THE IMPORTANCE OF METHODOLOGIES REQUIRED FOR EVALUATING & QUANTIFYING:
Carbon Sequestering, GHG Emission Reduction, Fossil Fuel Replacement Capacity, Carbon Credits Through:
A COMMUNITY DEVELOPMENT PROJECT IN PUNJAB, INDIA

M.P. Singh[a] and Geetika Kalha[b]

[a] *B. Tech.(Civil); M.I.E. (Mech.), Earthizenz & India Vetiver Network,*

Email: mpsingh@earthizenz.org

[b] *M.B.A; IAS; Earthizenz & India Vetiver Network*

Email: geetikakalha@gmail.com

ABSTRACT

This paper discusses a community development project in Punjab. It is called a community development project, because, in solving a major environmental problem, we end up with overall development of the community. It lists the solutions and suggests use of Vetiver grass in many of them, utilizing the multifaceted Vetiver advantage.The paper also examines the possible application of Clean Development Mechanism to the suggested components of the integrated solution. The paper suggests 'Bundling' of the various small scale CDM components, to get maximum benefit for the community.The hurdles faced in implementing the suggested solutions.

The Problem

In Punjab, India, there is a seasonal creek/rivulet flowing between Beas and Satluj rivers. This creek has been called Kali Bein. Kali Bein has a very important place in the Sikh history. It is along this rivulet, at a place called Sultanpur Lodhi, that Guru Nanak Dev Ji, the founder of Sikhism, spend his younger days and also attainted the 'enlightenment'. It is said that he dived into the Bein one day and resurfaced after three days and then uttered the words 'Japji'. These words have since formed the basis of the evolvement of the 'Guru Granth Sahib' the holy book of sikh religion.

The last four hundred years have seen total neglect of the Bein. On top of the neglect is callous discharge of waste water of eight towns and nearly fifty villages.

Sant Balbir Singh Seechewal took upon himself the task of cleaning the Kali Bein in the year 2000. Thousands of people living along the 160 km stretch of the Bein joined him in this good work. In Sikhism this is known as ‘kar sewa’. Meaning ‘donation of work’. Lakhs of people chipped in with money and materials and it became almost a revolution. The Government then woke up and constituted an SPV (Special Purpose Vehicle) under Mr. P Ram to support the Sant and to resolve the issues created due to the involvement of many departments. The then President of India, Dr. Abdul Kalam noticed all this and came specially to visit the Sant. After this visit, where ever the President went, in India or Abroad, he related the unique story of the unique effort where both the Government and the public joined hands to tackle the problem.

Earthizenz has been involved in the deliberations of the technical committee set up to coordinate and finalize the details of the various project activities to be taken up under the main project (the cleaning of the Kali Bein). First of all, the name of the Kali Bein has now been changed to the Holy Bein. Earthizenz has also been given the task of identifying the elements where CDM can be applied. Earthizenz will also define the small scale CDM projects and sub bundles consisting of various project activities.

The Package of Solutions

- Clearing a belt on both sides of the rivulets and greening it with trees and hedges and grass: Forestation, Vetiver hedges : Vetiver to protect the young trees from erosion.
- Providing an eco friendly pathway for pedestrians on both sides of the banks: stabilized earth blocks.
- Suitably stabilizing the banks: Vetiver
- Treating the solids and liquids of villages: wherever land is available: only with vetiver, wherever land is not available, biomethanation followed by polishing with vetiver: using the harvested Vetiver again as a feedstock in the biomethanation reactor.
- Treating the liquid and solid wastes of the towns in a self sustaining programme.
- Treating and maintaining the village ponds: major role of vetiver
- Creating water bodies and converting them to tourism spots out of the treated water prevented from going into rivulet and left over after utilizing for irrigation.

Application of Clean Development Mechanism

1. **Carbon sequestering:**

a. **Forestation & Reforestation:** Vetiver has a supportive role in terms of reducing the mortality of the plantation and taking care of some of the social issues and the leakage issues.

b. **Land Use and Land Use Change:** Direct role of vetiver: its own capability of sequestering carbon.

2. **GHG[1] Emission Reduction:**
   - **a. Methane:** Avoidance of Methane Emission due to wastewater treatment normally flowing into the river.
   - **b. Nitrous Oxide:** Capability of Vetiver to pick up excess Nitrogen from Wastewater.
3. **Dry Mass:** Contribution of Vetiver to a collage of other dry mass available in the village for combustion and power generation.
4. **Biomethanation:**Capability of Vetiver as part of a mixed feed stock to a biomethanation process installed for waste treatment.

The paper seeks to highlight the fact that the evaluation of the capacity of Vetiver grass to mitigate GHG[2] emissions and to substantially enhance Carbon stocks; thereby earning Carbon Credits, in all its applications, needs to be studied.

1. Introduction to Clean Developmeent Mechanism

1.1. Background of CDM[3] in Community Development Projects

Community Development Projects like Rural and Urban Sanitation, Waste Management, Poverty Elevation, have over the years been neglected because henceforth they were considered as an expense to be incurred by the state with no returns accruing; not even for the sustaining of the product itself.

