
بسم الله الرحمن الرحيم

BIO-POWER
AS
ALTERNATIVE ENERGY RESOURCE
FOR RURAL COMMUNITY IN PAKISTAN

BY

DR. MUHAMMAD ASHRAF

ASSTT: AGRI. ENGINEER (RESEARCH)

AGRICULTURAL MECHANIZATION RESEARCH INSTITUTE

DIVISION FAISALABAD

THE MOST BURNING ISSUE OF THE DAY IN AGRICULTURE SECTOR

- Energy (Diesel, Electricity, Gas)
- Water (for irrigation)

Water sources in Pakistan

- Rainfall
- Surface water from the Rivers, Canals
- Ground water

Water

- Surface water availability (Normal) 103.5 MAF
- Surface water available (2009-10) 93.3 MAF
- Surface water short fall (2009-10) 9.9 MAF
- **Expected water short fall by 2013** **108 MAF**
- Rain fall (2009-10)

Rainfall	**Mon son** (mm)	**Winter** (mm)
Normal	137.5	70.5
Actual	101.8	49.2
Shortfall	26%	30.2%

Ground Water

Due to insufficient supply of surface water for irrigation ground water pumping with tube well in Pakistan is a 2nd major source of water.

Tube well in Pakistan

- Diesel Tube Well 545,000
- Electric tube wells 84,000

FUEL CONSUMPTION

Three power source for tube well operation

1. Diesel tube well (Peter Engines)

   1.5-2.5 liters per hour

2. Tractor operated tube wells

   3.5-5.0 liter per hour

3. Electric tube well, on an average, are

   8 units per hour (with 10 horsepower motor).

Tube Well Operation Cost

Diesel Consumption/annum

- 950 million liters,
- 87 billions rupees

Electric tube wells/annum

- 1.02 billion kilo watt-hours (kwh)
- 26 billions rupees

Total energy cost/annum

- **113 billion rupees (for tube well operation)**

Tractor Operation Cost

- Farm energy source
- Tractors (Approx) 600,000 +
- Diesel consumption

  6 liters/hour (Average)
- Annual diesel consumption (Approx)

  6000lit/tractor
- Total diesel consumption 3600 million liters
- **Total energy cost/annum (Estimated)**
  - **330 billion rupees (for tractor operation)**

Bottle Necks and Solutions

- High rate of fuel and electricity
- Scheduled and unscheduled load shedding of electricity
- Un availability of diesel

We have to go to the

Alternate energy resources

- Biogas (Biogas is a source of green renewable energy)
- Solar
- Wind

What we Do?

Solution

?

Biogas

What is biogas?

- Biogas is produced by the breakdown of organic waste by bacteria without oxygen (anaerobic digestion).

Methane (CH_4)	40-75%
Carbon dioxide (CO_2)	25-55%
Hydrogen sulfide (H_2S)	50-5000ppm
Ammonia (NH_3)	0-1%
Water (H_2O)	0-10%
Nitrogen (N_2)	0-5%
Oxygen (O_2)	0-2%
Hydrogen (H_2)	0-1%

We have the potential

- Pakistan is agro-based country
- Total cropped area in Pakistan is about 22.2 million ha.
- Available crop residue in Pakistan 69 million tons/annum
- Biomass can generate 45,870 million kwh electricity per year
- Available animals in Pakistan 65 Millions (Approx)
- Available animal dung 650 Million Kg/day
- Collectable dung 325 Million kg/day (50% Collectability)
- Pakistan can generate 16.25 million m^3/day of biogas
- Pakistan can generate 9885 million kwh electricity per year
- Estimated bio fertilizer production is 12 million tones per year
- It can easily compensate around 20-30 % of fertilizer requirement in the crop fields.
- Pakistan has almost 3,000 MW power generation potential in sugar industry while producing only 700 MW

Misuse of potential and Environmental Effects

- Deforested area 7000 ha/year for burning in any form
- Approximately 1/3 of collectable dung (156 Million kg/day) is used for dung cake making for domestic burning and 2/3rd of collectable dung is open dumped for manure.
- Available energy from animal dung cake only 11%.
- More than 50% of crop residue is burnt causing the environment pollutions and retarding the favourable microbial activities in soil.

Traditional making of dung cake

Misuse of potential and Environmental Effects

- All the sources (forests, crop residue, animal dung cake, etc) either burnt or aerobically decomposed causes environmental pollution.
- Each year some **590-880 million tons** of methane is released worldwide into the atmosphere through microbial activity.
- Contribution of a methane (CH_4) to the greenhouse effect is 21 times greater than that of a carbon dioxide.

