Indian Pollution Control Agency: Ashish Jain New Delhi Organic Waste

City gives contracts to companies for waste removal & segregation

- individuals & ~~businesses~~ pay property taxes
- those taxes cover waste

- rates depend on location, type of property,
- city owns landfills - give contracts

★ No value for organic waste for rag pickers ★

- Some institutions (IIT) send organic waste to e.g. chicken, fish farms

150 mil tns of rice paddy waste is burned annually in India

household "greening" is encouraged w regulations on small digesters

large scale certifications
- local gov & ministries
- pollution control board (water, soil, etc)

★ 35 rupees/kg for natural gas
production cost of biomethane = 55 rupee/kg
- Gas grid tied
Capital cost 1000 m^3 ~ ~~25~~ million rupee

New Delhi Organic Waste (NDOC)

5 rupee / 20 kg of cow dung

Even at same price, Biogas may not be accepted

9 kg in mid sized car

1000 cal, 1 kg = 24 km, 60 km/h

Ashish Jain - site next to Sewage Treatment Plant
Vermicomposting site - 8 years old ? employees
- brings segregated waste to site - from residential area
- campaign for source segregation, but culturally difficult

low operating cost, land from local authority

huge demand for vermicompost - good NPK, (1:1:1)

100 rupee / 100 kg
sold whole sale, middlemen profit also

compost is 1/5 original volume
- no smell

revenue from collection fees, recycling
- some residences/colonies pay collectors
- sorted by hand, sifted final product.
some profit shortly
5 tons / month 25'35 day residence time

NDOW

land is a barrier

new law requiring developers to ~~test~~ handle waste

60% of waste is organic

converts informal to formal waste pickers
- including education
- improves income

Organic farmers high demand for vermicompost

15 days of pre composting prior to adding to worm beds

meat & liquid (fatty) waste go to fish + pigs especially

Decentralized management

3000 families currently served
9-10 tons/day total waste
60% biodegradable - 25% of that comes here
25% recycled
15% landfill - styrofoam, packages, etc. diapers

Edu sessions w/ residents, housekeepers, etc..

Only landfill dumping for everyone outside this program

1 employee / 200 households
running school, provide health care

Goa pays companies
600 rupee / ton for collection & disposal
(at certain points)

15 Biomethane plants - making gas for industries as natural gas replacement
- running on cow manure
23,500 m^3 biogas (55% methane)

Dairy owners supply manure - hard to find large dairies
- mostly small co-ops

MSW organic fraction is best option available

slurry from Biomethane sold - 40 per truck - 1500 rupee
liquid manure <10% solids
hard time getting rid of it

* Look into composting & PhD from
- CHECK WITH ANDREW LANE!

NDOW

Second site — community led effort

170 - 200 houses

25 kg = 250 rupees
For leaf + urea : 25 kg = 500 rupees

Same model: collect fees, recycle + compost

* Human touch foundation — look up

May 28 taxi : 250 Rupee

~~Expert taxi~~
May 29 - 1200 rupee

8-30-14

When fed to pigs/fish → what is value of food waste?
↑
What is cost of animal feed it replaces?

4½ rupee / kWh for domestic
up to 7 rupee / kWh for others?

CNG
14.2 kg cylinders - 12 per year — subsidized
38-40 rupees / kg

All energy are subsidized
5 kg / waste per day
1 hr cooking in morning, 1 hr. evening
25000 INR - Many people want this - scalable for multi family
waste is All used in gardens

NDOW

60-70 households doing organic gardens on

* Human Touch Foundation on Youtube, Facebook
  - lots of TV coverage here too.

Send Ranjhans data to Mrs Singh

Working with many villages near & far from Delhi

Mostly used for long cooking ...

June 3

How is waste handled in Jalgaon?
- Contracts? How much/ton?

How is it paid for?

Does company have to pay to dump in landfills/dump?
- who owns/manages landfill?

Biogas Specs

- ✓ Power Production (& value)
- ✓ tons/day feedstock
- ✓ tons/day compost
- ✓ value of compost
- Value of steam / waste heat?
- ✓ Goals for expansion? - Why ~~not~~ now?
- ✓ ROI?
- ✓ the others doing this? (Why/not?)
- ✓ Would you encourage at smaller scales?
- Biogas from sewage?

