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VILLAGE EMPOWERED:

Rural Bio-energy Production as an integrated CDM Project

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Introduction

This paper suggests:

- Application of CDM[1], to **all stages of bio-diesel production, separately,** and also its usage.
- Further treatment of **by products** generated for value addition.
- **Plugging of leakages** and **avoidable emissions** through waste management of wastes generated by the project.
- Extension of the waste management to the **wastes of the entire village/ project area**, resulting in further CDM benefits to the farmer and the village.
- Integrated development of the community through their collective participation.

[1]**Clean Development Mechanism**

Bio-diesel Production Cycle

1. Afforestation & Reforestation with Jatropha C
2. Oil extraction from seed; treatment of the by-products, de-oiled cake & Glycerine.
3. Trans-esterification;
4. Treatment of the by-products, fatty acids.
5. Integrated Management of Wastes.
6. Distribution & Usage

FFORESTATION & REFORESTATIO

APPLICATION OF CDM TO

IABARD* MODEL FOR WASTELAND

*ational Bank for Agriculture and Rural Development, India

Wasteland

Jatropha Cultivation: Traditional Costing/hectare Waste Land

Sr. No.	Particulars of Works	Unit	Cost (Rs. Per Year			Total (Rs.)	Total ($
			1	2	3		
1	Site preparation	10MD	500	0	0	500	11.1
2	Initial ploughing for 6 Hrs	100/Hr	600	0	0	600	13.3
3	Intercropping	Rs. 1000	1000	0	0	1000	22.2
4	Alighment & staking	5 MD	250	0	0	250	5.56
5	Digging of pits (45 cm3) & refilling @50	33/11 MD	1650	550	0	2200	48.8
6	Cost of FYM @2 Kg/pit	Rs. 150/ton.	500	0	0	500	11.1
7	Cost of fertilizer @ 250gm/plant	Rs. 2000	2000	2000	2000	6000	133.3
8	Cost of plants including transport (1666, 166	Re. 3 per	4998	498	0	5496	122.1
9	Cost of planting & replanting@100 per MD	16 & 5 MD	800	250	0	1050	23.3
10	Weeding, soil working, application of Fertilizer etc. (3,2,1)	10 MD per working	1500	1000	500	3000	66.6
11	Plant protection measures	LS	100	100	100	300	6.67
12	Pruning	20 MD	1000	1000	1000	3000	66.6
13	**Sub Total**	**Rs.**	**14898**	**5398**	**3600**	**23896**	**531.0**
14	Contingencies	5%	744	270	180	1145	26.5
15	**Grand Total**	-	**15662**	**5668**	**3780**	**25090**	**557.5**

rce: Kamarkar & Haque (2004)

Spent by the farmer in three years without any returns

Traditional Cost. Contd…

Yield and Income p
Ha. Of Jatropha
Cultivation

Cost Benefit Chart

ear	Seed per tree	No. Of trees	Seed (kg)	Price per kg	Income (Rs.)	US$
3	0.5	1500	750	5	3750	83.33
4	0.5	1500	750	5	3750	83.33
5	1	1500	1500	5	7500	166.7
6	1.5	1500	2250	5	11250	250.00
7	2	1500	3000	5	15000	133.33
8	2.5	1500	3750	5	18750	416.67

ear	1	2	3	4	5	6	7	8
ost	15643	5668	3780	-	-	-	-	-
enefits			3750	3750	7500	11250	15000	18750
et enefit	-15643	-5668	-30	3750	7500	11250	15000	18750
S$	-347.62	-125.96	0.67	83.33	166.67	250.00	333.33	416.67

ource: Kamarkar & Haque (2004)

Negative benefit for
first three years

Possible Application of CDM (Afforestation and Reforestation) to NABARD Model for Wastelands

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Giving More to the Farmer

Enhanced Pri
for Seed to
Farmer

	Seed/Kg (Rs.)	No. of Trees	Qnty. Of seed (Kg)	Suggested Price per Kg.	Total Income (Rs)	US$
	0.5	1500	750	8	**6000**	**133.33**
	0.5	1500	750	8	**6000**	**133.33**
	1	1500	1500	8	**12000**	**266.67**
	1.5	1500	2250	8	**18000**	**400.00**
	2	1500	3000	8	**24000**	**533.33**
	2.5	1500	3750	8	**30000**	**666.67**

