

ENGINEERING INTERVENTIONS FOR HIGHER & SUSTAINABLE AGRICULTURAL GROWTH IN INDIA

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- Introduction**
- Agriculture Scenario**
- Mechanization of Agriculture**
- Processing and Value Addition**
- Energy Management**
- Sustainable Agriculture**
- Recommendations**

INTRODUCTION

- **Life is energy**
- **Energy comes from food**
- **Food comes from agriculture**
- **Agriculture depends on solar energy**
- **Solar Energy is natural & renewable**

**Energy is capacity for activity
(Physiological and Mechanical)**

Survival, convenience and comfort of human beings depend on how best the Solar Energy is captured, transformed and utilized.

Agriculture plays VVI Role in human survival, health and happiness.

INTRODUCTION - 1

- Food
- Water
- Air



1025 Million Indian people
(17% of world population
with 2.4% land)

<p>Agriculture</p> <p>↓</p> <p>Food</p>	<p>Raw Food Materials</p> <hr/> <p>Plant based : 650 Mt</p> <p>Animal based : 100 Mt</p>
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- GOI is committed for HHF&NS through enhanced agricultural productivity, diversity and value addition, on sustainable basis.
- ICAR/NARS is MANDATED FOR THIS.

Agricultural Scenario in India

Geographical Area and Agricultural Land

• Total geographical area	328.7 Mha
• Net cropped area	142.8 Mha
• Grossed cropped area	190.0 Mha
• Net area under irrigation	55.0 Mha
• Land distribution pattern	
• Large, > 10ha (17ha)	15%
• Medium 4-10 ha (6ha)	25%
• Semi-medium 2-4 ha (2.7ha)	24%
• Small, 1-2 ha(1.4ha)	19%
• Marginal > 1ha(0.4ha)	17%

Operation in Production and Post-Production Agriculture

Plant Based (Food & Fibre)

PRODUCTION TECHNOLOGY (PT)

- | | |
|---|---|
| <ul style="list-style-type: none">• Land Levelling• Seed bed Preparation• Sowing and Planting• Irrigation and Fertilization• Weed Control and Plant Protection• Harvesting and threshing | <ul style="list-style-type: none">• Cleaning and grading• Handling and transport• Drying and storage• Processing and value addition• Packaging, transport and marketing• Preparation for utilization |
|---|---|

AUGMENTATION OF FOOD PRODUCTION IN INDIA THROUGH ENGINEERING INTERVENTIONS

Activity/Intervention	Augmentation of total food production, %
•Farm Mechanization	10-15%
•Post-Harvest Management	5-10%
•Value Addition	25-400% (value)

Contribution of Agricultural Mechanization in India

•Saving in seed	15-20%
•Saving in fertilizer	15-20%
•Saving in time	20-30%
•Reduction in labours	20-30%
•Increase in cropping intensity	5-20%
•Higher productivity	10-15%
•Reduction in drudgery of farm workers especially that of women	

ENERGY SOURCES AND FARM POWER

Energy Sources	Farm Power
<ul style="list-style-type: none">•Conventional or commercial (coal, water, petroleum, gas & electricity)•Non-conventional or Renewable (solar, wind, biomass and animate)	<ul style="list-style-type: none">•Animate (human and animal)•Mechanical (Tractor, power tiller, diesel & electricity)•Renewable (Solar, biogas, produce gas)
<p>High and rising cost of depleting petroleum and irregular supply of electricity in rural sector compel the development and promotion of RES based gadgets and power supply for better rural living.</p>	

Percent contribution of different power sources in Indian Agriculture (2005-06)

• Agricultural worker	6	Total power = 1.5 kW./ha
• Draught animals	8	
• Tractor	47	
• Power tiller	01	
• Diesel engine	18	
• Electric motors	20	

Present population and annual production of some of the farm implements and machines

Implements/machines	Annual sales	Population in 2004-05, Million
Tractor	175,000	3.00
Power tiller	10000	0.130
Combines	600	0.006
Irrigation and diesel pumps	700,000	32.00
Power sprayer/duster	450,000	0.150
Seed drills	250,000	1.700
Threshers	400,000	2.500

model need to be set up in production catchments to establish the benefits of mechanization of farm operations and post-harvest for increasing production and productivity and employment generation. The employment generation will be through increasing cropping intensity and creation of secondary business of agro-processing, value addition and marketing at rural level.