✓ Biogas / composting
✓ Ghandi ? (Gift shop?)
Jalgaon waste system
Farmers?
Solar station

* P economics in India: 1 kg P_2O_5 50¢ 30-60 kg/acre ← still a big #
Gov. subsidy is lower now, but still present (30-40%)?
: subsidy goes to fertilizer producers (state owned companies)
major fert companies
- IFFCO - Indian Farmers Fertilizer Cooperative
- KRIBHCO - Krishak Bharati Cooperative (Bharti = Indian)

June 3 & 4 Biogas Notes 4 digesting tanks

2 Phase - commissioned in 2010
Hydrolysis is aerobic

From food processing & sugar plants
1000 rupee / ton for sugar waste - used to give away to farmers
- remnants from processing sugar cane
mixing yard to create homogeneous slurry of 10-12%

Hydrolysis tanks break down complex molecules
From tank 1 → tank 4 over 6 days
Acidogens & Acetogens - create volatile fatty acids

From tank 4 to two digestors - Methanogens bacteria
monitors pH, temp, VFA's to maintain conditions for methanogens
regular analysis for sulfur tests so they can treat it as they accumulate
food waste has low S, sugar waste has higher
25-30 day Hydrolic Retention Time (HRT)
From pipes on top of tank - to processing
CO_2, H_2S & CH_4, water vapor
only remove H_2S
Starting project to capture & process CO_2 for Food Grade use
S removed by Biological scrubbers, added to compost
- make their own scrubbers
- liquid bacteria cultures in scrubbers, other media possible plastics, beads etc
Thiobacillus

Ask finance Q regarding

After scrubbing, 2nd scrubbing: H_2S is corrosive & could damage engine
~~Also covered by Gas regulations~~ GE engine requires below 500 ppm

Biogas Notes

55-65% methane

After 2nd filtration, condensers to remove water, gravel (filter sand) excess impurities (particulates)
then storage in 4 ballons (act as buffers)
transfer ~~from~~ of methane is continuous, ballons help when engines need maintenance
- other parts of ~~facility~~ compound are connected to biogas for cooking use, generator in Health Research Foundation
Flaring is LAST option

1) Hectare Facility Scrubbers cleaned annually

1.7 MW per Hour - 24 hrs/day
10.11 rupees per kilowatt hour to BUY
Cost to Produce is 14 rupees per kWh!
(AFTER)
RECs from Gov: 3.5 rupee/unit

Sun Valley uses 7 MW per HAR

GRID issues in
Reasons: 1) Leave world better than he found it = VISION
2) Waste management cost reduction
3) Energy production

Biogas Notes

Waste heat recovery? 1 ton = $?

400 tons/hour of refridgeration

- make steam from ~~waste~~ exhaust
- Steam sent to vapor absorption machine
- water used to cool engines is circulated through pipes in tank 4 of digesters to maintain temp

water reused from slurry for gardening or sent back into digesters. → mixed in NPK, used pH

Compost C: 12% min N: .8%, pH 6-7
P: .4% K: .4%

~100-150 tons/day of material going into MIXING tanks (including water)

10 tons/day of compost produced

300-350 m^3 of actual waste 400-500 m^3 capacity

TS & OLR (organic load rate)
(↓ this determines efficiency of process) ~ 40%-50% mass reduction?

maybe double in the future!

Continuous Flow

Food waste trucked ~ 1 mile from plant...

- mango stones sent through "de-stoner"
- stones sun dried & sent to boiler!

Seem expanding to onion plant & bagasse

300 Metric tons of MANGO waste per DAY!!!

150 from peels, 150 from stones

What would it cost to dispose of 300 metric tons/day?

Hatch on tanks to remove sand if needed, 1x in 3 years

digester cleaning 1 time in 25 years

Why aren't others doing it?
- takes vision
- skilled manpower problem
- Gov recognized deposit units
- Seasonality & waste stream... of market
- lack of strong regulation

Want to expand to collect municipal organic waste
- Mumbai is doing biogas from municipal organic waste
- Jalgaon wants to supply organic waste segregation is the problem.
- Jalgaon HAD a compost program but it failed - poor quality, poor leadership & lack of knowledge

Multiple MWTPs in Tan Valley
- Biogas uses treated water from MWTPs
- solids sent to composting yard

$ Ministry of New & Renewable Energy (MNRE) gave grant for 26 million rupees

Solar RECs 10-12 rupee/kWh
Biogas REC 2.5-3 rupee/kWh

Indian Gov promotes solar & growing rapidly

20L 6.5 MW/hr, soon 24
- (make their own panels?)