A Community Development Project, therefore, is a project:

- Resulting in overall development of Community
- Direct involvement of the community
- Preferably involving link up of inter dependent activities
- Project should mitigate climate change
- Should be self sustaining

[1] Green House Gas
[2] Green House Gas
[3] Clean Development Mechanism

With the integration of various community project components, the projects become inter-supportive and hence sustainable. Once the project is self sustaining, encouraging the community to participate in the maintenance of the project becomes easy. For example: take the case of conventional waste water management. As a stand alone project, it can involve heavy initial investments, heavy maintenance cost and heavy input of energy in terms of electricity (which in itself is a big headache in developing countries like India). But when taken up with management of other biodegradable wastes, it becomes somewhat sustainable. If we reverse the objective and set up a waste to energy project, with the sole aim being to produce energy 24X7, even if we use bought out feedstocks), then the sanitation part becomes a byproduct.

The Kyoto protocol has been set up to reduce the emission of these harmful gases and to encourage renewable energy usage. This Protocol offers, through CDM[4], tradable Carbon Credits to developing countries[5]. The value of these Carbon Credits is market driven and is sharply rising, thus making an effort to reduce emission becomes increasingly economically attractive.

The countries of the world have been divided into two parts for purposes of CDM

1. Annex I Countries or industrialised countries: Binding emission reduction targets have been put on these countries. On failure, to bring down emission levels upto targeted levels, heavy fines have been imposed for every tonne of CO_{2e}[6] emitted in excess of the targeted level. So, these countries have the following options:
    - Upgrade their Technology to reduce emissions: This is often the most expensive.
    - Offset their excess emissions by purchasing Carbon Credits from countries falling under S.No. 2 below.
2. Non-Annex I countries, e.g. India or Developing Countries: Voluntary participation of developing countries in developing Carbon Sequestration, GHG Emission Reduction Projects.
    - These Projects earn Carbon Credits
    - These Credits are Traded in the Market and their value varies according to the demand.

[4] Clean Development Mechanism
[5] to be purchased by industrialized countries to offset their excess emissions.
[6] Carbon Dioxide Equivalent

The participation of community and overall additional benefits in terms of upliftment and betterment of their lives accruing to the community are an integral and important component of a CDM project.

CDM project can be large or small scale. Since the cost of registering a CDM project is quite high the UNFCCC[7] has given special consensus to small scale CDM projects in terms of simplicity in the process of registration and reduction in the cost of registration and subsequent monitoring. Further, UNFCCC and CDM Board have allowed the bundling of several small scale CDM projects within the same cost and the same process of registration and maintaining. This reduces the cost of individual small scale projects and brings CDM within the reach of even smaller communities. A bundle of small scale CDM project can not only contain similar projects but can also contain sub-bundles of different project activities. This makes a bundled CDM project extremely interesting and lucrative. It encourages the project developers of integrating several inter supportive sub projects activities within a community development project.

Small Scale Projects: Special Provisions

- Simplified Methodologies;
- No change in project cycle, the approval process is fast track
- Single OE[8] for validation and verification;
- Simplified PDD[9];
- Administrative levy halved.
- **All these only influences limited share of transaction cost. Still the cost remains high for a single Small Scale Project as is clear from the details given below**

Baseline Study- 18k;

• Validation - 28k;

• Registration- 5k;

• Negotiation- 18k;

• Verification- 20k;

• Certification -1k

• **Total ~ 90k**

---

[7] United Nations Framework Convention on Climate Change

[8] Operational Entity: They monitor the project through the project cycle at the National level on behalf of UNFCCC

[9] Project Design Document

All Figure in USD

(Source : UNFCCC Sec)

Concept of Bundling

In order to further reduce the burden of cost of registration, a provision of several Small Scale CDM Projects, in a project area has been made, this is subject to a ceiling on the total emission reductions.

What is a Small Scale CDM Bundle?

- Bringing together of several small-scale CDM projects,
- Without the loss of distinctive characteristics of each activity.
- Can be arranged as one or more "sub-bundles" with each activity retaining its distinctive characteristics,
- Technology/measure,
- Location,
- Application of simplified baseline methodology.
- Project activities within a sub-bundle are of the same type.
- Sum of output capacity of activities in a sub-bundle must not exceed the maximum output capacity of its type

Catagories of Small Scale Projcts

i: Projects for Renewable Energy

ii: Energy Ffficiency

iii: Other Projects not covered in above

General Bundling Principles:

- Should be indicated when requesting registration.
- Once project activity is part of a bundle for a particular project cycle stage, it cannot be "de-bundled" for that stage.
- Bundle composition cannot change over time.
- Activities in a bundle cannot be taken out or added after registration.
- Same crediting period for all activities.
- Should be demonstrated that bundle will remain under the limit for that type, every year during the crediting period.

- If bundle goes beyond its limits, maximum claimable ERs is capped at level for that type. That is, excess ERs generated will not be eligible.