	1	**2**	**3**	**4**	**5**	**6**	**7**
	15643	5668	3780	0	0	0	0
	0		6000	6000	12000	18000	24000
efit	-15643	-5668	2220	6000	12000	18000	24000
enefit	18000	18000	9000	9000	9000	9000	9000
nefit	**2357**	**12332**	**11220**	**15000**	**21000**	**27000**	**33000**
	52.38	**274.04**	**249.33**	**333.33**	**466.67**	**600.00**	**733.33**

CDM Interpolation

Total CDM Benefit of Rs. 90,000, proposed as advance to the farmer @ 2yrs'Credits i 1st yr. 2yrs' Credits in the 2nd and one yr's CDM each in the next 6 yrs. This ens returns from the year one.

3 NABARD MODELS UNDER PROTECTED IRRIGATION CONDITIONS

DEL	TREES/ha (Nos)	COST ($)	LOAN ($)	TOTAL INCOME (8 Yrs.) ($)	IRR %	NET SURPLUS 8TH YEAR
CLONAL MODEL	1000	400	360	805.56	19.37	1144.35
SEEDLING MODEL	1000	333.33	300	1051.78	18.41	638.89
: DIBBLING MODEL	1000	258.89	233	1027.78	25.62	1027.78

Making Plantation more Viable for Grower

- The NABARD models are OK from the Banker Point of View
- What about the Grower?
- Why grow only Jatropha?
- Intercropping?
- Flexi & area specific models should be designe

Barriers for CDM Application to Jatropha Plantations

Definition of Forest

As per COP7[1] (2001) through COP 10 (Feb. 2005), a forest is:

- Forest is a minimum area of land of **0.05-1.0 hectares**
- With tree crown cover of more than **10-30** per cent
- With trees with the potential to reach a minimum height of **2-5 meters** at maturity in situ.

Countries' Choice

- The choice of the foregoing parameters was left to individual countries.
- Both India and Ghana have made their choices
- India: Min area of land: .05 Ha, Single min. tree crown cover: 30%, Min. Tree Ht.: 5m
- Ghana: 1Ha, 30%, 5m

Barriers ---Contd.

- Minimum Tree height: 5m
- Is Jatropha 5m?
- Other Oil Bearing Trees in mixed forestry?
- Can the DNA choice be changed?
- Land use and land use change?
- Base line methodology for A/R for land currently under agricultural use has been approved for large scale plantation.

-EB 26 of UNFCC , 29.09.06

Application of CDM to Oil Extraction

Oil Extraction & Transesterification: Traditional Costing: Existing Unit

Only Rs. 4/Kg. has be
paid to the farmer
price of seeds

osting of Oil extraction & Transesterification: By M/s Gujrat Oleo chem Ltd.	
Oil recoverable per ton of seed (based on reported 33-50% oil	0.333
Cost of Seeds Rs. per Ton	4000
(based on discussions at NABARD)	
Crushing and refining Rs. per Ton	600
(Industrial average cost of crushing)	
Cost Oil Rs. per Ton	**13814**
Processing Charges to Biodiesel	10000
(At our plant in operation)	
Total Cost per ton of Biodiesel A+B	**23814 (Say 24/L)**

US$ 306.98

US$ 529.20/ton

urce: Chaturvedi (2004)

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Oil Expelling Costing with Methane Recovery

- Farmer has been paid Rs.
- Methane Recovered from
- Residue is a richer manure

	Qty.(Kg.)	Rate(Rs.)	Amt(Rs.)	Sale(Rs.)	US$
	100	8.00	800.00		
f Expelling	100	1.00	100.00		
per 100kg. Seed			**900.00**		**20.00**
roducts					
ed Cake	70				
ne gas from cake	35				
nutient Cocentrate	35				
f Methanation@Re1/ Kg.	70	2.00	70.00		
of By-products					
s (60kg./100kg cake)	35				
ne @80% of gas	28	15.00		420.00	**9.33**
er matter	35				
nt (80% of leftover)	28	2.00		56.00	**1.24**
cost of oil/ income			**970.00**	**476.00**	
Cost of 30 kg. oil			**494.00**		
Cost of 33 litres oil			**494.00**		
per litre of oil			**14.97**	**15.00**	**0.33**
t/Litre of oil @10%			**1.50**		

CDM Credits for Methane Capture not been taken as it is assum be a BAU scenario. However, methane when used for gener electricity for captive consum it would attract CDM Credits.

