

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

# Potential of Renewable Biomass as a Source of Alternate Energy

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# Renewable Energy

Replenished by nature i.e. Sun, wind, water

- Carbon Neutral
- Decrease imports
- Need sophisticated technology
- Highly skilled labor
- Huge investment
- Availability not universal



# Biomass energy

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Organic material, i.e plants, forest Residue, wastes

- De-centralized or Universal Availability
- Simple Technology
- Increase in Production and Employment
- Ordinary Farmers can Practice
- Decrease in Imports



# Environmental Impacts of Biomass

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- CO2 Neutral
- Land up gradation:
  - Absorb nitrogen from air and transfer it to soil
  - Prevents soil erosion
  - Prevents the effects of floods etc.
  - Decrease pathogens
  - Reduction in weed seed



# Types of Biomass

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- Oil Crops
- Non-Woody Grasses
- Short Rotation Energy Crops
- Aquatics
- Agricultural Residues
- Livestock manure
- Municipal Solid Waste



# Oil Crops

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Non-edible

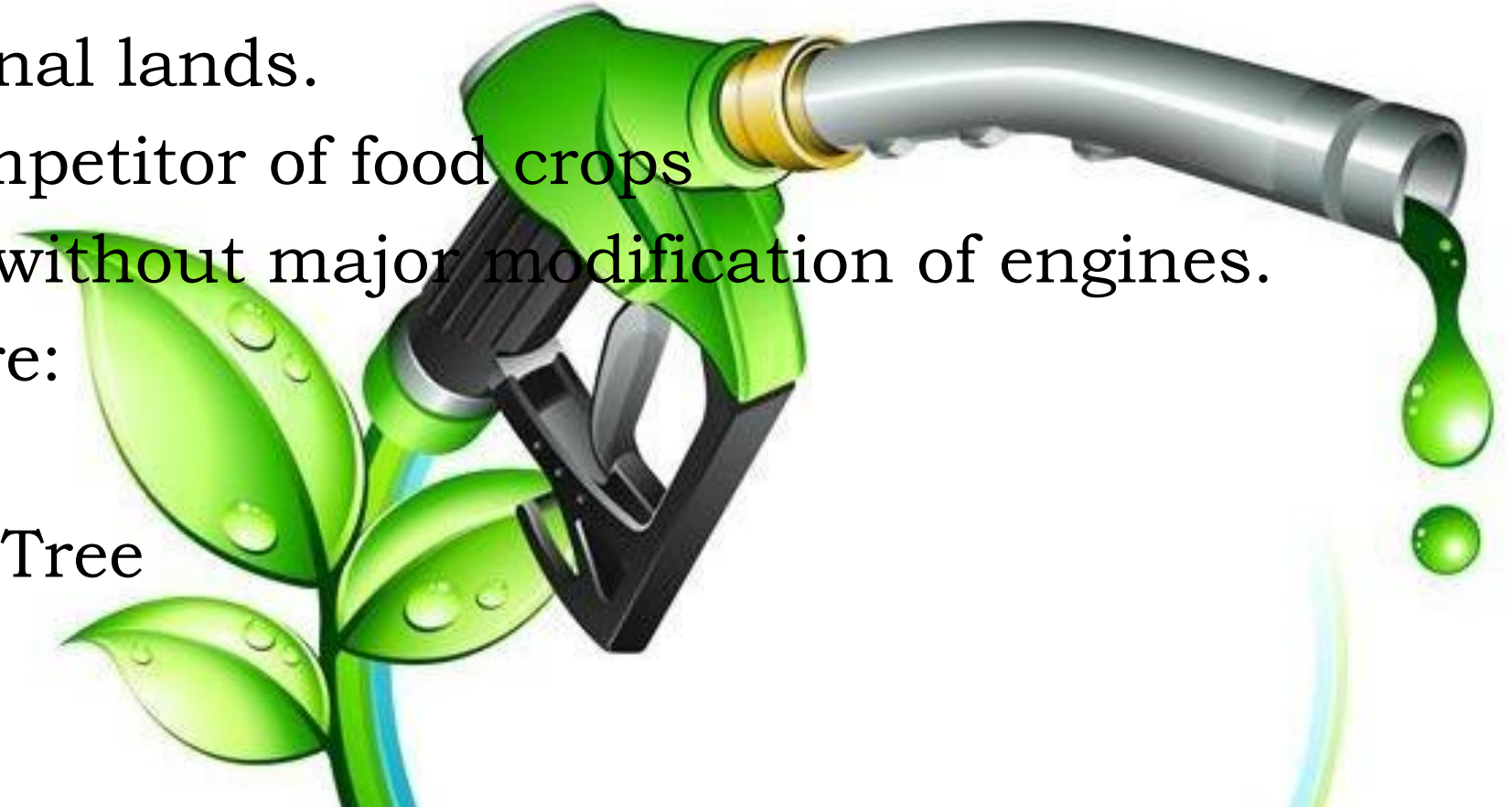
Grown on marginal lands.