Mechanization Package for Agriculture

Use of appropriate implements & machinery would result in:

- 15-20% Seed saving
- 15-20% Fertilizer saving
- 5-20% Increase in C. I.
- 10-15% higher productivity

•Region and crop-wise mechanization package consisting of animal drawn and tractor operated implements and equipment have been developed.



Mould Board Plough

Cost: Rs.15,000-16,000
Capacity: 0.2 ha/hour
Cost of Operation: Rs.1050/ha



Seed-cum-Fertilizer Drill

Cost: Rs.4500
Capacity: .18-0.24 ha/hour
Operation: Rs.165/ha



Inclined Plate Planter

Cost: Rs.16,000
Capacity: 0.40-0.50 ha/hour
Cost of Operation: Rs.740/ha

Resource Conservation Equipment & Technology

•Laser land leveler	•30-50% saving in water
•Rotavator	•50% fuel saving & better quality seed bed
•Zero till drill/minimum till drill/ multipurpose tool bar/ raised bed planter	•5-10% increase in yield and saving of Rs. 2000- 3000/ha.
•Pressurized irrigation	•20-30% saving in water
•Rotary power weeder	•20-30% saving in time and labour
•Vertical conveyor reaper/ combine	•Timely harvesting, more yield
•Multi-crop thresher	•50% saving in labour and time and 54% saving in cost of threshing
Straw combine	•Recovers 50% straw and also 70-100 kg grain/ha resulting into an average saving of Rs. 1250/ha.
•Straw baler	•Makes bales and checks environmental pollution
•Straw cutter-cum-spreader	•Cuts and spreads the straw evenly and helps in sowing by zero till drill.
•Improved manual harvester for mango & kinnow	•No damage to fruit and higher capacity

Laser Land Leveler



- **30-50% saving in water and 5-10% higher yield**
- **Cost is about Rs. 400,000 – 500,000. Getting popular among small and medium farmers on custom-hire basis**

Zero Till Drill



Saves Rs. 2000-3000/ha on account of time and fuel

Zero till drill



Benefits

- 50 to 65% saving in time in land preparation and sowing.
- 40-65% reduction in cost of operation
- Saves Rs. 2000-3000/ha.
- Yield increase by 5%
- Saving in fuel by 30 %

Potential

- Total wheat area =26 Mha
- If only 11Mha is sown by zero till drill, total expected saving is Rs.2200-3300 crore (*US\$ 550 - 825 million*)
- Average Field capacity is 3 ha/day (sowing time=20 days)
- Number of drills needed=180,000
- Funds needed = Rs. 360 crores (*US\$ 90 million*)
- Saving in cost of production =Rs.2200 crores (*US\$ 550 million*)
- Increase in wheat production= 2 Mt.