This profit is addition t CDM Cre earned du power ge and the c usual ele purchase

CDM Application to Energy Generated Using Methane Captured During Oil Extraction

- Methane captured during the oil extraction process should be harnessed for power generation, within the project cycle.
- Electricity from thermal or mixed sources, when replaced by that from renewable sources, attracts Credits under CDM.
- CDM Credits can be got by bundling Small Scale projects.
- A sample calculation for possible CDM Credits from a one TPD oil extraction plant, is given in the next slide.

CDM: Elec. Gen. : Continued

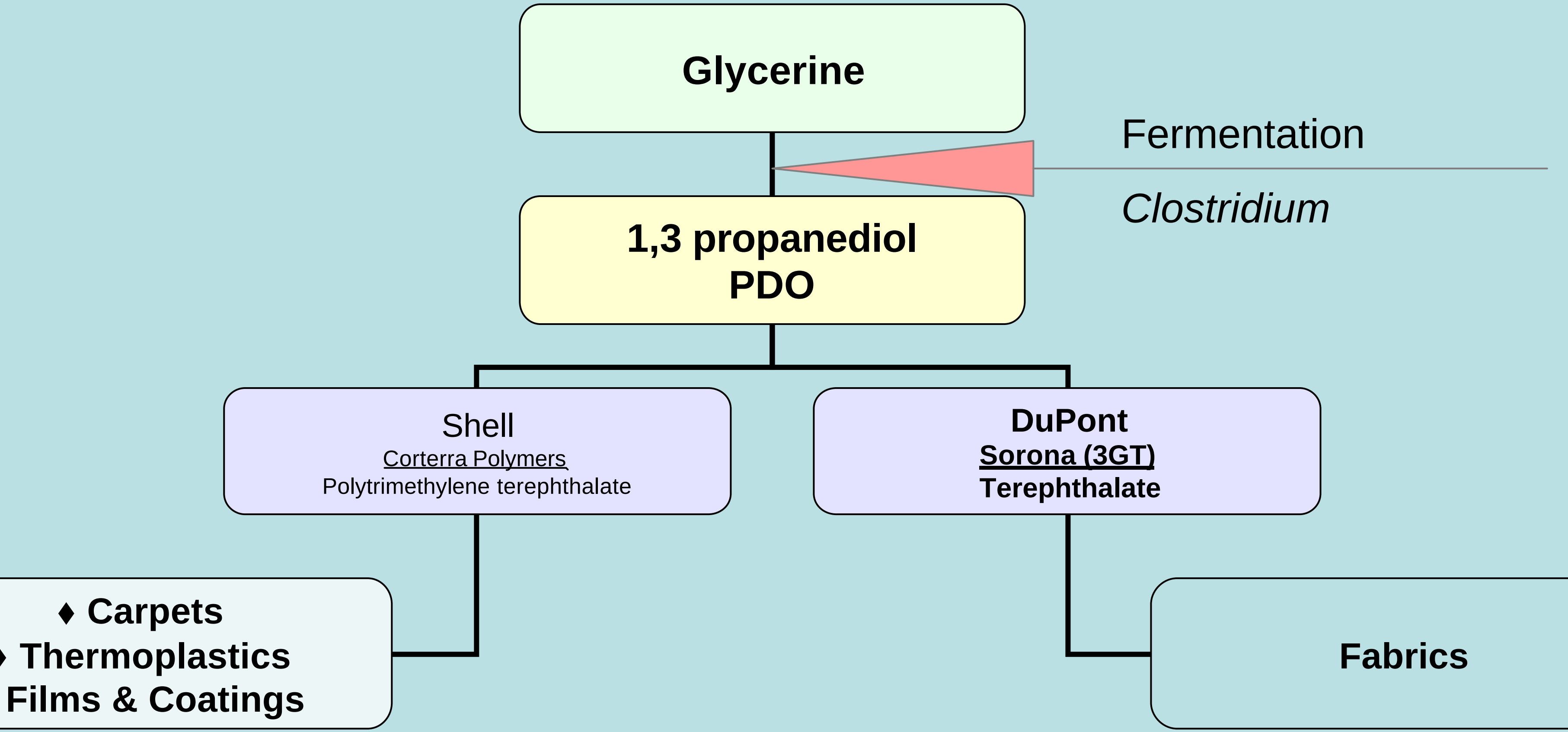
- A **1TPD oil** extraction plant will produce **2100Kg.** of de-oiled cake in a day.
- This can produce **840 Kgs. of Methane**.
- At 80% efficiency, running 24 hours, this can produce **560KWh** of electricity per annum.
- A carbon emission factor of 0.4 is attributed to a situation where electricity from mixed sources is replaced.
- This translates into 224t CO_2e
- At the current rates this would mean Rs. 100800 per annum.
- At oil production of 00 Kilo Litres per annum, this comes to Rs.336/KL.
- That is **Rs.0.34 ($ 0.007) /Litre of oil** or **Rs. 0.36 ($ 0.008)/litre of Diesel**.