Homogeneous Bundles (Same type, same category, same technology/measure)

- Same baseline may be used under some conditions
- One DOE can validate.
- Common monitoring plan for the bundle, one monitoring report
- Conditions for sampling
- Same length and starting date of crediting period
- One verification report.
- One issuance – same time, for same period, 1 serial number for all projects (the bundle).
- Sum of all activities should be as per SSC[10] limits.
- Must use SSC methodologies

Homogeneous Bundles *(Same type, same category but different technology*

(b) Same type, different category, different technology

(c) Different types)

- Same baseline may be used under some conditions
- One DOE can validate.
- Different monitoring plans, separate monitoring reports.
- Same crediting period for all activities.
- One verification report, one issuance, one serial number.
- Sum of all activities? This question is pot yet fully answered.
- Must use SSC methodologies

Upper Limits

Type I (Ren. Energy): ***Maximum output capacity of*** **15 MW (or an appropriate equivalent);**

Type II (Energy Efficiency.): *Maximum output of* **60 GWh per year (or an appropriate equivalent);**

Type III: (Others) *emission reductions of less than or equal to* **60 kt CO2 equivalent annually.**

Relevent Green House Gases and their GWP[11]

[10] Small Scale Methodology

1) Carbon Dioxide

Global Warming Potential **1tCO_2e**[12]

2) Methane

Global Warming Potential **21 tCO_2e**

3) Nitrous Oxide

Global Warming Potential **310 tCO_2e**

---

[11] Global Warming Potential

[12] Tonnes Carbon Dioxide Equivalent

Exhibit 4-3. Methane Emissions from Wastewater by Country: 1990–2000 (MMTCO2E)

Country	1990	1995	2000
China	64.9	68.8	72.0
India	56.9	62.4	67.9
Cambodia	56.8	60.0	62.8
Indonesia	40.7	44.5	48.3
United States	24.1	26.7	28.4
Brazil	18.0	19.3	20.7
Mexico	10.0	11.0	14.6
Iran	12.0	13.1	14.1
Bangladesh	10.4	11.7	13.0
Russian Federation	9.4	9.4	9.3
Nigeria	6.8	7.9	9.0
Pakistan	6.9	7.8	8.9
Viet Nam	6.7	7.4	8.0
Turkey	5.7	6.3	6.8
Jordan	6.2	6.3	6.5

Source: EPA, 2005.

The Tables above and below show that China and India lead the world in both emission of Nitrous Oxide and Methane from Waste waters. We must not overlook the importance of the ability of Vetiver to pick up Nitrogen so effectively from wastewaters. The GWP of Nitrous Oxide 310.

Exhibit 4-4. N_2O Emissions from Wastewater by Country: 1990–2000 (MMTCO2E)

Country	1990	1995	2000
China	16.7	17.6	18.4
India	8.5	9.4	10.2
US	6.7	7.4	8.1
Indonesia	2.0	2.2	2.4
Brazil	2.0	2.2	2.4
Russian Federation	2.2	2.2	2.2
Japan	2.0	2.0	2.0
Pakistan	1.2	1.3	1.5
Mexico	1.3	1.4	1.5
Germany	1.3	1.4	1.4
Nigeria	0.9	1.1	1.2
France	1.1	1.2	1.2
Bangladesh	0.9	1.0	1.1
Turkey	0.9	1.0	1.1
Italy	1.1	1.1	1.1

Source: EPA, 2005.

Advantages of Bundling

- ❖ Can save costs, depending on case.
- ❖ 1 DOE[13] for validation and verification
- ❖ Sampling allowed in monitoring plan.
- ❖ 1 PDD[14] collects all small project activities.
- ❖ Single entity can act on everyone's behalf.
- ❖ Good way for small, rural, scattered projects to access carbon finance.

Example:

Nepal Micro Hydro

Program: Installation of MH stations range 3 – 100kW

Up to total of 15MW

~ 750 plants covered in 1 PDD

Govt. of Nepal on behalf of all MH operators (World Bank Carbon Finance)

Limitations of Bundling:

- Can also raise costs.
- What if # of project activities amount to greater than SSC limits?
  - Make large-scale bundle, with regular methodologies, if available
  - Parse into different PDDs
  - **how many PDDs will this produce? Answers not yet available**
- Ex-ante identification of project activities

Sites? Villages? Municipalities? Districts? Answers not yet available

Example:

Nepal Biogas

Program: Installation of 162,000 – 200,000 biogas plants.

1 PDD covers ~9000 average sized plants

PDD writing + validation + verification yr1= $30K

Plus $10K per year verification x # of years

Not withstanding modality repetition per PDD (World Bank Carbon Finance)

Concept of VERs

---

[13] Designated Operational Entity
[14] Project Design Document

- VER is a verified emission reduction. Many Annex one companies trade in VERs.
- These are mutual arrangements between buyers and sellers.
- They are verified by Designated Operational entities in the Host country.
- Later approved by the host country.
- **They need not go to the CDM Executive Board for approval. These have the minimum risks as well as the minimum costs.**
- **These can be beneficial for very small projects.**

Possible Applicable Methodologies to the Project

Reference	Methodologies Title
AMS-I.A	**Electricity generation by the user**
AMS-I.D	**Grid connected renewable electricity generation**
AMS-II.F	**Energy efficiency and fuel switching measures for agricultural facilities and activities**
AMS-III.B	**Switching Fossil Fuel**
AMS-III.D	**Methane recovery in agricultural and agro industrial activities**
AMS-III.E	**Avoidance of methane production from biomass decay through controlled combustion**
AMS-III.F	**Avoidance of methane production from decay of biomass through composting**
AMS-III.G	**Landfill methane recovery**
AMS-III.H	**Methane recovery in wastewater treatment**