Manual Rice Transplanting



Self propelled 6-row Rice Transplanting



Sprinkler Irrigation



Drip Irrigation



CIAE Twin Wheel Hoe

Manual Weeder



Power Weeder



Power Sprayer



Manual Harvesting



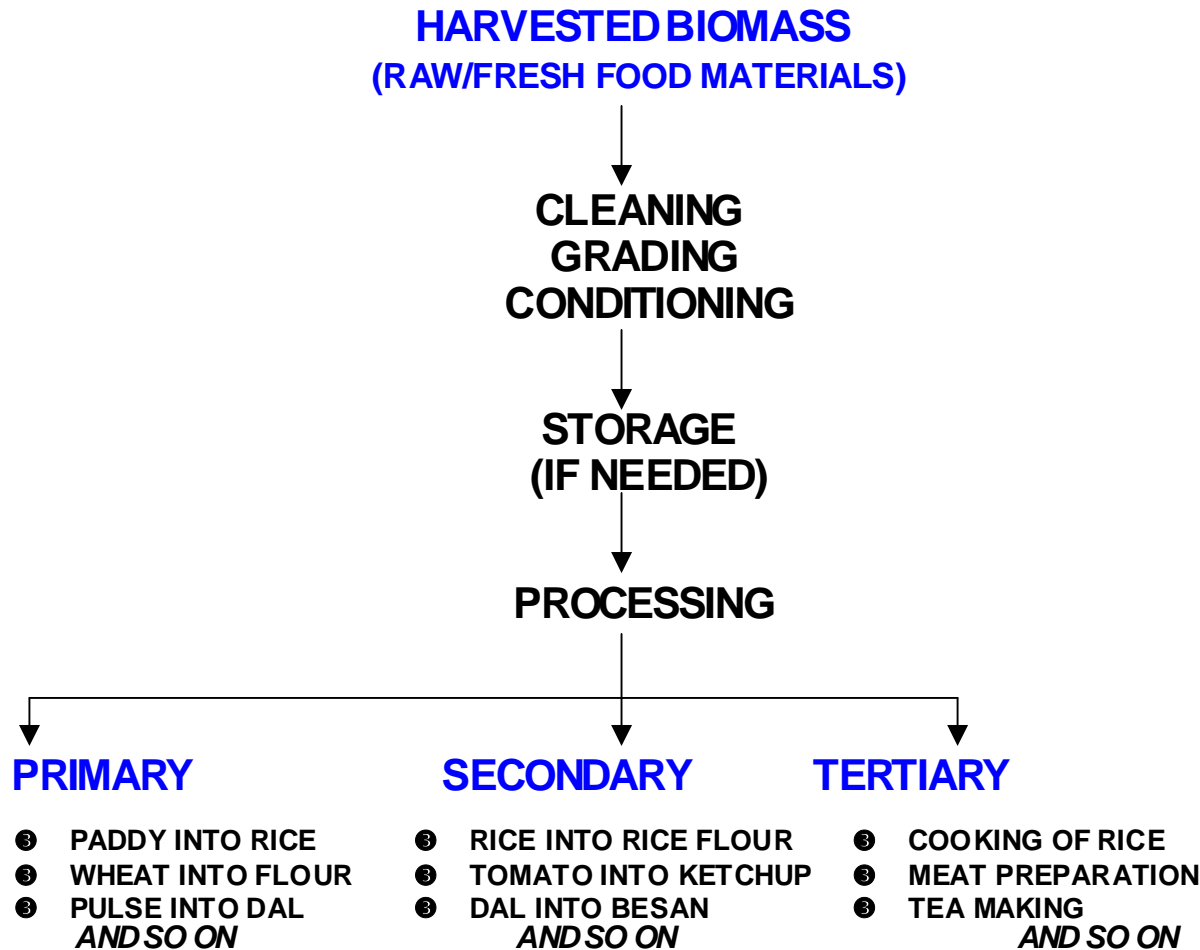
**SELF PROPELLED VERTICAL CONVEYOR
REAPER**



Combine Harvester in Operation

Combine Harvesting

PROCESSING AND VALUE ADDITION



Estimated value additions to the raw food materials through primary and secondary/tertiary processing in India are 75% and 25% respectively.

**AT EVERY STAGE OF PROCESSING
VALUE IS ADDED TO THE PRODUCT**

Agro-Processing

- **Processing and value addition in the Production Catchment for:**
 - **Loss Reduction**
 - **Income Generation**
 - **Better Quality Products**
 - **By-products Utilization**
 - **Reduced Transportation**

Resulting in better human, animal and soil health

AGRO PROCESSING CENTRE



An investment of Rs. 100,000 can generate employment for 1-2 persons and an income of Rs. 3000-5000/month for the entrepreneur

Soybean (8-9 Mt)