Cost of Trans- esterification

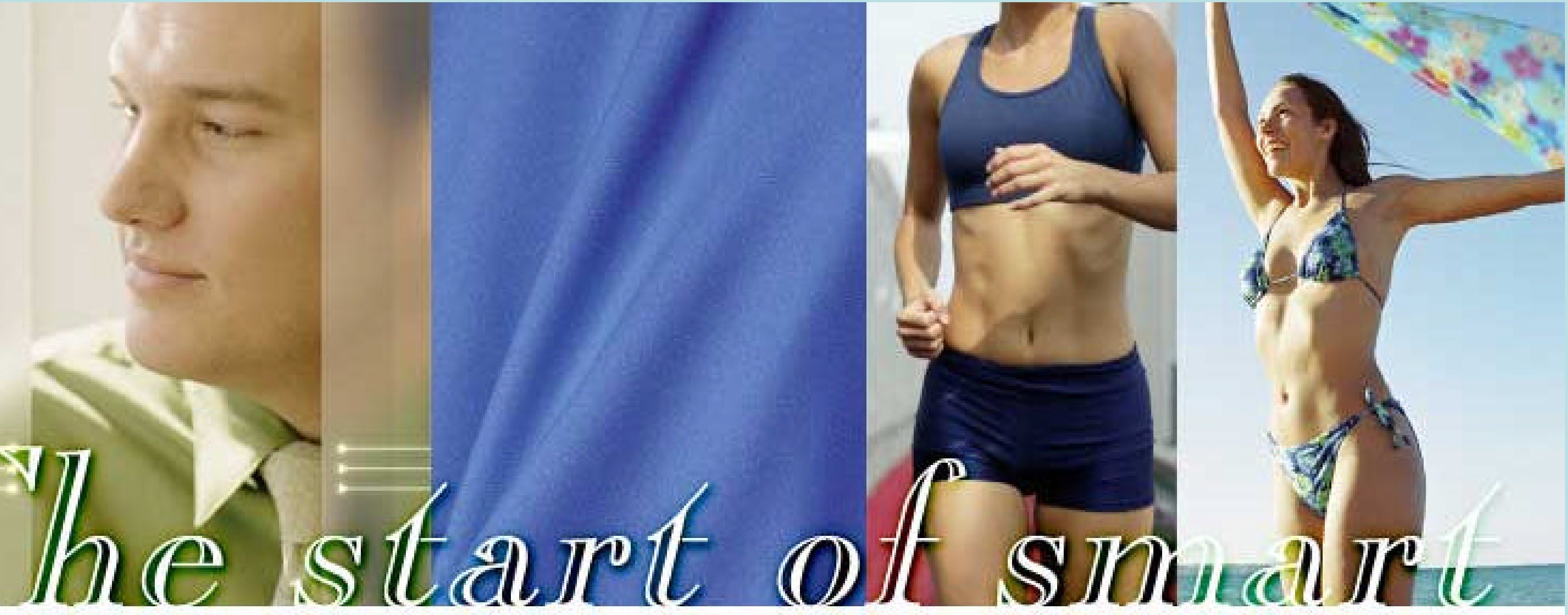
Item	Qty. (Li	Rate Rs./Litr	Cost (Rs.)	Sale (Rs.)
Cost of oil	100	16.5	1650.00	
Transportation	100	0.5	50.00	
Trans estrification charges	100	10	1000.00	
By product Glycerol	10			
Sale of Glycerol	10	20		200.00
Total cost / sale			**2700.00**	**200.00**
Net Cost off Biodiesel/litre			**25.00**	