AMS-III.I	**Avoidance of methane production in wastewater treatment through replacement of anaerobic lagoons by aerobic systems**

Source UNFCCC (selectively taken)

Application of Vetiver to the Project

1. **Afforestation & Reforestation:**
    a) It is planned to have a green belt all along the 160Km long river. Vetiver will be a part of this greening which would essentially have trees too. Following Paras carry calculations of application of CDM in a A/R project involving Jatropha Caracus. The authors have taken it from there own paper presented at the UNCTAD ECOWAS Bank Workshop on Biodiesel at Ghana in Nov. 2006. These calculations are presented here purely for the purposes of demonstrating the extent to which CDM can affect the economics of a project.
    b) **River Bank Stabilisation with Vetiver:** The Carbon Sequestering Capacity of Vetiver will help evaluate Carbon Credits. We expect to get some data on this aspect of Vetiver at this workshop.

2. **Wastewater Treatment of Villages**
    a) Total Treatment with Vetiver:
        i. **Methane:** We hope to prove that by using vetiver, we are preventing the methane from escaping to the atmosphere, which would have been the case under the BAU[15] scenario. Methane having a GWP of 21 CO_2e[16]. The Carbon Credit earning potential in this case would be substantial.
        ii. **Nitrous Oxide Emission Prevention:** Keeping in view the Nitrogen uptake capacity of Vetiver, we presume that whatever Nitrous Oxide that goes into the atmosphere in the BAU scenario. The GWP of N_2O is 310. This needs tobe studied so that quantification can be done.

    b) Secondary Treatment with Vetiver:

[15] Business as usual
[16] Global Warming Potential

i. **Residual Methane Removal:** This is an important aspect while calculating Carbon Credits. Residual Methane removal by Vetiver needs to be researched.

ii. **Nitrous Oxide Removal:** As discussed above.

c) **Treatment of Anaerobic Ponds:** Reshape deep ponds into shallow ponds and have Vetiver on their slopes and grow vetiver suspended in floats. This will prevent methogens from forming.

d) Solid Waste Management of Villages:

i **Co-Feedstock in Biogas digester treating kitchen and other biomass wastes:** Methane generating capacity of Vetiver needs to be studied.

ii **Secondary Treatment of :** Same as in the case of waste water**.**

e) Solid & Liquid Waste Management of Towns:

Application of Vetiver in the case of towns will be the same with the addition of **Landfill Leachate Treatment.**

In the following paras we will discuss the various aspects and try to give the kind of impact that can be expected on the whole project:

1.2. Afforestation[17] & Reforestation[18]:

As per COP[19]7 (2001) through COP 10 (Feb. 2005), afforestation and reforestation are the only eligible land use activities in the CDM. The definitions of forest for this purpose 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 ms. at maturity in situ.

*Special provisions are provided for small scale afforestation & reforestation projects. Many small scale projects can also be bundled(**UNFCCC[20]**), so that the fixed costs of registration can be spread out.*

[17] Direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land.
[18] Direct human-induced conversion of non-forested land to forested land. Land was forested earlier but had to be converted to non-forested land. The land should not have contained forest on December 31, 1989.
[19] Conference of Parties

1.2.1. *The CDM Impact On Afforestation & Reforestation*

The first phase of CDM until the year 2012 is open to reforestation and afforestation projects in developing countries as defined in the CDM guidelines and modalities and procedures finalized at COP[21] 9 & COP 10 for such projects. The main criteria to be met by projects include meeting benchmarks of additionality (ie on top of business as usual scenario), permanence of emission reductions achieved and no leakage (ie ensuring that emissions achieved at one location are not emitted elsewhere).

"Small-scale afforestation and reforestation project activities under the CDM" are those that are expected to result in net anthropogenic greenhouse gas removals by sinks of less than 8 kilotonnes of $C0_2$[22] per year and are developed or implemented by low-income communities and individuals as determined by the host party. If a small-scale afforestation or reforestation project activity under the CDM results in net anthropogenic greenhouse gas removals by sinks greater than 8 kilotonnes of $C0_2$ per year, the excess removals will not be eligible for the issuance of tCERs[23] or ICERs[24] ". **(UNFCCC)**.

The key features as per the definition are:

- The projects should sequester upto 8 kilotonnes of carbon annually.
- They are implemented by low income communities.
- There is scope for bundling of projects of similar nature so that cumulatively the units sequester upto 8 kilotonnes of carbon.

Assuming an average productivity of 5 tons/ha[25], the area required for bundled small scale CDM projects would range between 250 to 400 ha, varying with species and plant density. The energy plantations of Jatropha would be principally eligible under this category of CDM projects. **(Hooda & Rawat, 2004).** At the current rate of exchange of CERs ($10/$tCO_2e$[26]) this translates into $ 80,000 per annum, which means $ 800,000 (Rs. 360 lacs) over a 10 year period. Taking the worst case scenario, that is size of project as 400 Ha, we have CDM credit amounting to $ 2000/ha or Rs.90,000/ha. This is nearly 3.5 times the total cost of cultivation on one Ha of wasteland. This could significantly increase

---

[20] United Nations Framework Convention on Climate Change
[21] Conference of Parties
[22] Carbon Dioxide
[23] Temporary Certified Emissions Reduction
[24] Long term Certified Emissions Reduction
[25] Hectare
[26] Ton Carbon Dioxide equivalent

The above is a broad example, however, each project would be calculated as per its *'Net anthropogenic GHG removals by sinks[27]',which would be'Actual net GHG removals by sinks[28]' minus 'Baseline net GHG removals by sinks[29]'*, minus *'Leakage[30]'*.