Conventional Products

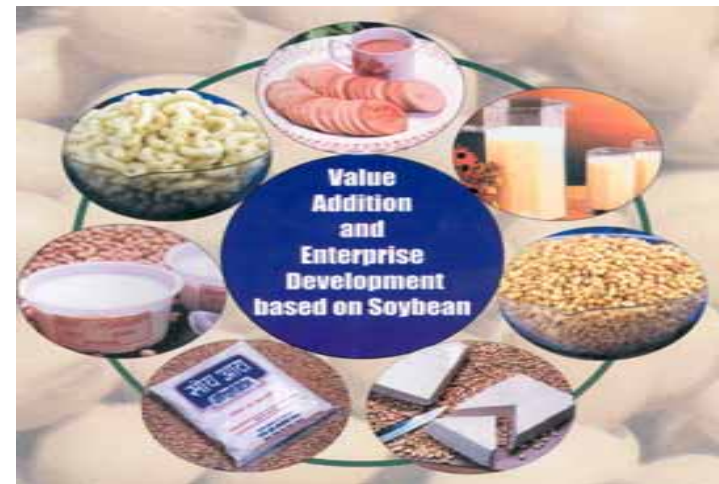
- Oil and Cake

Diversified Products (whole soybean based)

- Soy-based dairy analogs
- Soy fortified baked products
- Roasted and fermented soy snacks
- Soy-cereal-millet based baked/ extruded RTE foods
- Dietary fibre from soyhull & okara

Potential Value Addition

- Fullfat Soyflour : 40%
- Soymilk : 150%
- Soypaneer: 400%





Sugarcane based diversified products for small and micro enterprises in rural sector.

CASE STUDY

Techno-economic feasibility analysis of a typical Agro-Processing Centre in a production catchment in Ludhiana, Punjab

• **Processing of paddy (100t), wheat (400t), oilseeds (75t), spices (4t) and cotton carding (7.5t)**

• **Total Investment : Rs. 5,40,000**

• **Annual profit : Rs. 3,90,000**

• **Monthly profit : Rs. 32,500**

• **Payback period : 1.4. Years**

• **Breakeven point : 1050 h**

• **Employment: Four Persons**

• **Value Addition: Rs 2800/t of paddy**

• **Additional Income to farmer Rs. 1800/t**



Entrepreneurship Development in Soy-Dairy Analogs



**Cost of
200 l/day(8h) or
50 kg soypaneer per day Plant = Rs. 270,000**

Some of the Women friendly Post Harvest Tools and Machines - 1



CIAE Tubular Maize Sheller

Cost: Rs.30=00
Capacity:- 18-20 kg/h
Cost of Operation:Rs.60/q



Cost: Rs. 750=00
Capacity: 30-40kg/h
Cost of
Operation:Rs.25/q



Cost: Rs. 900=00
Capacity: 60-70kg/h
Cost of
Operation:Rs.15-20/q

Hanging type grain cleaner



Cost: Rs.2000=00
Capacity:- 150-200 kg/h
Cost of Operation:Rs.5-6/q

Some of the Women friendly Post Harvest Tools and Machines-2



Flour sifter

Cost: Rs.22000=00
Capacity:- 80-120 kg/h
Cost of Operation:Rs.15/q

Dal mill



Cost: Rs.4000=00
Capacity:- 100kg dal/h
Cost of Operation:Rs.15-20/q

Energy Management in Agriculture Status, Issues and the Strategy

- **Solar Energy and Agriculture**
- **Farm Power and Energy**
- **Energy Use in Agriculture**
- **Energy Issues and Recommendations**

SOLAR ENERGY & AGRICULTURE

- **Solar radiation**
- **Photosynthesis**
- **Primary agricultural produces**
- **Processed agricultural products**
- **Food & Feed for humans & animals**

**Humans & animals are used as Animate
Sources of power for agriculture**

Percent contribution of different power sources in Indian Agriculture (2005-06)

• Agricultural worker	6	Total power = 1.5 kW/ha
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Tractor density in some of the states of India

States	Number of tractors per 1000 ha	Remarks
<ul style="list-style-type: none">• Punjab• Haryana• Uttar Pradesh• Tamil Nadu• Gujarat• Rajasthan• West Bengal• Orissa	<p>71.4</p> <p>60.1</p> <p>28.0</p> <p>12.3</p> <p>12.3</p> <p>9.8</p> <p>1.5</p> <p>1.3</p>	<p>Tractor density in India</p> <p>Highest in Punjab: 72</p> <p>Lowest in Orissa : 01</p> <p>All India : 13</p>
<ul style="list-style-type: none">• All India	<p>13</p>	