History of Biogas technology in Pakistan

- History of Biogas in Pakistan is about 35 years old
- Around 7000 digesters have reportedly been installed across the country.
- Technical potential of about 5 million digesters.
- Government of Pakistan started comprehensive biogas scheme in 1974 and total 4,137 biogas plants installed up-to 1987. These are Floating drum biogas plants with capacity 5-15 cubic meters gas production per day.
- Pakistan Centre for Renewable Energy Technologies (PCRET) Installed of around 2500 biogas plants till the end of 2008.

History of Biogas technology in Pakistan

- NGO, (IRSD) installed 150 biogas plants with support from the UNDP.
- NGO ‘Koshis’ helped villagers to build over 200 biogas plants in Sialkot district.
- In June of 2007, PRSP installed 12 Dome type Biogas plants in tehsil Pasrur of Sialkot with help of Foundation for Integrated Development Action (FIDA)
- 1982 to 1985, 1000 Nos. of biogas plants were installed in various districts of the Punjab by the Pakistan Council of Appropriate Technology with collaboration of Agriculture Department (Field Wing).

History of Biogas technology in Pakistan

- 2009-2010 Agriculture department (Field Wing) launched a programme “Adaptation of Biogas technology to mitigate the energy crises” to install 750 Nos Family Size Biogas Plants all over the Punjab, this project is in progress.
- In District Faisalabad PRSP installed 500 Nos Biogas plants under PDBP (Pakistan Domestic Biogas Programme.
- Some medium size Biogas plants have been installed in private sector to meet the energy requirements for
  - tube well operation for agriculture purpose,
  - cooking and lighting for domestic purpose, and
  - electricity generation for small industry operation during load shedding.

Basic Design of Biogas Plants

- Biogas plants installed by different organizations are:

1. Drum type Biogas Plant

   (Constant Pressure basis)

2. Dome type Biogas Plant

   (Constant Volume basis)

- Almost all biogas plants are simple and accessories like Stirring, heat exchanger, compressor and storage reservoir have not been provided to the biogas plant

Drum type Biogas Plants

- Experimental Biogas plants
- Family size Biogas plants
- Medium size biogas plants

Family Size Biogas Plant

(Drum type)

Family size Biogas plant

- Gas production — 4-5 m^3
- Gas consumption — 0.5 m^3/head/day

  (for cooking and lighting)
- Average family size — 8 members
- Gas consumption/family/day — 4.0 m^3
- Estimated N @ 1.84 % — 2.13 kg/day
- Estimated P @ 1% — 1.16 kg/day
- Estimated K @ 1% — 1.16 kg/day
- Estimated NPK /day/plant — 4.45 kg/day

1625 kg/annum/plant

Factors affecting Biogas generation

1. pH concentration
2. Temperature
3. Total solid content of the feed material
4. Loading rate
5. Uniform feeding
6. Diameter to depth ratio
7. Carbon to nitrogen ratio
8. Nutrients
9. Mixing or stirring or agitation of the digester
10. Retention time or rate of feeding
11. Type of feed stocks
12. Toxicity due end product
13. Acid accumulation inside the digester.

Domestic cooking with Biogas

A Step Ahead

Family size to Medium Biogas plants for

- Small industry
- Electricity generation
- Community use
- Tube well operation

Biogas plant sites

- Al- Hamad Exports

  Sityana Road Faisalabad

- Ashraf Zia Textile industries

  Khurrianwala- Jaranwala Road Faisalabad

- JK Farms

  Jumera Road Faisalabad

- Tahir Dairy Farm

  128 RB Wahley Chak Jumera Road Faisalabad

Medium Size Biogas Plant

(Al-Hamad Exports Sityana Road Faisalabad)

Biogas Plants at Al - Hamad Exports Sityana Road Faisalabad

- Feed rate 1.5 t/day
- Gas production 30-35 m^3/day
- Gas utilization
  - Cooking
  - Electricity generation to address load shedding

  Equipments
  - Stirring system (Mechanical)
  - Heat exchanger (Hot water circulation)
  - Compressor
  - Additional gas reservoir
  - Gas regulator
  - Electric generator (Dual Fuel System)

Gen. Muhammad Ali (Chief Executive)

Live Stock and Dairy Development Board

Gen. Awais is visiting site

Flame of Biogas

Electricity generation

(Dual Fuel System)