This means that we need to:

- Facilitate the bundling of small forestation projects so that the total net GHG removal is just under 8 kilotonnes per annum (definition given above).
- Finalize the carbon stocks of the areas at the time in the past arrived at by definitions of afforestation and reforestation and estimate the baseline net removals.
- Ensure that the credits accruing thus, are tranferred to the small farmer via the gaurantee of pay back of loan refinanced by banks like NABARD etc. (Singh and Kalha 2006)

1.2.2. *A sample Cost Of Jatropha Curcas Cultivation In One Hectare Waste Land (The sole purpose is to stress the tremendous impact on costing) It also leaves the scope of growing Vetiver as part of the project for later interpolation when data is available.This is followed by tables with interpolated values of accrued CDM Credits.*

Placed below (Table 1a) is the traditional costing of a jatropha plantation, giving the farmer inadequate and unattractive returns. It provides, to the farmer, a sale price of only Rs. 5 per Kg. of seed. This shows that the farmer has to spend nearly Rs.25, 000 in the first three years, without any accruals. Though the table contains a cost of Rs. 1000/- for intercropping, the later tables on accrual and cost benefit analysis do not take into account any intercropping.

Table 1(b) gives the projected annual yield of one hectare. And table 1(c) gives the cost benefit analysis.

The argument of the authors is that the system can afford to pay a higher price to the farmer.

---

[27] Actual net GHG removals by sinks minus the baseline net GHG removals by sinks minus leakage

28 Sum of the verifiable changes in carbon stocks in the carbon pools within the project boundary, minus the increase in emissions of the GHGs measured in CO_2 equivalents by the sources that are increased as a result of the implementation of the AR project activity, while avoiding double counting, within the project boundary, attributable to the AR project activity under CDM.

[29] Sum of Changes in Carbon stocks in the carbon pools within the project boundary that would have occurred in absence of AR project activity under CDM.

[30] Increase in GHG emissions by sources which occurs outside the boundary of an AR project activity under CDM which is measurable and attributable to AR project activity.

Table 1(a)

Traditional Cost of Jatropha Curcus Cultivation Per Hectare Waste Land (Seeding)

Assumptions

Espacement: 3 M x 2M
No. of Trees/HA.: 1666
Survival/HA.: 1500 Nos.
Avg. Wage Rate : Rs.50/MD
Casualty Replacement: 10%

S. No.	Particulars of Works	Unit	Cost (Rs. Per Year			Total (Rs.)
			1	2	3	
1.	Site preparation	10MD[31]	500	-	-	500
2.	Initial ploughing for 6 Hrs	100/Hr	600	-	-	600
3.	Intercropping	Rs. 1000	1000	-	-	1000
4.	Alighment & staking	5 MD	250	-	-	250
5.	Digging of pits (45 cm3) & refilling @50 pits/MD & 150 pits/MD	33/11 MD	1650	550	-	2200
6.	Cost of FYM[32] @2 Kg/pit	Rs. 150/ton.	500	-	-	500
7.	Cost of fertilizer @ 250gm/plant	Rs. 2000	2000	2000	2000	6000
8.	Cost of plants including transport (1666, 166 nos.)	Rs. 3 per plant	4998	498	-	5496
9.	Cost of planting &replanting @ 100 plants Per MD	16 & 5 MD	250	-	-	1050
10.	Weeding, soil working, application of Fertilizer etc. (3,2,1)	10 MD per working	1500	1000	500	3000
11.	Plant protection measures	LS[33]	100	100	100	300
12.	Pruning	20 MD	1000	1000	1000	3000
13.	**Sub Total**	**Rs.**	**14898**	**5398**	**3600**	**23896**
14.	Contingencies	5%	744	270	180	1145
15.	**Grand Total**	**-**	**15642**	**5668**	**3780**	**25090**

Source: Karmakar & Haque (2004)

This shows that the farmer has to spend nearly Rs.25, 000 in the first three years.

[31] Man Days
[32] Farm Yard Manure
[33] Lump Sum

Table 1(b)

Yield and Income per Hectare of Jatropha Cultivation of Wasteland

Yr.	Seed per tree (kg.)	No. Of trees	Seed (kg)	Price per kg.	Income (Rs.)
3	0.50	1500	750	5	3750
4	0.50	1500	750	5	3750
5	1.00	1500	1500	5	7500
6	1.50	1500	2250	5	11.250
7	2.00	1500	3000	5	15000
8	2.50	1500	3750	5	**18750**

Source: Karmakar & Haque (2004)

Table 1(c)

Economics of Jatropha Cultivation in one Hectare of Wasteland

Year	1	2	3	4	5	6	7	8
Cost	15643	5668	3780	-	-	-	-	-
Benefits			3750	3750	7500	11250	15000	18750
Net Benefit	**-15643**	**-5668**	**-30**	**3750**	**7500**	**11250**	**15000**	**18750**