530 kWh capacity per engine x 2 engines
15,000 - 16,000 m^3 biogas per day
1 m^3 gas = 2 kWh

Belt press: slurry piped to compost yard
Coagulant added - belt press squeezes out water

300 rupees for 50 kg

Neem seeds pressed for oil & used in house
- neem cake used in compost or other use in house

waste management related jobs - 175
- 25 engineers/scientists/techs } all good wages
- 100 casual laborers

Jain is a reputable place to be...
- men working here are respected by prospective wife parents
- supportive management
- emergency assistance for any employee - like a family
- very good social aspects to company
- possibility to learn anything you want within Jain
- all ideas are accepted - even direct line to chairman!

- Ask about examples of staff improving Jain through idea
- staff designed machine to separate skin from seeds & pomegranate
- 2004 graduate designed entire biogas plant (costly German design)
- worlds largest onion dryer built/designed in-house

Senior leadership gives responsibility to junior staff
vs dictating what to do
- innovation & ideas respected

Abhishek Satyam - will answer financial ?'s tomorrow
- is in charge of all biogas Plant Managers
- helped design this plant - with German partners
June 2012 - Sustainable Solutions in Sugar Industry Waste Management
- organized by Jain, MNRE, and Maharashtra Energy Dev Agency
Lots of interest, but lack of follow through
- Academic articles / magazines/ papers also written

could buy 1000 rupee/ton organic waste
- but no collection system exists.

Jain tried to organize w/ market - they wouldn't segregate
- many people collect it for their cattle, sheep, goats etc.

Jalgaon municipal waste collected in bins, taken where?

Jalgaon large market
- can we follow people collecting food waste back to their farms?

Jalgaon composting site
- even though it's closed, can we still see / talk to someone?

Jalgaon municipal waste... can we talk to someone?
- recycling?
Jain vermicomposting?

Any small co-ops or non profits working with waste? How about handmade goods?

Mr. Jitesh Sharma and Mr. Prasanna Joshi
Plant operators

SWACH - waste pickers association

1 lakh = 100,000

satyamev Jayte Season2 _ full episode #3
Don't waste your garbage Subtitled

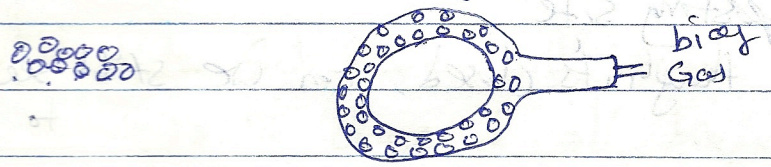
contract farmers get education, training, seeds, irrigation equipment & compost

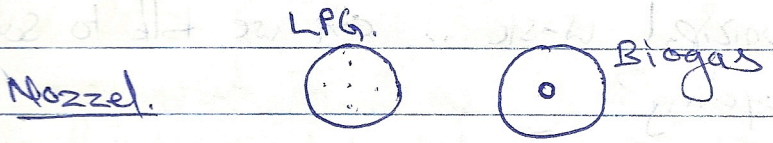
- future organic line

Hole size needs to be bigger for biogas due to low pressure of biogas system
LPG is higher pressure

Domestic biogas plant burner

Pressure - 5 to ~~30~~ mbar





Pr. 4-10 kg

200 mbar

Bins placed around city for trash
- community takes trash to bins
- contract labor also does this

- bins dumped in compactor before going to the "compost yard" where it gets sorted out

- rag pickers go through the bins too.

No formal location for waste picking

construction debris + trash also

Middlemen stockpile & sell

70-80% is recycled! ~10% paper recycled
cars dismantled, everything recycled or sold!
tires too
- Scrap cars is a big market

No real landfill in Jalgaon - just fill in low spots
- Munis usually own them
Jalgaon is taking care of trash while looking for company to ...
- NO sewage treatment in Jalgaon!!!! Septic tanks the ...
- riverbanks strewn w/ trash too
Previously a composting operation - now closed ~25 staff
- under large roof ; multi-bin process
- losing money

Private Biomedical waste disposal company
- incinerates
- profitable

rag pickers ignite trash piles
- No scales, lighting, equipment: ANYTHING!
contracted company collects waste, gets paid, and can make compost to sell.