- Studies have shown that inferior fractions of glycerol and fatty acids when added in a controlled way to the biomethanation reactor, the result is an accelerated and increased %age of methane.
- If Methane can be captured from the fatty acids, this would mean the production of an equally valuable Bio-fuel as bio-diesel. CDM Credits would then accrue.
- Value addition likely to increase through new end uses of glycerin

Emerging Uses of Glycerine



New Uses of Glycerine



na® makes a **softer** fiber than either polyester (PET) or nylon while still offering desirable attributes like **superior comfort-stretch and recovery and dyeability**.

Post Production CDM Application to Biodiesel Usage

Calculation under the switching fossil fuel category is as under:

- Emission factor for Diesel is 3.2 Kg. CO2@/ L (IPCC)[1]
- Bio Diesel gives a reduction of 78%
- Hence, reduction in emission is 2.50 Kg.CO2/L or 250 Kg/KL or 0.250 t/KL biodiesel
- 1t CO_2 is reduced by 0.4 KL of biodiesel
- In other words, 0.4 KL of biodiesel earns 1CER
- At current exchange rates, 0.4 KL of BD earns $10 or Rs. 450
- **1 Litre of BD will earn Rs.1.13 ($ 0.024)**

[1]Intergovernmental Panel on Climate Change

Calculations of CDM done on the basis of 'Effect of CDM on Bio-diesel: Rana (2004)' and also from paper by Panigrahi (2004).

Post Production CDM Application to Biodiesel Usage

- The First Biodiesel Methodology from India, submitted to UNFCCC. has run into rough weather
- The observations made by the Methodologies Panel (of UNFCCC) in this case,seem to suggest that the ideal applicants for Credits (under switching fossil fuels category) may not be manufacturers.
- Because they have no control over the ultimate utilization of the biodiesel.
- Credits under this category should accrue to the agency that actually replaces the fossil fuel with Bio-Diesel, such as Oil Companies, Railways, road transport Cos., Power generation etc.
- A mechanism needs to be evolved so that this credit also trickles down to the Biodiesel manufacturing process; for instance better pricing for biodiesel.

Leakage & Avoidable Emissions in the Manufacturing Cycle

Leakage means increased emissions outside the project boundary, due to the project itself. For example

- Construction of manufacturing site on potential AR land is leakage.
- Ferrying biodiesel in fossil fuel driven trucks is leakage.
- Enhanced use of non-renewable energy for production of bio-diesel is leakage.

Avoidable emissions from within the project boundary must be taken care of to make the entire effort of CDM registration etc. worthwhile. Some of them are taken up in the next slide.

Avoidable Emissions etc. Contd…

Some emissions within the project boundaries are due to the projects themselves. For example:

- Emission from N-fertilizers used in the cultivation.
- Decaying biomass (leaves, fruit pulp etc.) and cow dung emit methane.
- Farm implements run on fossil diesel.
- It can be said that all degradable waste within the project boundary is a potential source of avoidable emission.

Avoidable Emissions etc. Contd…

The solutions to the above problems are:

- ✓ Avoid excessive use of N-fertilizers and use organic soil conditioners. These conditioners can be derived from the waste itself.
- ✓ Instead of piling biomass, it should be either subjected to controlled combustion or biomethanation.
- ✓ Biomethanation of leafy wastes produces richer manure and also results in methane recovery in addition to attracting the CDM benefit.
- ✓ The centrality of the methane recovery in the village scenario is now established.

This brings us to integrating various wastes in the village to make more economic sense. This is taken up in the following slides.