They are not competitor of food crops

Oil can be used without major modification of engines.

Some of these are:

- ❖ Jetropha
- ❖ Chines Tallow Tree
- ❖ Rocket Seed



# Jatropha

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- No technology required
- Weather resistant, drought resistant
- Can be grown on infertile and margin land
- Life: 60+ years
- Production: up to 5000 kg per acre annually
- (PKR 5000\*50=250000 per acre)
- Cost: One time cultivation cost, not more than 60,000 per acre





# Jatropha

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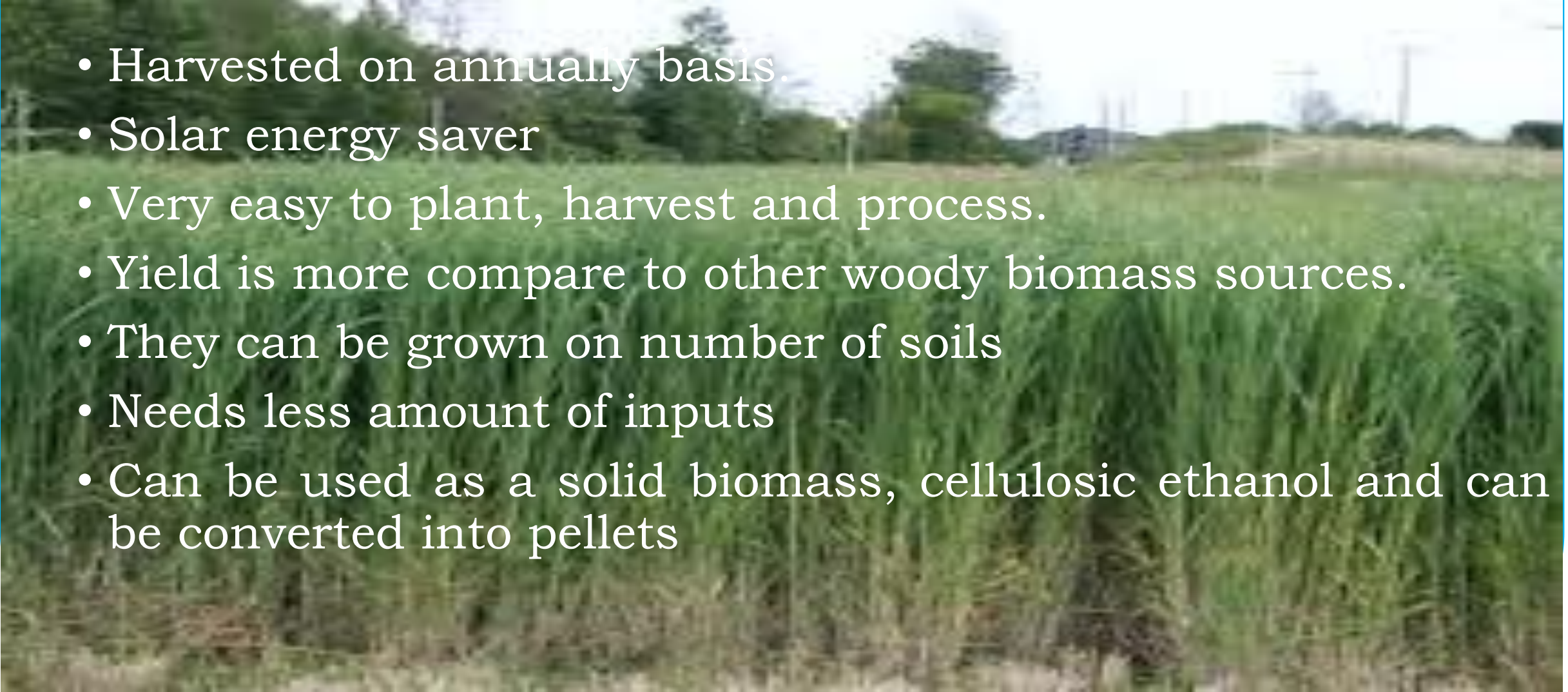
- Cultivation over 1000 acre land can save forex of PKR 81 million @Jan-16 prices
- Can provide livelihood to approx. 2000 people
- In the cost of orange line train project (US\$ 1.5 billion), 2.5 million acre land could be cultivated providing livelihood to >2.5 million people and saving an annual Forex of PKR 200 billion
- India is currently the leading cultivator of jatropha with more than 0.4 M ha (million hectares) of area under this crop