Wealthier part of city much cleaner
Each building required to have septic tank
- series of channels connect tanks to river

WITH contract - composting does happen

JUNE 6 -
2 years before Biogas plant opened, research effort opened
~~Sludge~~ treatment is 1200 acres + 500 acres = whole campus
Biogas = 4 hectares including stock yards
Sewage - canals dry up before septic water reaches city
- tanks rarely overflow
- Septic ONLY takes toilet water
- all other greywaters directly to canals
- septic tanks are 4-5 m³ for households

Water to crops ~~project~~ org
Water to Crops project: Indo-EU 12 Indian 8 Euro
- treat & use wastewater for agriculture
- sewage, industrial, households
- how to treat, how to utilize in ~~crop~~ drip systems

BK interview

Getting Biogas Plant Started... (2010)

- Small Biogas Plant since 2004 w/ cow dung
- 2 medium ones in 2005
- 2007 Lab research - feedstocks, conditions, etc.
  - Started construction on huge plant 07-08
  - technical collaborator from Germany (still visits)
- Jump started large plant w/ microbes from smaller plant
  - 3 to 4 month build-up phase
- additional biogas from onion wastewater treatment since 2007

Biogas was waste management initiative, also biomass from energy, steam, compost

Why isn't it replicated?

there are a few plants in India

- capital startup costs
- Municipalities COULD afford it
  - manage
- segregation is difficult / costly : could be automated, economics is the question...

WASTE PER PERSON is very low here

Sustainability Cell within Jain
- Studies impact of Jain
  - Carbon footprints, water footprints
- Course in plastics factory (?)
- Hazardous waste taken by city

→
- recycled plastics?
- bad plastics?
- Promote model of working with small farmers
- waste management for cities?

sensors

Generators need maintenance every ~20,000 hours (~2¼ years)

LABS

Lack of education is part of waste segregation problem

Lab at Plant, & Lab at Tissue Culture

1) Anaerobic Glovebox: VFA's are most important & methanogens that consume H2
   - Methanogens can't tolerate ANY oxygen

2) Gassing Manifold prepares substrate to feed Glovebox

3) Gas Chromatographer

4) Methanogens need to eat VFA's (acetate is most important)

5) other GC samples gas from plant for methane, CO_2, H_2O

6) 25L digesters for pilots

7) BMP - Biochemical Methane Potential
   - tests different waste methane capacities
     sample ports & water displacement
   Room kept @ 35-40°C

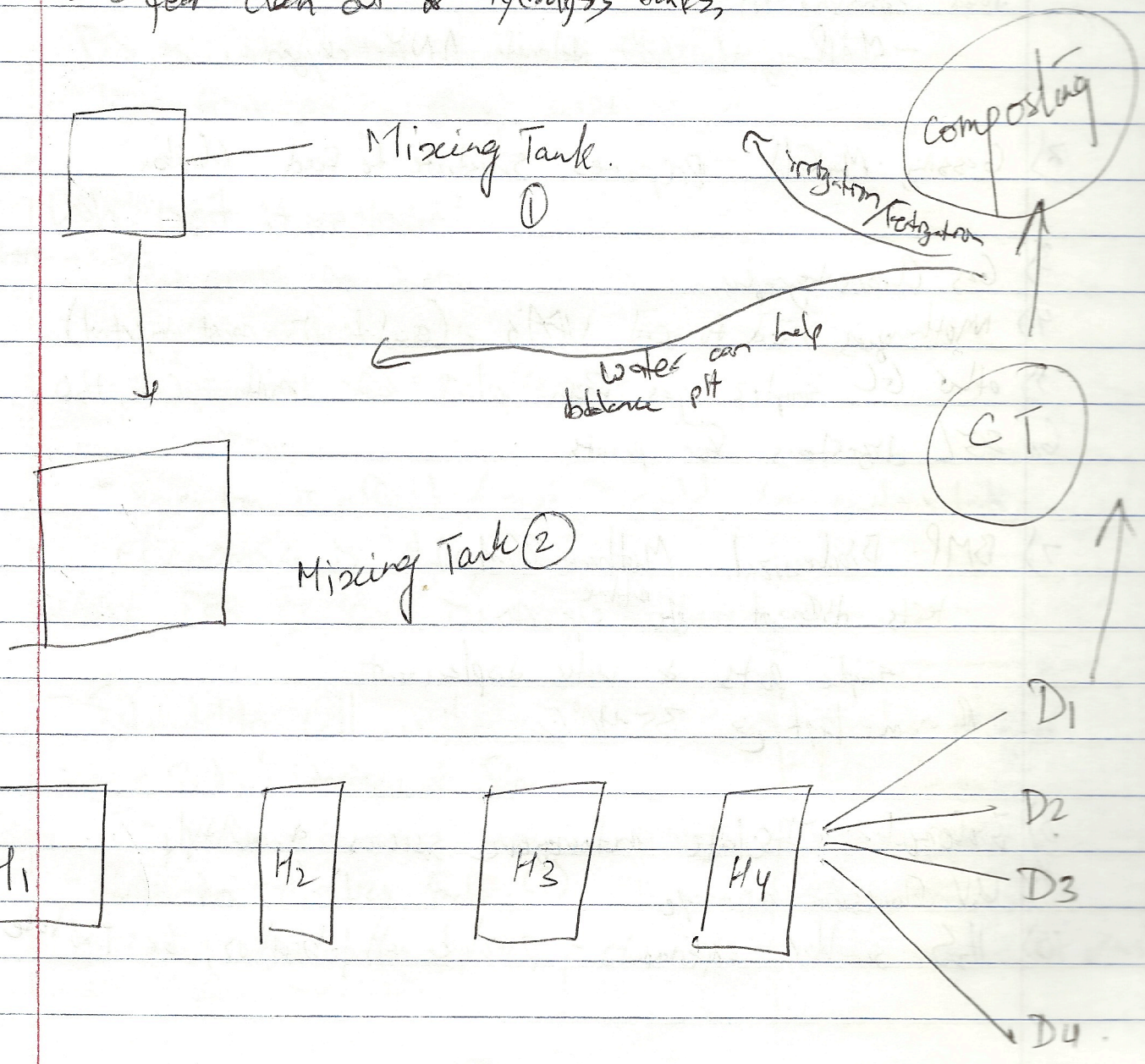
8) Biocomputer: Isolate methanogen species & multiply