Organic Fertilizer from BGM

Biogas Plants JK Farms

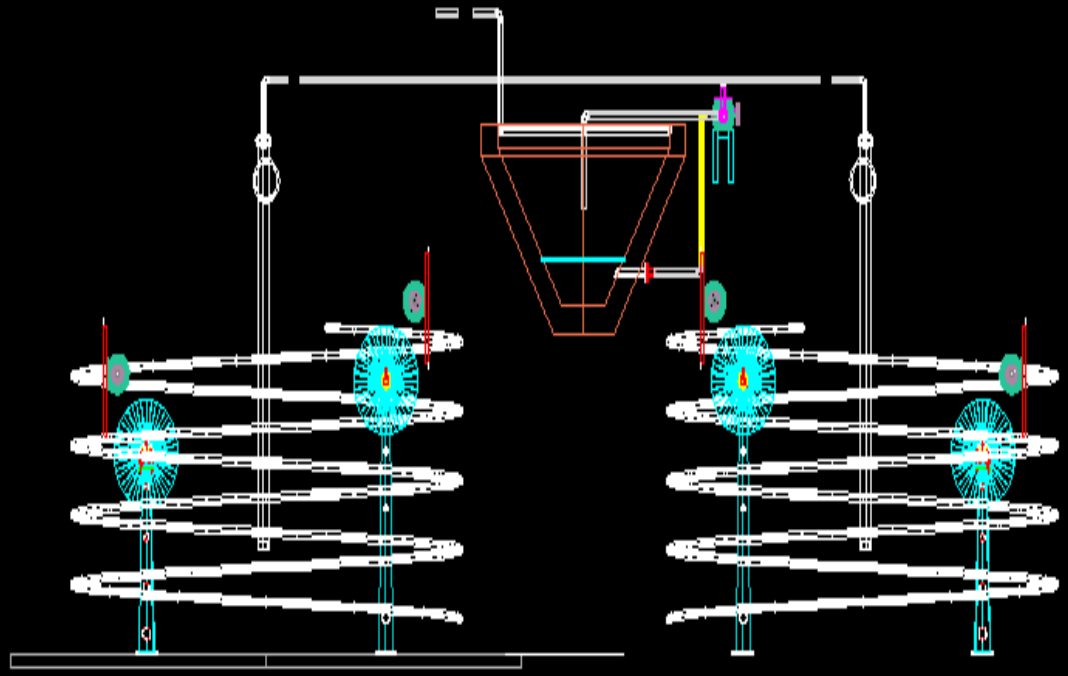
Biogas plants JK farms

- Design — Constant pressure based
- No of plants — two
- Feeding rate — 3t/day/plant
- Gas production — 60-70 m^3/plant/day (expected)
- Equipments
- Heat exchanger (Hot water circulation)
- Stirring system (Mechanical /electrical)
- Compressor
- Additional storage reservoir
- Forced flow circulatory feeding system

Biogas produced will be used

At Farm house for

- Cooking
- Heating (heat exchanger and other appliances)
- Electricity generation (25 kvA)
- Tube well operation (on dual fuel system)



Construction of fermentation Chamber Biogas plant at JK Farms

At site Manufacturing of Fibre Glass Gas Holder JK Farms Faisalabad

Heat exchanger installation in Fermentation Chamber at Ashraf - Zia Industries

Compressor for Biogas plant

Instrumentation to ascertain the Drum movement At Ashraf Zia Textile Industries

Gas Compressor and Gas Storage

(Ashraf-Zia Textile industries)

Feeding Tank and Mixing system
(Gravity Flow)