# Chines Tallow Tree and Rocket Seed

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- The average yield potential of Chines Tallow Tree is 14 metric ton seeds per hectare annually.
- It is estimated that 2442 liter of oil can be extract from seed of one acre trees.
- some time it can reach up to 3673 liter which is higher than other oils seeds
- Mature plant of Rocket Seed Crop is comprises 20% seed and 80% straw.
- Seeds consist 35% oil content and rest is oil cake.
- Oil cake can be used as animal fodder or burnt to generate heat

# Non-Woody Grasses

- Harvested on annually basis.
  - Solar energy saver
  - Very easy to plant, harvest and process.
  - Yield is more compare to other woody biomass sources.
  - They can be grown on number of soils
  - Needs less amount of inputs
  - Can be used as a solid biomass, cellulosic ethanol and can be converted into pellets
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# Non-Woody Grasses

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- These grasses are being produced in different areas of Punjab, NWFP and Azad Kashmir.
- Can grow on tropic, sub-tropic and temperate regions
- Can be grown on unfertile land even on coarse river sands to heavy clay soils.
- Can grown on degraded lands, in wastewaters or salty lands.
- They can produce 20-30 tons of dry matter per hectare and dry matter of one ton can give 240 liters of ethanol

# Short Rotation Energy Crops

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- Available during whole year.
- Ready to harvest in their fourth growing season after fallen leaves.
- These leaves add nutrient to the soil and give better production in next season.
- Willow
- Bamboo