PWC@ 15% 20373.84
PWB@ 15% 24970.74
BCR 1.23
IRR 20.20%
Source: Karmakar & Haque (2004)

The above tables, drawn up in 2004, show that the farmer gets an income of Rs.18750 in the 8th year, without taking into account any income from intercropping. *We also notice that the net benefit to him is negative in the first three years. The income of Rs. 18750 is not enough incentive to encourage a farmer to go in for Jatropha cultivation. The above finacials are OK from the debt recovery point of view but not from the farmer's point of view.*

1.3. Giving More To The Farmer:

If however,

- We calculate the effect of CDM on afforestation/ reforestation under the Kyoto protocol and interpolate the advantage in the cost-benefit chart, giving the farmer advance from his own potential credits against the CERs earned.
- And recalculate the economics of Jatropha cultivation, assuming a sale price of Rs. 8 per Kg., The result is a better and more attractive deal for the farmer.

1.3.1. *Interpolation of Enhanced Price and CDM Effect of Afforestation*

It is suggested here that the sale price of seed for the farmer be taken as Rs.8 per Kg. The additional Rs.3/- can be made up in the next two stages of the Bio-diesel manufacturing process by taking into account the positive impact of additionalities and further CDM credits. The suggested total Income & net benefit charts are presented below:

Table 2

Yield & Income/Hectare of Jatropha Cultivation of Waste Land with Enhanced Sale Price of Seed

Year	Seed/Tree (Kg.)	No. of Trees	Qnty. of Seed (Kg)	Price per Kg.	Total Income (Rs)
3	0.5	1500	750	8	6000
4	0.5	1500	750	8	6000
5	1	1500	1500	8	12000
6	1.5	1500	2250	8	18000
7	2	1500	3000	8	24000
8	2.5	1500	3750	8	**30000**

Table 3

Cost Benefit Analasys after Interpolation with Enhanced Seed price & CDM Benefit from Afforestation

Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Cost	15643	5668	3780	0	0	0	0	0
Benefits	0		6000	6000	12000	18000	24000	30000
Net Benefit	-15643	-5668	2220	6000	12000	18000	24000	30000
CDM Benefit	18000	18000	9000	9000	9000	9000	9000	9000
Total Benefit	**2357**	**12332**	**11220**	**15000**	**21000**	**27000**	**33000**	**39000**

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

If the government advances the AR[34] benefits as suggested, the farmer does not have to wait three years to get financial returns from the afforestation. The CDM credits can be given in advance and the farmer earns steadily each year. The government would, of course, have to identify afforestation and reforestation projects and deal with them accordingly. Small scale projects will have to be so bundled so that the collective net anthropogenic GHG removal by the sink is just about 8 Kilo tons.

1.3.2. Discussion on CDM under Afferestation /Reforestation.

Having shown the impact of the application of CDM to Afforestation/Reforestation, it is necessary to point out certain facts:

- Countries were free to choose their own values for Land Area, Tree Crown Cover, and Minimum Tree Height to define a forest from the ranges given in forest definition above.
- India chose .05 Ha., 30% and 5M. While this choice helped in showing larger tracts as unforested in the baseline, they limit the choice of trees that can be used for A/R activities.
- The maximum height achieved by Jatropha is 4.5 m, therefore, if used as the only tree in a forest, would not be eligible[35].
- The NABARD model discussed above (for wastelands) as well as the subsequent models for irrigated conditions show an IRR between 17% and 25%, without taking into account any intercropping or CDM. This is a healthy figure with regard to recovery of loan vs money lent is concerned. The per Hectare income generated is just not enough.
- In Mali, the IRR achieved is 17%, including CDM. That seems more realistic. Mali's definition of forests are also favourable[36].
- **Vetiver can be grown inbetween and used as mulch. This would reduce the use of Chemical Fertilizers.**

[34] Afforestation & Reforestation
[35] Singh and Kalha 2006, Galinski. W. 2006, Kreiss O. , 2006
[36] Kreiss O., 2006

2. Leakage & Avoidable Emissions in the Manufacturing Chain:

If emission reduction achieved at one place results in increased emission in another, outside the project boundary, it is termed as leakage. Here we have termed losses within the project boundary as negativities.

The AR activity itself can cause unwanted and avoidable emissions. Examples:

- Emission from N-fertilizers used in the cultivation. The use of these fertilizers should either be avoided in the project or properly accounted for.
- Decaying biomass (leaves, fruit pulp etc.) and cow dung emit methane. Instead of piling up such biomass, biomethanation should be used to capture and harness the methane.
- Wrong sourcing of FYM[37]: FYM sourced from an open air composting site can & should be avoided. The final residue after methane recovery described above, should be used as organic fertilizer.
- Building the manufacturing facility on a potential AR site is a leakage. Location of these facilities should not be on such sites.

We, thus, see that Methane (GWP[38] 21) recovery can have a huge socio-economic impact on village. Discussed below is,

a) Avoidance of methane generation through controlled combustion.

b) Integrated Recovery of Methane in the rural scenario through biomethanation along with other biowastes, including wet garbage, dung. & even wastewater.

3. Avoidance of Methane Production from Biomass Decay through Controlled Combustion

This category (controlled combustion) does not capture methane, it avoids its release. This would come under small scale project category IIIe[39] for purposes of CDM.