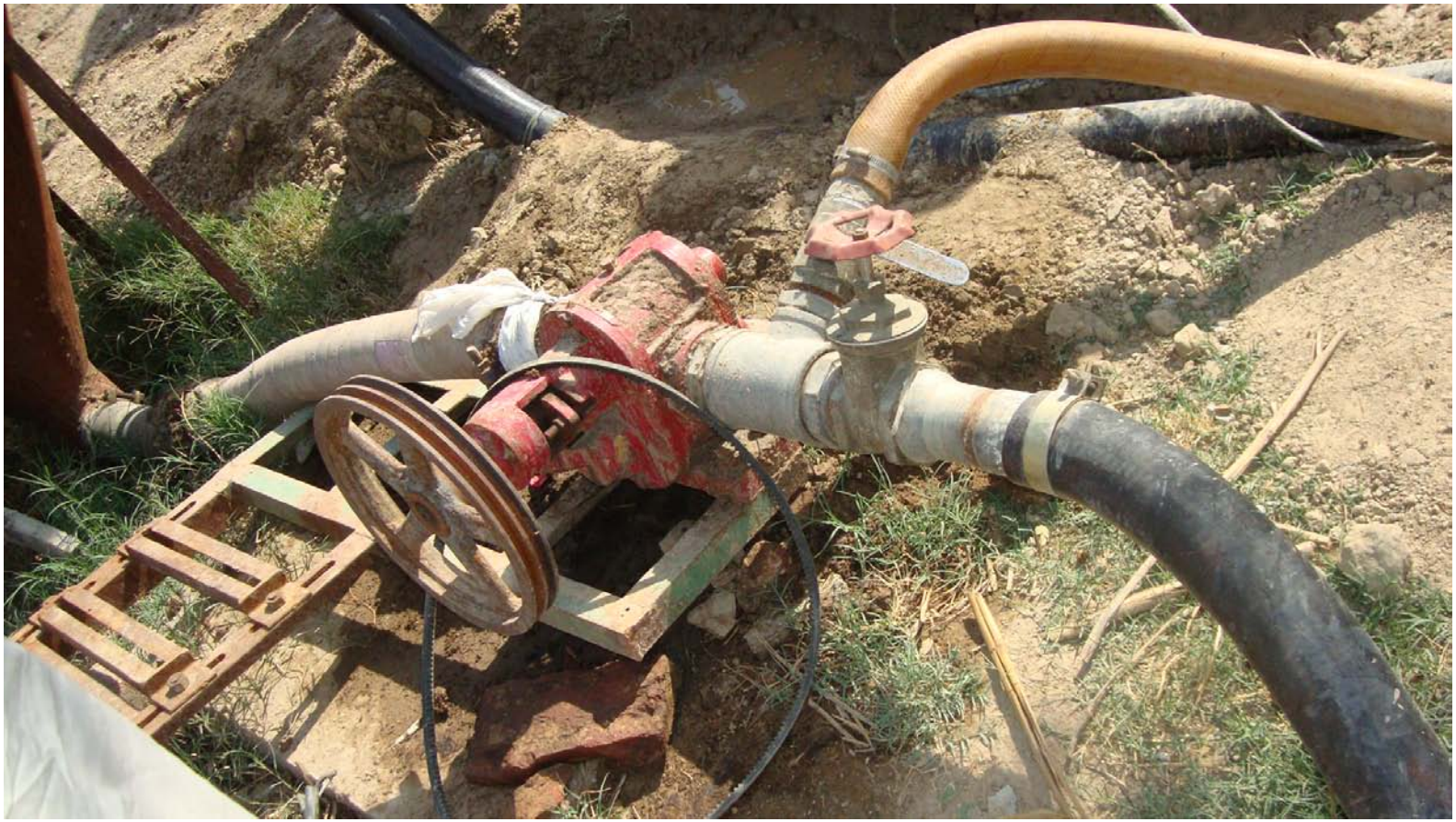
Dome Type Biogas Plant (Tunnel Shaped)

Tahir Dairy Farm 128 RB Wahley Chak Jumera Road Faisalabad

Electricity Generator (15 kvA)

(Dual Fuel System)

Gear Pump Type Forced flow circulatory mixing feeding system



Inspection of Hairline Cracks in Dome

Hairline Cracks in Dome

Tube Well operation on Dual Fual System

Tube well operation operation on Dual Fuel System (Biogas+Diesel)

Cost-Benefit Analysis of Biogas plant

Sr. No.	Diesel consumption	Time	Diesel consumed with biogas Lit/hr	Fuel consumption (L/hr) with diesel	Saving in term of diesel (Lit/hr)	Saving in term of money (Rs/hr)
1	240	40	0.36	1.5	1.14	104
2	550	85	0.38	1.5	1.12	103
3	470	75	0.37	1.5	1.13	103
		Average	0.37	1.5	1.13	103

On dual fuel system engine consumed only 25% diesel

	liters	Rupees
Diesel Saving in 10 hrs	11.30	1040.00
Diesel Saving in a week	22.60	2080.00
Diesel Saving in a month	90.40	8320.00
Diesel Saving in a year (on account of diesel saving)	1084.80	99840.00
Expenditure on diesel (if operated only on diesel) in a year	1440.00	132480.00
Expenditure on diesel (if operated on Biogas and diesel) in a year	331.20	30470.40