# Willow (salix)

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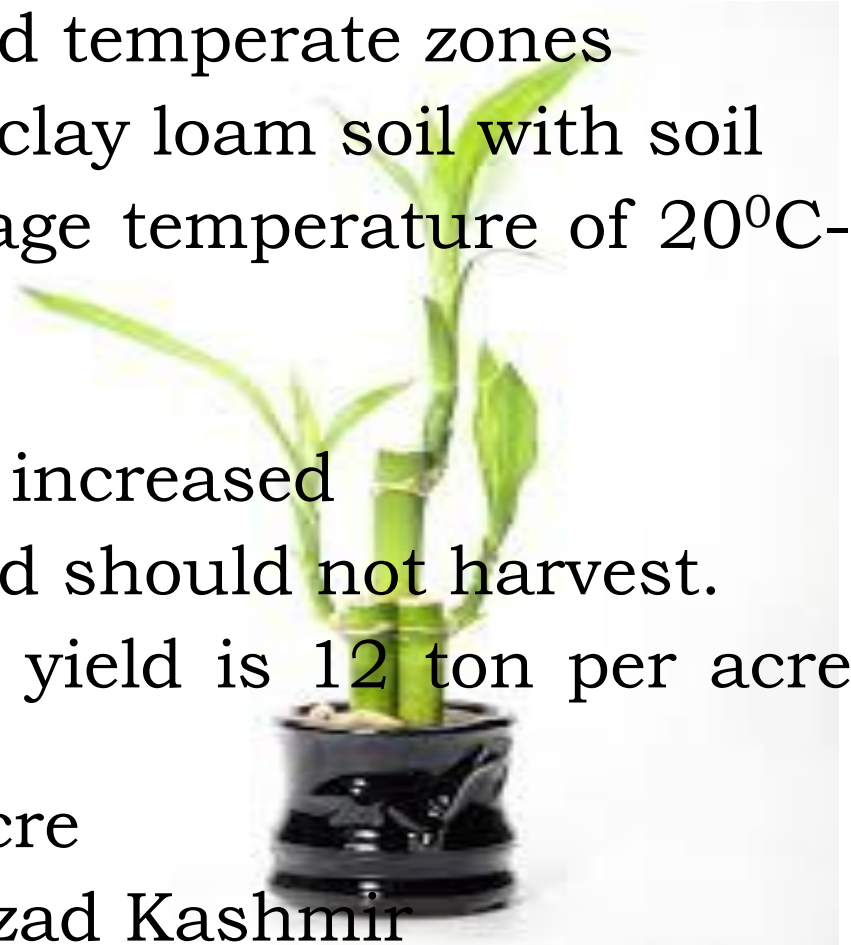
- They can be grown on sandy, clay and loamy soil
- Soil pH 5.0-8.0 on average temperature ranging 16<sup>0</sup>C-27<sup>0</sup>C.
- Water is the main input needed to produce willow.
- Can grow even on waterlogged areas
- Convert the area into capable of cultivation of other crops.
- The cost of plants, their plantation, cuttings of trees and their maintenance require 50,000/- per acre
- The approximately yield of willow is 18 tons of fresh or wet matter.
- If this is sold at the rate of 300/- per 40 kg, then a farmer can earn almost 135000/- per acre in the first harvest season
- The yield increases with the life of willow
- Rawalpindi, Abbottabad, Mansehra etc



# Bamboo (Bambuseae)

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- They are grown naturally in tropic and temperate zones
- They can be grown on sandy loam to clay loam soil with soil pH ranging between 4.5-7.5 on average temperature of 20<sup>0</sup>C-32<sup>0</sup>C
- Harvesting: starts after five years
- After every year the number of culms increased
- The culms that are one or two year old should not harvest.
- In first year of harvest the potential yield is 12 ton per acre with 200 plants per care
- 30 ton by planting 1000 plants per acre
- Different areas of Punjab, KPK and Azad Kashmir



# Bamboo in China and India

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- Known as Green Gold
- The total standing stock of bamboo in China is about 71.22 million tonnes and the annual yield about 7 million tonnes
- The annual production of bamboo in India is about 4.6 million tonne



# Technology Requirements for Short Rotation Energy Crops

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The technologies which are being used for fossil fuels convert the feedstock into heat or electricity.

In this process heat is dominant factor which is generated by these technologies and then converted to some other energy forms.

Mainly these technologies include:

- ❖ Combustion
- ❖ Combined Heat and Power
- ❖ Gasification
- ❖ Pyrolysis

# Aquatics

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- The amount of endogenous nutrients in lakes and rivers is rising due to the inclusion of wastewater of industrial, agricultural and household activities.
- This water contamination can be controlled by the utilization of aquatic plants.
- The plants that can grow in water, wet soils or on marshy lands have excellent quality to purify the water with little operations.
- These aquatic plants grow rapidly and start decaying if they are not used immediately, so it causes another pollution.
- But if they are harvested and used as a source of biomass can generate an equal amount of energy with terrestrial plants