Integrated Waste Managemen at Village Level

- Ecological advantages of agro-forestry are negated if the biomass waste is allowed to decay and release methane gas into the atmosphere.
- Decay and unscrupulous burning of biomass can result in unwanted emissions within the project boundaries.
- Methane has a Global Warming Potential of 21.
- Capturing and harnessing this gas can, not only generate another biofuel, but can earn sizeable amount by way of Carbon Credits through CDM.
- Integrating the treatment of project wastes with all other wastes in the geographical boundary (village) would have an exponential effect on the economics of the project in addition to additional credits under CDM to the village as a whole.

Case Study: Kishengarh : Total Waste Management& elec gen

The Waste consists of:

- ❑ Kitchen waste from a population of 20000 = 2 tons/day
- ❑ Cow dung from 500 cattle = 6 tons/day
- ❑ Fruit and vegetable market waste = 12 tons/day
- ❑ Sewage from 20000 population @100lpd = 2 mld /day

The net methane capture/annum = 164.5 Tons

Certified Emission Reduction eligibility = 2961tCO_2e/ann

Translated into money this comes to **Rs. 40,00,000 ($870)/ann**

Case Study: Kishengarh : Total Waste Management

- The methane calculated above is capable of generating 100 KW (0.1MW) in a day running 24 hours.
- At 80% efficiency, this =700 MWh per annum
- Emission of replaced electy. = mixed cycle = $0.4tCO_2/MWh$
- Carbon Credit =280 tCO_2
- At current CER rate this comes to **Rs. 3,50,000 ($7609) per annum.**
- Revenue from Sale of Electricity @ Rs.2/- per unit, leaving 30 units per day for self consumption.

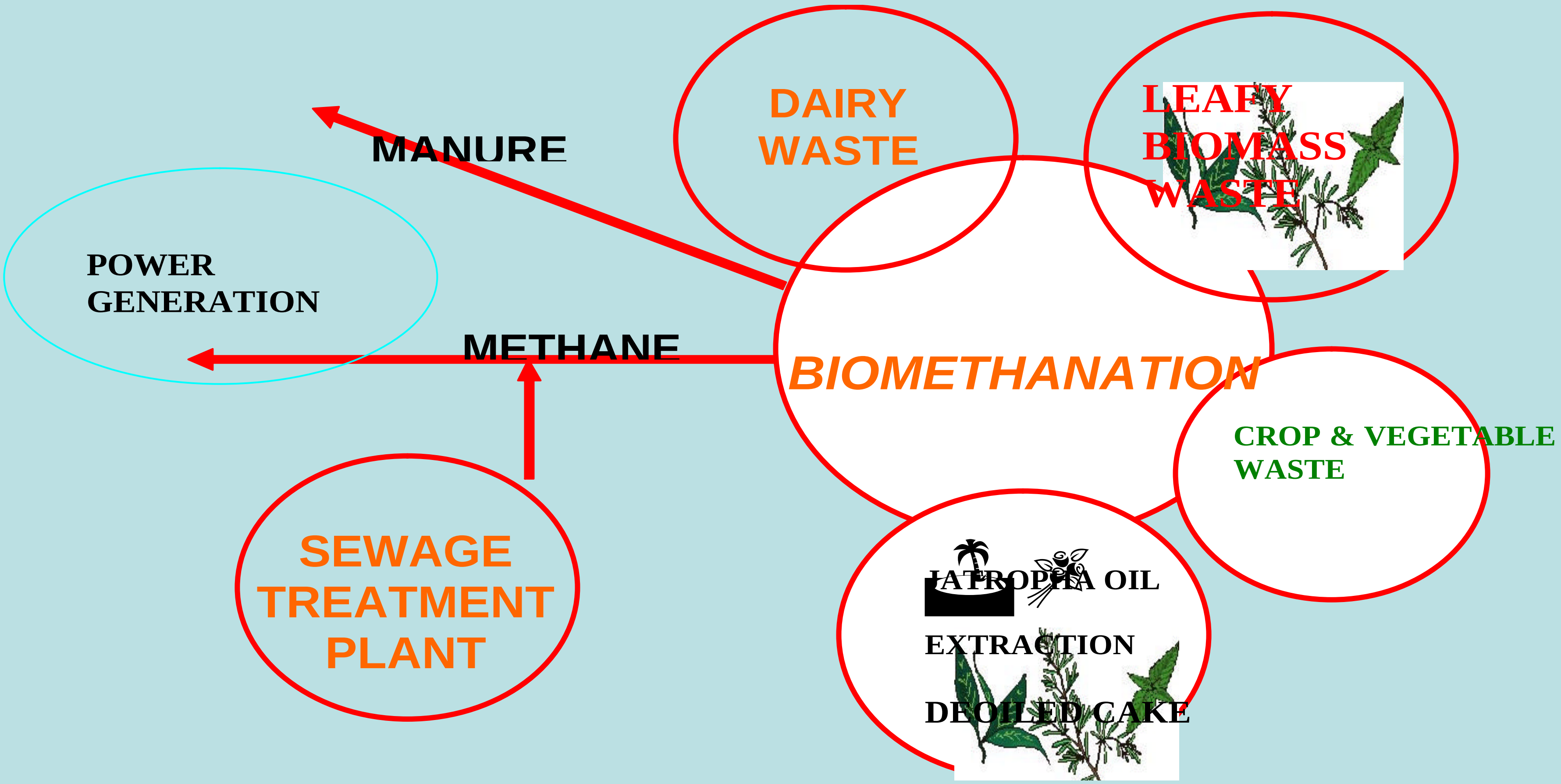
  = Rs. 10, 08,000 ($ 21913) per Annum
- Revenue from Sale of 2 t of Organic Fertilizer @ Rs. 2/-