Estimated cost of proposed Biogas plant(with all the accessories and storage)	Rs. 800000.00
Proposed life of Biogas plant Estimated fertilizer (NPK)/annum (In digested slurry) Approximated average cost (NPK)	15 Years 9110 kg Rs 35/kg
Estimated cost of fertilizer/annum	Rs. 318850.00
Estimated cost of FYM /annum (2.5t/trolly and Rs.1200/trolly)	Rs. 175200.00
Net saving in terms of fertilizer/annum	Rs. 143650.00
Saving in terms of domestic fuel/annum (20 kg/month @ Rs 100/kg)	Rs. 24000.00
Total saving (Domestic fuel, Diesel and fertilizer)/annum Payback period	**Rs. 267490.00** 3Years

DESIGN OF BIOGAS PLANT FOR TUBE WELL OPERATION

- Inner Dia. Of fermentation chamber — 16 ft
- Depth of fermentation chamber — 14 ft
- Volume of fermentation chamber — 2966.37 ft^3
- Total weight of feeding material (fermentation chamber) — 84000 kg
- Retention times — 42 days

(incase of controlled temperature RT will be in the range 20-25 days that will change of feeding rate and gas production)

- Dia. Of feeding tank — 4.0 ft (1.22 m)
- Depth of feeding tank — 4.5 ft (1.37 m)
- Capacity of feeding tank — 1.5 m^3

- Feeding material/day 84000/42 — 2000 kg
- Slurry (water: animal dung) — 1:1
- Animal dung required per day/plant — 1000 kg
- Water required /day — 1000 kg
- Animal required/plant — 70-100
  (based on collect ability)
- Gas production/day/plant — 50 m^3
- Gas production (65-70% plant efficiency) — 35 m^3
- Dia. Of gas holder — 15.5 ft
- Height of gas holder — 4 ft
- Type of mixer (feeding tank) — mechanical
- Stirring system (fermentation chamber) — mechanical
- Heat exchanger — hot water circulation
  (consume 10% of daily gas production in winter)

- Average gas consumption/person/day (for cooking and lighting) — 0.5 m^3
- Average family size — 8 members
- Total gas consumption/family/day — 4.0 m^3
- Gas consumed by a family in 3 days — 12 m^3
- Total Gas Production by Plant in 3 days — 105 m^3
- Gas available for tube well operation — 93 m^3

- Tube well engine power (assumptions) — 20 hp
- Gas consumption/hr — 9 m^3
- Tube well operation duration — 10 Hrs

A tube well (20 hp Engine) of 1 cusec discharge will be operated twice (10 hrs each) in a week and a family of 8 family members will also be accommodated for cooking and lighting purpose.

CATTLE HOLDING STATUS IN PAKISTAN

	Pakistan		Punjab	
Animals Range	**H.H**	**Total Animals**	**H.H**	**Total Animals**
1-2	2667710	4405000	1695492	2733198
3-4	1699983	5938722	1005454	3477822
5-6	836347	4555829	446042	2419996
7-10	618948	5063011	278734	2253712
11-15	207073	2597817	73423	916016
16-20	69744	1234484	20568	363317
21-30	46100	1132365	14570	359700
31-50	23838	923390	7580	287657
51- above	18531	3708204	8166	1600913

A study conducted last year revealed that

- Biogas production was increased up to 15% and 20% with addition of 10% poultry waste and sugar mud respectively.

General Benefits of technology

- **Jump-start new biomethane gas production**
- **Begin the creation of the biomethane infrastructure and biomethane industry**
- **Increase biomethane “reserves”**
- **Creation of green jobs**
- **Expand the rural economy and increase revenues for farming and agricultural operations**
- **Increase energy independence**
- **Reduce greenhouse gas emissions.**

Specific Benefits of technology

- Production of energy (heat, light, electricity).
- Transformation of organic wastes into high quality fertilizer.
- Improvement of hygienic conditions through reduction of pathogens, worm eggs and flies.
- Reduction of workload, mainly for women, in firewood collection and cooking.
- Environmental advantages through protection of forests, soil, water and air.
- Global Environmental Benefits of Biogas technology.

A question arises

- Struggle of 35 years.
- Installations 7000 biogas plants.
- Technical potential of 5 million plants.

- What are the bottlenecks

- Why we are far behind ?

Where is the gap?

- No awareness of the peoples about the technology.
- No training facility in this regard
- No follow up to address these problems.

Recommendation

- Establishment of Biogas Directorate
- To carry out the R&D activities
- To disseminate biogas information
  - Through print and electronic media
- To conduct training sessions
- To provide technical advisory services
- To give the follow ups
- To coordinate with international experts

THANKS