# Aquatics

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- Micro Algae and Macro Algae are the two main types of aquatics.
- Micro Algae is fast growing unicellular microscopic plant. It does not possess roots, stems and leaves.
- They can survive in severe conditions because of their unicellular and simple formation
- Some algae just consume sun light and convert into chemical energy. Some of its species rely only on organic compounds and some other species ingest both sun light and organic matters

# Aquatics

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- They produce natural oil by converting the water and carbon dioxide in the existence of sunlight.
- They are easily established, can grow with little or no care and consume the water which is not consumable by humans.
- They require almost 49 times less area compare to other biomass oil producing trees for producing same amount of oil.
- Generally they double their biomass within 24 hours.
- They provide feedstock for various type of biofuel like biodiesel, methane and ethanol.
- The biodiesel perform exactly same like petroleum diesel by omitting less amount of carbon dioxide

# Aquatics

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- Macro algae is multi cellular plant deprived of stem and roots. Some of its species can grow in salt water without competing the land and fresh water for agricultural crops.
- They can change their internal system depending on the environment where they are growing
- Some of its species can generate more amount of energy compare to terrestrial plants by acquiring less land
- like seaweed can generate 13.1 kilo gram dry weight per meter square annually compare to sugar cane with produce 10 kilo gram per meter square per annum

# Agricultural Residues

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- Agricultural residues are capable to perform as a sustainable source of biomass.
- They are easily available in abundance at very low cost.
- They are available round the year and have the potential to serve many types of energy in environmentally positive way
- The potential of energy which can be generated from the crops residues is given in following table:



# Agricultural Residues

	RPR	Lower Heating Value LHV (mj/kg)	Production of Crop (000 tons)	Production of Straw (pro*RPR)	Potential EJ (Pro st*LHV)
Rice Husk	0.28	16.01	6,798	1869.45	29,929.99
Rice Straw	2.19	13.45	6,798	14887.6	200,238.22
Maize stalk	2.67	12.46	4,944	13175.8	164,104.59
Maize Cob	1.00	15.46	4,944	4944	76,434.24
Cane Tops	0.20	16.61	67,460	13492	224,102.12
Cane Bagasse	0.22	12.93	67,460	14504	187,536.72
Cotton Sticks	3.39	16.21	12,769	43223.1	700,646.45

# Livestock Manure

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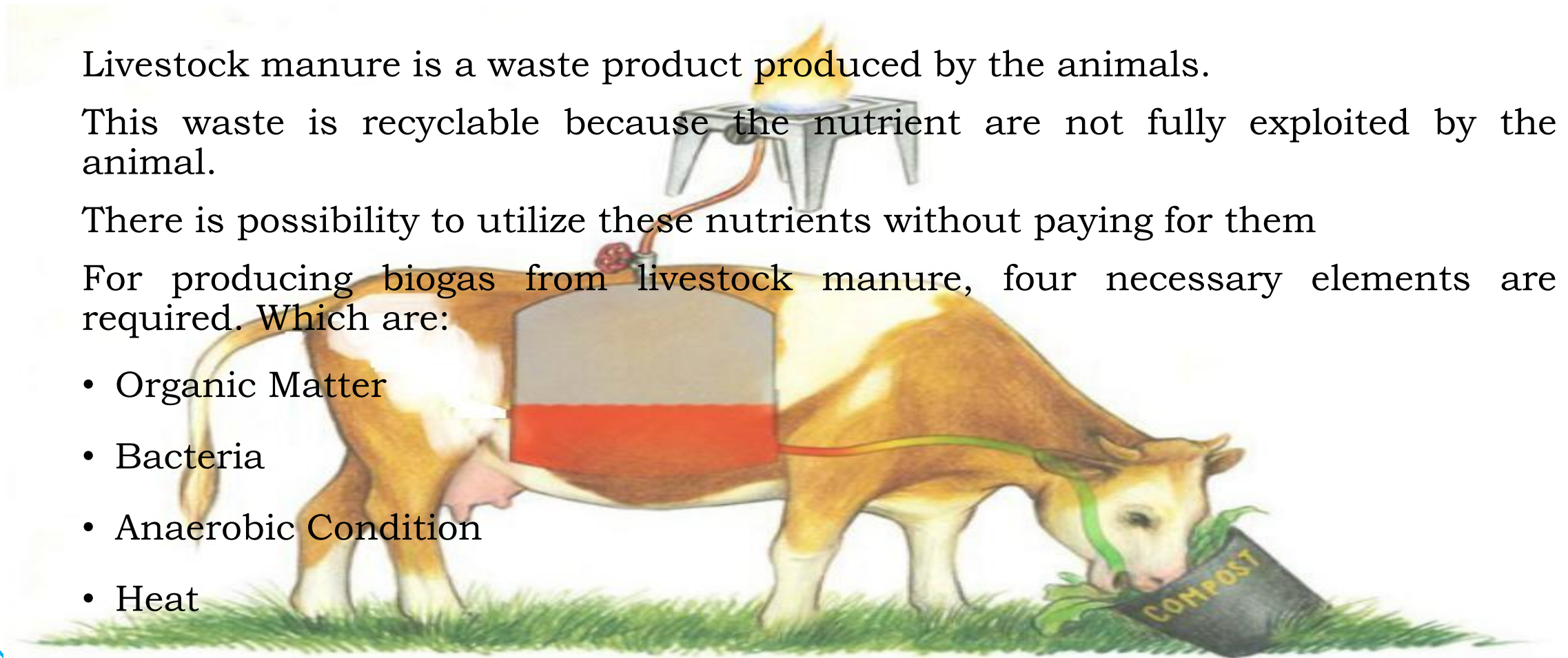
Livestock manure is a waste product produced by the animals.

