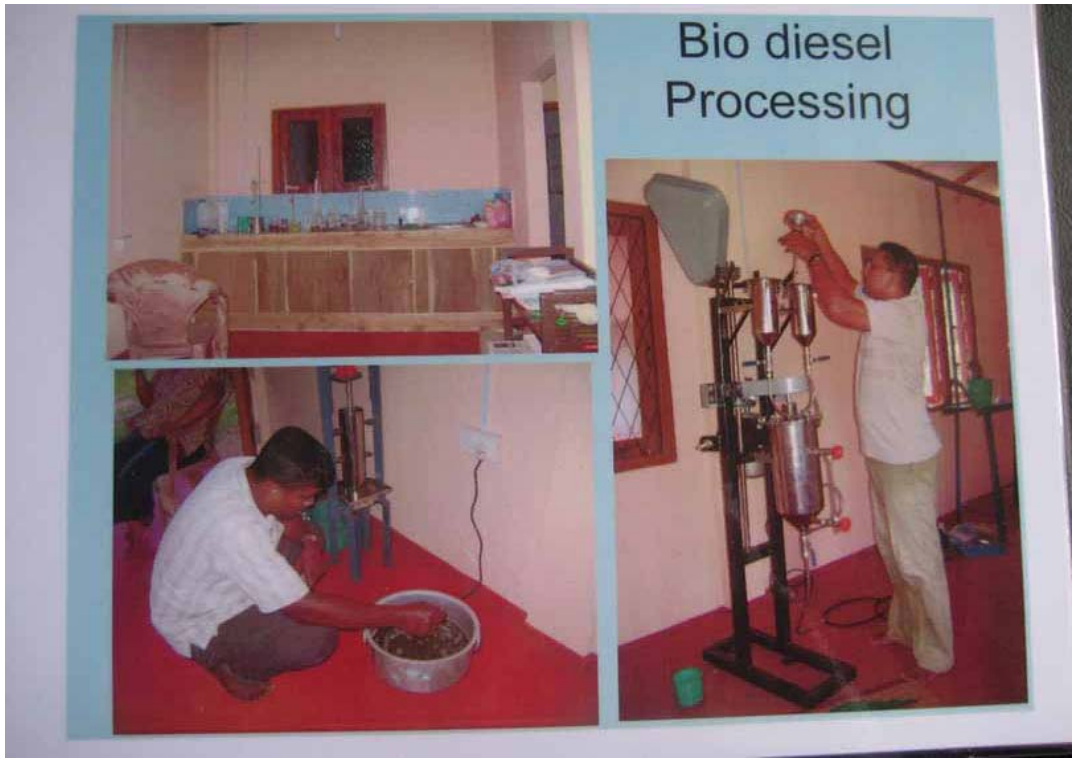
Total Unsturated Fat (78.4 %)

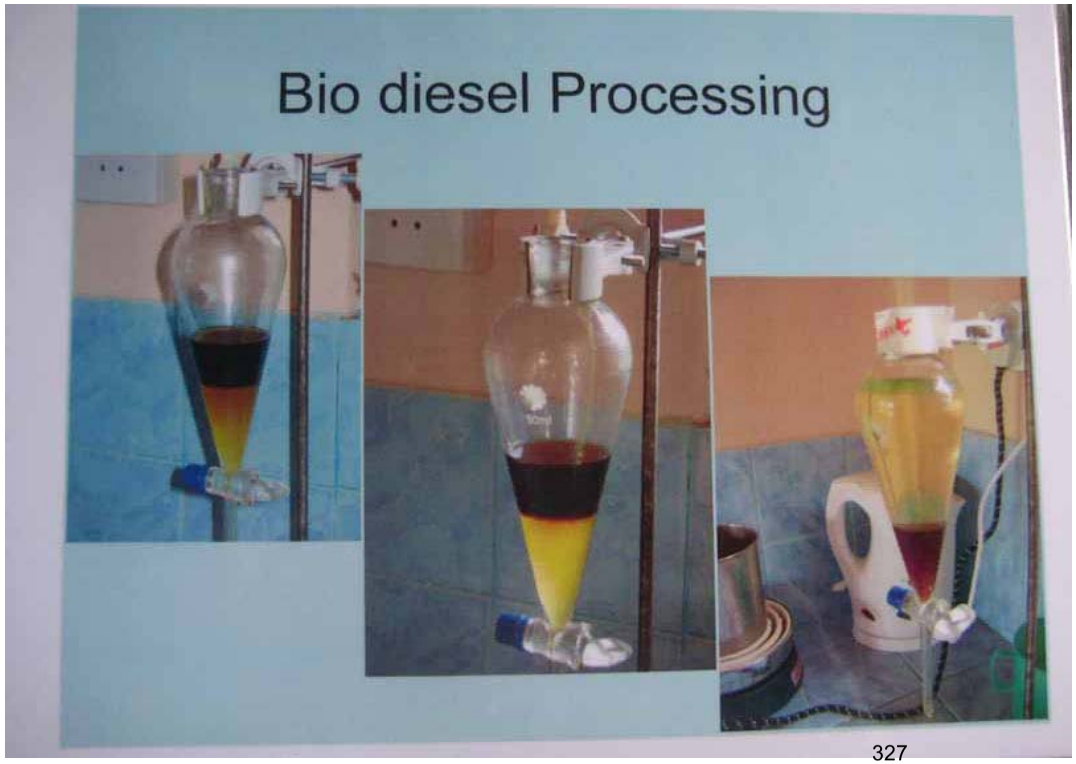
Fatty Acid Composition Rubber Seed Oil

Name	Composition	Mean %
Palmitic acid	C 16:0	17.51
Stearic acid	C 18:0	4.82
Oleic acid	C 18:1	25.33
Linoleic acid	C 18:2	37.50
Linoleic acid	C 18:3	14.21
Other		0.63

Total Unsaturated Fat (77.67%)







Biodiesel Samples

- From left to right
  Jatropha, Castor, Rubber, Neem, Domba and Coconut

Our Objective