Farm power availability and average productivity of Foodgrains in some of the states of India in 2000-01

Name of the State	Farm Power Availability, kW/ha	Food grain productivity, kg/ha
Punjab	3.50	4032
Haryana	2.25	3088
Uttar Pradesh	1.75	2105
Andhra Pradesh	1.60	1995
Bihar	0.80	1622
Madhya Pradesh	0.80	907
Orissa	0.60	799
Chhattisgarh	0.60	799
All India	1.35	1723

Energy Issues Involved in Agriculture-1

Source of Energy	Issues Involved
Draught Animal Power (DAP)	<ul style="list-style-type: none"><li data-bbox="506 394 1780 608">• Enhancement of DAP utilization efficiency through appropriate harnesses and matching equipment for different breeds <i>(Draughtability, matching equipment and work rest cycle)</i><li data-bbox="506 808 1780 1022">• Expanding the annual use of DAP through haulage (carting) and rotary mode of operation for agro-processing and electricity generation <i>(Rotary mode of operation)</i><li data-bbox="506 1150 1780 1365">• One pair DAP based optimum farm size and other annual usage for economic viability <i>(DAP based optimum farm size)</i>

Energy Issues Involved in Agriculture-2

Source of Energy	Issues involved
Renewable Energy Sources (RES)	<ul style="list-style-type: none">● Crop residue based decentralized power generation (DPG) through gasification (flue gases) or anaerobic decomposition (biogas) or fermentation (fuel alcohol). Systems and gadgets need to be developed, tested and upgraded to pilot plants of appropriate sizes. Performance evaluated and management package developed. <i>(Biomass based DPG using thermal or bio-conversion route)</i>■ Promotion of biomass based improved cook stove, solar cooker and biogas & SPV appliances in rural sector. <i>(RES based gadgets and appliances)</i>■ Bio-fuel from Jatropha and Karanj for tractor and diesel pump sets. <i>(Bio-fuel/diesel)</i>

Energy Issues Involved in Agriculture-3

Source of Energy	Issues involved
Conventional Energy Sources (Petroleum)	<ul style="list-style-type: none"><li data-bbox="849 634 1740 1162">• Development and promotion of energy conservation technology and maximization of energy use efficiency <i>(Energy saving technology)</i>