---

[37] Farm Yard Manure.
[38] Global Warming Potential
[39] Small Scale Project Category under UNFCCC

The baseline calculation for a given mix of Biomass mix, which is to be combusted, is done as per formulas and factors laid down by ***IPCC*[40].**

If a mixed biomass from a rural area is assumed to be 20 Ton/day, the base line emission of **4.02 t CO_{2e}** per day. The Carbon Credits entitlement would depend on how much less Carbon Dioxide is emitted during controlled combustion of the 20 ton mixed biomass. **The impact of the addition of Vetiver Biomass needs to be studied.**

Combustion may not be the best method to adopt, unless the waste is not very easily biodegradable. It may be desirable to go in for biomethanation wherever possible. The simple reason is that methane recovered has more options of use and the residue in the process is a very valuable soil conditioner.

4. **Other Agriculture/Land use and Land use Change related CDM Possibilities**

- ✓ Reduction in methane emission with appropriate water management in irrigated paddy fields may meet a major part of the required methane mitigation from anthropogenic sources and help to stabilize the methane concentration at present level[41].
- ✓ This would result in lesser use of water and hence conserving energy.
- ✓ Controlled use of Nitrogenous Fertilizers would result emission reduction of N2O[42]. Use of Vetiver as mulch would reduce this possibility.
- ✓ Most Starchy/ Sugary crops and crop wastes are excellent sources of Methanewhen subjected to biomethanation. Sweet Sorghum grains and stalks can generate methane at mch lesser cost than they can produce Ethanol[43]. **The methane generating Capacity of Vetiver, if used as a co-feedstock needs to be studied.**

5. **Integrated Methane Recovery from Total Waste Biomass (Agroforestry, Kitchen and Cow Dung) and Village Wastewater:**

As discussed, ecological advantages of agro-forestry are negated if the biomass waste is allowed to decay and release methane gas into the atmosphere. Decay and burning of biomass can result in unwanted emissions within the project boundaries. The following calculations will clearly show that waste can be effectively treated in a biomethanation reactor more gainfully than the controlled combustion above. The only limiting factor is the ease or otherwise of fermentation of certain types of bio-wastes.

---

[40] Intergovernmental Panel on Climate Change
[41] Parashar et al, National Physical Laboratory, New Delhi.
[42] Nitrous Oxide: Global Warming Potential of 310.
[43] Jayanarayanan E.K. January, 2006

A lot of work has been done at Indian Institute of Science (CST[44]) towards designing biomethanation reactors that can tackle mixed feedstock of waste material for methanation (Chanakya).

Now that the application of the fermenter has widened, there is no need to mix fresh water with cow dung for bio-gas. A village has a lot of bio mass waste, apart from cow dung. The UASB reactor has been suitably modified and can produce a higher percentage of bio-gas, using mixed feed stock. Tailor made solutions need to be designed for different areas.

A case study using biomethanation of mixed wastes as discussed above is given below:

5.1. Case Study from proposed facility in Kishengarh village at Chandigarh (IN)

5.1.1. *The CDM impact of Methane recovery:*

The authors have, on behalf of the Village Life Improvement Foundation, upon request from the Government, had given a proposal for treatment of biomass waste along with wastewater at village Kishengarh, Chandigarh. The mixed waste consists of:

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

Expected Biogas Recovery from the biomass mix per day	= 1000 cum = 0.6 tons	
Methane component in this biogas @60%	0.36tons	
Baseline: 100% discharge of methane to atmosphere.		
Methane available for credit @ 100%	= 0.36 tons	**(A)**
However, 2 mld wastewater is going for aerobic treatment.		
Biogas recovery expected from wastewater	= 450 cum = 0.25 tons	
Methane Content @ 60%	= 0.15 tons	
Baseline: Due to aerobic treatment now 60%		
Methane available for credit @60%	= 0.09 tons	**(B)**
Total methane credit per day {(A)+(B)}	= 0.45 tons	
Total Methane credit per annum	= 164.5 tons	
GWP of Methane	= 21	
GWP of methane combustion	= 3	

[44] Centre for Sustainable Technologies (formerly ASTRA) Indian Institute of Science.

CER = 164.5*(21-3)

= 2961 tCO_2/annum

At the current exchange rate this comes to USD 29610 or **Rs.13,32, 000/annum**

NOTE: The Secondary Treatment in this case can be done with Vetiver. This would increase the carbon credits as no Fossil Energy will be used in the Polishing.

In case the primary treatment s also replaced with Vetiver, the applied methodology would change from methane recovery to methane emission avoidance, from the approved methodologies listed above.

5.1.2. *CDM Impact of power generation from methane captured:*

As per UNFCCC guidelines, if the methane captured in a project is further used to generate electricity used in place of electricity generated by fossil fuels, Carbon Credits can be claimed under the same project

The methane calculated above is capable of generating 100 KW (0.1MW) in a day running 24 hours.

At 80% efficiency, this tanslates into (0.1MW*365days*24h*0.80) =700 MWh per annum

Carbon emission of replaced electricity = mixed cycle (CEF=0.4kgCO_2e/KWh)

= 0.4tCO2/MWh

Carbon Credit 700MWh/annum*0.4tCO_2/MWh =280 tCO_2

At current rate ($10per tCO2) this comes to $2800 that is **Rs. 1, 26,000 per annum.**

The **baseline** scenario in the case of Methane capture is that in the absence of this project all the methane would be sent to the atmosphere due to decay, as there is no municipal rule set in Rural areas.