This waste is recyclable because the nutrients are not fully exploited by the animal.

There is possibility to utilize these nutrients without paying for them

For producing biogas from livestock manure, four necessary elements are required. Which are:

- Organic Matter
- Bacteria
- Anaerobic Condition
- Heat





# Livestock Manure

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There are 76.8 million livestock (Buffalo and Cow) available in Pakistan which generate approximately 768 million kilogram manure per day.

According to FAO half of this manure is collected and used as fuel and fertilizers.

If half of the manure is collectable then there is possibility of the availability of 384 million kilogram animal dung on daily basis

With this amount of manure, approximately 19.2 million cubic meter biogas (at the rate of  $.05 \text{ m}^3$  per kg of animal dung) can be produced

# Livestock Manure

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- Biogas is methane rich gas which has the ability to replace the all petroleum, deiseal and electricity in the rural areas of Pakistan.
- As one cubic meter biogas is equal to 6.4 KWh and one litter oil is equal to 10 KWh.
- The feedstock and material for construction of plant of biogas is locally available
- so it increases the number of employees and demand of bricks and cement companies.
- It causes the increase in production and employment of the country. This ultimately results high economic growth

# Municipal Solid Waste

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- Municipal solid waste comprises solids, semi-solids and non-soluble materials
- Waste in Pakistan was estimated between 0.283-0.612 kg per capita on daily basis
- It is increasing at the rate 2.6% annually.
- Population of Pakistan is 188.02 million.
- We can get 173.79 million kg on daily basis



# Municipal Solid Waste

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- This waste is being dumped in landfills which causes many environmental problems.
- The amount of waste generated and reached to the landfills depends on the system of waste management.
- In Pakistan all the waste is not reached to the landfills which pollute the air, water and soil.
- If there would be a proper waste management system this waste can be used as a source of biomass after separating the recyclable material.
- The heat value of solid municipal waste is estimated 6.89 MJ per kilogram.

# Biomass In India

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- India is producing about 20,757 lakh cubic meters biogas in 2014-15, which is equivalent to 5% of its total LPG consumption on daily basis.
- India has launched a “National Mission” of plantation of 11 million ha jatropha on the unused land.
- A similar program was started with Ethanol production from sugarcane molasses, which is to replace 5% of transport petrol in the first phase



Thank You