Role of RES and GOI Programme

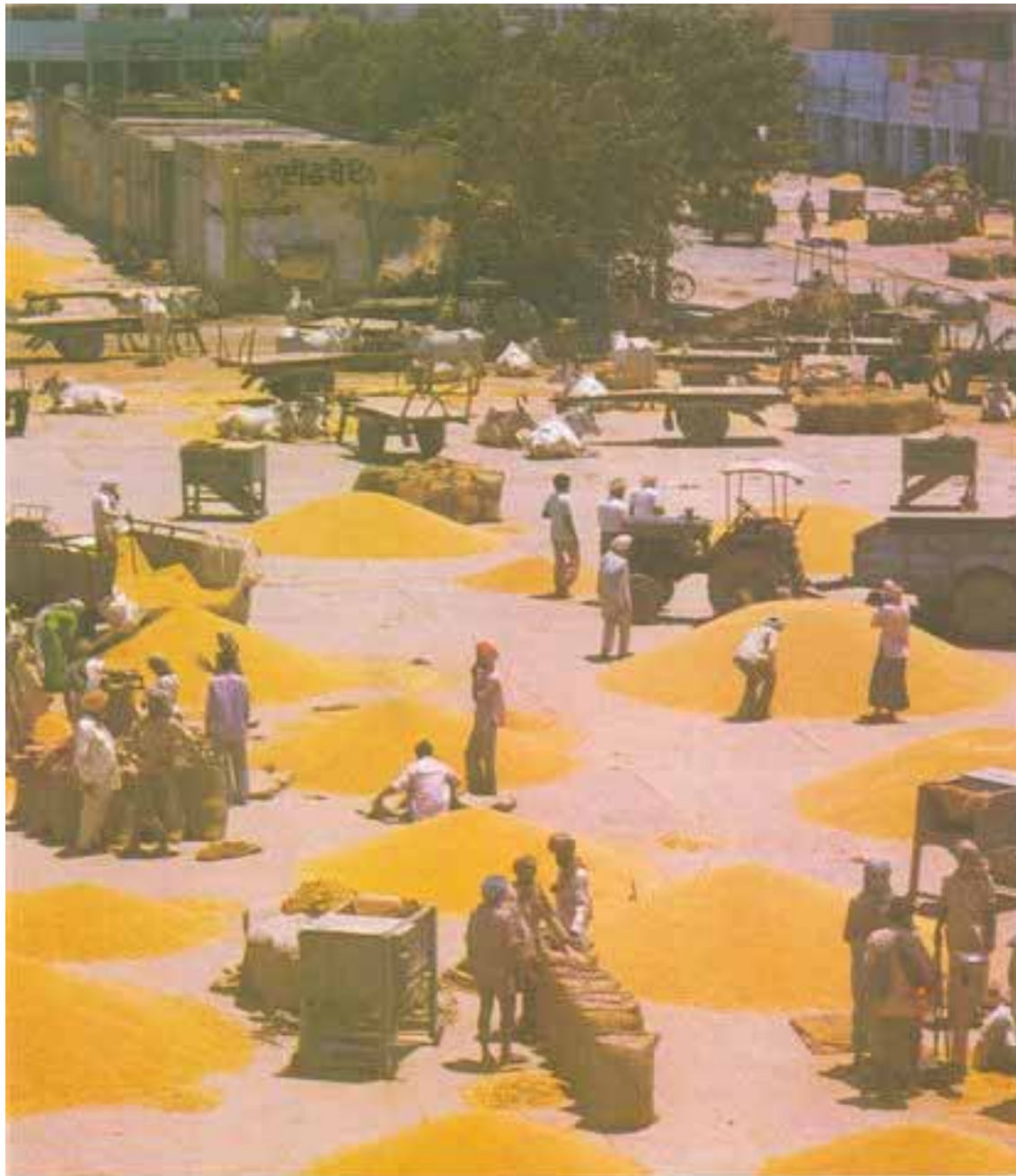
- RES is inexhaustible and Environment friendly. District Advisory Committees on renewable energy have been constituted (532/605).
 - Energy consumption as an Indicator for Growth & Progress
 - Electricity consumption per capita in India is 36 kWh
-
- RES like sun, wind, water and biomass are being used from very beginning of human life on the planet earth. It is needed to be modernized and strengthened.



**Wind Mill for
Water Lifting
and Solar
Energy for
Crop Drying**



**Biogas run
Water Pump**



Solar/Sun Drying and Marketing of Agricultural Produce

Renewable Energy Technology and Gadgets for Rural Sector

For Domestic Application

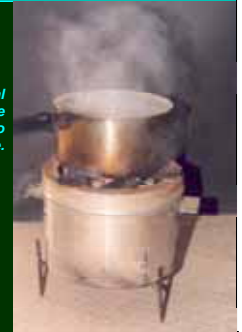
- Biogas Plant
- Biomass Cook Stove
- Solar Cooker
- Solar Water Heater
- Solar Dryer

For Agro-industrial Application

- Solar Photovoltaic Pump
- Solar Tunnel Dryer
- Biomass gasifier
- Biogas slurry as manure

Improved Cookstove

It has higher thermal efficiency and less smoke emission as compared to traditional cook stove.



Biogas Plant



Solar Cooker



Photovoltaic Pump

Thermal and Motive Energy for Agricultural Production and Processing in Rural Sector

- **India produces about 500 Mt of crop residues annually**
- **25% of crop residue (125 Mt) is available for energy generation (12500 MW) in rural sector**
- **Gasification based system/ technology costing Rs. 10-15 million/MW is available**



Producer gas system installed in an industry near Anand (Gujarat) for chicory roasting

Benefits of Biofuels

- **Carbon neutral**
- **Renewable**
- **Support rural livelihood**
- **Save foreign exchange**
- **Indigenous energy self-sufficiency**