The above calculation does not include the cost of dung and the sale accruals of:

- Two tons of high quality organic Fertiliser that will be produced/sold every day.
- 60 KW (1440 units) of electricity per day.
- Currently, the administration is spending Rs. 1,50, 000 per month on transportation of the vegetable waste to the dumping site. Most of that will be saved as the proposed treatment is near the vegetable waste source.

Conclusion

The Clean Development Mechanism can play a very important part in in Community Development projects. The role of Vetiver in the community development project of sanitation and soil erosion is significant. There is an urgent need for research to quantify the tremendous impact this plant can have on the economics of such project.

There is a need to study the CDM potential of all the applications of Vetiver. It would appear that the reduction in Methane and Nitrous oxide emissions need to be looked at vey seriously as the quantum of credits in these cases can be very high due to the tremendous global warming potential of the two gases.

If Carbon Credits can be managed in such projects, the Vetiver Technology would take off well in Developing countries.

The facts put forward in the paper suggest that the evaluation of the capacity of Vetiver grass to mitigate GHG[45] emissions and to substantially enhance Carbon stocks; thereby earning Carbon Credits, in all its applications, needs to be studied.

[45] Green House Gas

REFERENCES

1. Chanakya, H.N., Venkatsubramaniyam, R., Modak, J. 1997. Fermentation and Methanogenic Characteristics of Leafy Biomass Feedstocks in a Solid Phase Biogas Fermentor.Bioresource Technology 62 (3), 71-78.
2. Chanakya, H.N., Srikumar, K.G., Anand, V., Modak, J., Jagadish, K.S. 1999. Fermentation Properties of Agro-residues, Leaf biomass and Urban Market Garbage in a solid phase biogas fermenter. Biomass & Bioenergy 16 (6), 417-429.
3. Chanakya, H.N., P. Rajabapaiah and J. M. Modak, Evolving biomass-based biogas plants: The ASTRA experience, 2004; Special section: Application of S&T to Rural Areas, Current Science, vol. 87, no. 7, 10 October 2004
4. Earthizenz: www.earthizenz.org or www.oceanofdrops.com
5. Galinski W.; Project Based Mechanisms, UNFCCC Secretariat; Presentation made at the UNCTAD & ECOWAS Bank Regional Workshop Financing Biofuels and Jatropha Plantation Projects with Special Emphasis on Clean Development Mechanisms (CDM), Accra, Ghana Nov 13-14, 2006
6. Hooda N. and Rawat V.R.S., Role of Bio-Energy plantations for carbon-di-oxide mitigation with special reference to India, 2004. Paper presented at International Conference on, 'Greenhouse Gas Emissions and Abrupt Climate Change: Positive Options & Robust Policy' at Paris.
7. Intergovernmental Panel on Climate Change (IPCC). www.**ipcc**.ch
8. Jayanarayanan E.K. Economics of Production of Biogas and Ethanol from Cane Juice, Grains, Sweet Sorghum, Sugar Beet and other Agriculture based Raw Materials, Paper presented at the 3rd International Conference on Biofuels, New Delhi. Jan 17-18, 2006
9. Karmakar, K.G. and M. S. Haque, Economics of Cultivation of Bio-Diesel Tree, Jatropha Curcus in Wastelands, Paper presented at International Conference on Biofuels, New Delhi, Sept. 16-17, 2004.
10. Kreiss O., President Eco Carbone; Presentation made at the UNCTAD & ECOWAS Bank Regional Workshop Financing Biofuels and Jatropha Plantation Projects with Special Emphasis on Clean Development Mechanisms (CDM), Accra, Ghana Nov 13-14, 2006
11. Panigrahi, S.K. and A. Mohan Reddy, Energy Security, Environmental Benefits and Carbon Trading Potential of Biofuels in India- with a case study of first bio-diesel project for CDM. Paper presented at International Conference on Biofuels, New Delhi, Sept. 16-17, 2004.
12. Parashar D.C., Garg S.C., Mitra A.P. Parameters Controlling Production and Emission of Methane from Paddy Fields, National Physical Laboratory New Delhi
13. Pavgi Jayant, Biomethanation of Biomass, Paper presented at International Conference on Biofuels, New Delhi, Sept. 16-17, 2004.
14. Rana, A, Clean Development Mechanism and Potential of Bio-Diesel. Paper presented at International Conference on Biofuels, New Delhi, Sept. 16-17, 2004.
15. Singh M.P. & Kalha G.; Presentation made at the UNCTAD & ECOWAS Bank Regional Workshop Financing Biofuels and Jatropha Plantation Projects with Special Emphasis on Clean Development Mechanisms (CDM), Accra, Ghana Nov 13-14, 2006
16. Tale V.P. et al Community Based Biogas Plant Operated on De-oiled Jatropha Seed Cake: a success Story; Paper presented at the 3rd International Conference on Biofuels, New Delhi. Jan 17-18, 2006
17. UNFCCC, (United Nations Framework Convention for Climate Change) www.cdm.unfccc.int