  = Rs. 14, 60,000($ 31739) per Annum

Case Study: Kishengarh : Total Waste Management

Total Projected project cost	= Rs. 40 million
Loan Amount (Say)	= Rs. 20 million
Total Revenues Generated	= Rs. 6.82 Million/Annum
Less Estimated O&M Cost	= Rs. 2.40 Million/Annum
Net Revenue before Interest	= Rs. 4.42 Million/Annum
Interest on Loan	= Rs. 1.60 Million/Annum
Net Revenue Earned	= Rs. 2.82 Million/Annum
Return on Investment	= 7.05 %

Integrated Rural Sanitation and bio-energy production



Bundling of Household Level Biogas Digesters

- Household level digesters running on kitchen waste, cheap flour, and sugar cane wastes are now available.
- Cow-dung can be added, if available.
- In the case of Nepal even latrine waste goes through this biogas digester.
- World Bank has, in May this year, signed an Emission Reduction Purchase Agreement with Nepal for such plants.

Village Level Energy Development from SVO*

- Straight Vegetable Oil has been successfully used on static diesel engines for generating power at farm level.*
- Offsets Fossil Fuel Usage
- This is also possible for larger scale generation.
- Advantage: Accountable Fossil Fuel Replacement
- Hence eligibility for Carbon Credits.

•Straight Vegetable Oil

• Sadaphal Parimal M. Winrock International

Village Level Energy Development through Bio Methanation

Use of

- Sugar Cane juice
- Sweet Sorghum
- Sugar Beet
- Cheap Grains
- Other agriculture based products.*

- Jayanaryanan E.K. at the international bio fuels conference ,N. Delhi 2006

Kali Bein Project
Integrated Community Development

- Kali Bein rivulet has being polluted by waste wate
  from 48 villages and 8 towns.

Proposed solutions with community participation.

- Stabilization of banks with vetiver plantation.
- Afforestation along the bank.
- Integrated solid and liquid waste management of t
  entire project area.
- Taking the project through the CDM cycle.
- Earthizenz engaged to advise on the project and take it through the CDM process

Conclusion

- Bundling of small scale projects needs to be facilitated.
- Separate bundles will have to be made of individual steps in the production cycle. We can have:
  - o A bundle of small scale AR projects, within limits as discussed.
  - o A bundle of Methane Capture from de-oiled cake and subsequen power generation projects.
  - o A bundle of integrated solid waste management (waste to energy) projects.
  - o Credits for fuel substitution, bundled small scale projects in some cases and stand alone in other cases, depending on the scale o operation.
  - o Integration of village sanitation projects with the entire biomethanatior programme.

Conclusion

- A truly integrated approach will have to be followed to achieve all this.
- Once this is achieved, it would ensure that the farmer gets a good deal, the village gets a better environment and the process of making biodiesel becomes more cost effective.