Major Sources of Biofuel

Biofuel	Sources
Bioethanol	<ul style="list-style-type: none">- Sweet sorghum- Crop residues- Sugarcane- Maize- Cassava
Biodiesel	<ul style="list-style-type: none">- Jatropha- Pongamia- Other TBOs- Soybean/ rapeseed- Other oils

GHG reduction relative to gasoline

Biofuel Source	Feedstock	GHG reduction
Sugar	sugarcane sweet sorghum	100 %
Oil	Oilpalm Soybean rapeseed	41-66 %
Starch	Maize	13-53 %
Cellulosic	maize and sorghum stalk grasses crop residues	50-100 %

World Ethanol Production (2005)

Country	M litres	% share
<ul style="list-style-type: none">• USA• Brazil• China• India• Others	<ul style="list-style-type: none">16,20016,0003,8001,7008,500	<ul style="list-style-type: none">35358418
World Total	46,200	100

World Biodiesel Production (2005)

Country	M litres	% share
Germany	1900	54
France	500	15
USA	300	9
Others	800	22
World Total	3500	100

Production and Productivity Potential of Jatropha Seed & Oil



- **Plant population**
- **(2 m x 2 m) : 2500**
- **Fruiting starts : 2nd year**
- **Fruiting stabilizes : 5-6 years**
- **Fruiting continues: 40-50 years**
- **Jatropha seed : 4-5 kg/plant**
- **Oil content : 30-35%**
- **Oil yield : 3.0-4.0 t/ha**



Jatropha Plant and Fruits



Jatropha seed



Jatropha seed and kernel



- Sustainable production, conversion and application of biofuels are in the National Interest

Jatropha Oil & Cake

Biofuel Value Chain

- **Trait development**
- **Seed production**
- **Feedstock production**
- **Bioprocessing**
- **Biofuel distribution**
- **Consumer fuels**
- **End users**

Biofuel Policy

**Replacement of fossil fuels by
biofuels to the extent of**

5 % by 2012

10 % by 2017

20 % beyond 2017

Researchable Issues

- To evaluate different biofuel feedstocks for energy efficiency and mitigation of GHG
- To engineer microbes for efficient biomass conversion into biofuels
- Genetic enhancement of biofuel crops for rainfed marginal or non-agricultural lands

Researchable Issues

- Development of genebanks and molecular breeding for biofuel crops having high photosynthesis and metabolism and low lignin with easy breakdown for biofuel conversion
- Development and standardization of technology for PHM, fuel processing and byproducts utilization

Suggestion

- Energy autonomy potential through DPG based on biomass need to be explored in terms of technology and management
- RES based gadget and appliances such as solar cooker and water heaters; SPV lightening and pumping; biogas stove and engines system need to be promoted on large scale.
- Development and promotion of energy conservation technology and maximization of energy use efficiency and the promotion of bio-fuel from Jatropha and Karanj
- Enhancement of DAP utilization efficiency through appropriate harnesses and matching equipments for different breeds and optimum farm size for economic viability of DAP need to be established
- Statistical data on use and problems of RES based gadget and appliance & biomass potential and present uses need to be collected and analyzed.

Sustainable Agriculture

- Economically viable
 - Eco - friendly
 - Socially acceptable
-
- Judicious use of Natural Resources (Soil, Water, Bio)
 - Use of RES & Gadgets
 - Diversification of Agril (IIFS)
 - Use of Resource Conservation Farm Tools & Equipment
 - Post harvest management and processing

Sustainable Agriculture Management

- Resource Conservation Technology and Machines
- Contract, cooperative and Corporate Farming
- Agricultural Produce Markets
- Food Security and RTF
- Strong Agril Extension System

Suggestions/Recommendations-1

- Scientific management of soil, water and bio resources.
- Development and promotion of farmers' friendly farming systems including livestock and fishery to maximize the system output.
- Crop and site specific agricultural mechanization using a proper blend of conventional and renewable energy sources.
- Adoption of integrated nutrient and pest management practices.

Suggestions/Recommendations-2

- Post-harvest management and value addition in the production catchment.
- Bridge the knowledge gap through effective extension.
- Provide easy access to credit at affordable rate

*HAPPY NEW
YEAR 2008*

Thank You