9) UV florescent microscope

10) H_2S scrubber experiments - purchase thyobacillus, or isolate

Biogas
Waste from Plant is tested for BOD, COD
to meet pollution control board regulation
- if it exceeds regulations, Notify ETP, troubleshoot
solve the problem!
- Every stage is monitored, so problem is fixed quickly
- Daily operations
- monitor and provide feedback to biogas plant
PH, acidity, VFA, temp, H_2S level, Acidity/Alkalinity ratio

2-3 year clean out of hydrolysis tanks,



Community scale waste should be constant:
- organic loading rates are critical
- should be consistant feedstocks too

(can be achieved by feeding to cows & using manure)

$1 m^3$ is smallest for household
5-8 kg's/day = 2.5 → 3 m^3 Biogas is enough for 1 family of 5!
1kg of kitchen waste to 2-3 L

smaller scale, OLR is important

A number of companies sell this!
at Different Scales

Biogas is only from Fat, Protein, Carbohydrates
~~90%~~ ← 70-80% → 60-70% → 50-60%

This is UNIVERSAL
- to include yard waste requires Hydrolysis phase

4 stages:
1) ~~4 stages of~~ Hydrolysis
2) Acidogenesis
3) Acetogenesis
4) Methanogenesis

In 1969, Indian commission established 2 million plants in varying capacity from 40-100 m^3 in plants across India, using cowdung
- used for cooking
- KVIC Khadi Village & Industrial Commission

All 4 stages in 1 tank
- Requires strong monitoring
- constant feeding
- education etc.

Over 80% failed

Splitting reactors + monitoring results in successful operation
Only VFA's enter anaerobic portion

Small hole in Hydrolysis tanks provide O_2
Positive pressure sends Hydrolysis exhaust to biofilters
- Biofilter is wet scrubber:
  - porosity water holding capacity

SEEDING BIOGAS: culture from Fort ETP
UASB Upflow Anaerobic Sludge Blanket

* Small scale: if not fed, will take several days to kick-in again
  - cattle dung is universal seeding for biogas

~70 employees ONLY for Biogas
15-20 technical staff

Regulations for ETP, for Biofertilizer, Slurry: Different regs.

Jains requested contract for waste management in the city, but politics is preventing it...

* Waste to Energy in Pune - 400 km from Jalgaon
  - Biogas from municipal solid waste
  - & recycling;

Feasibility project from Dilat
  - 1' spot solution from Jain

Apart from regular analysis & support
  1) Calculate potential of different feedstocks
  2) Pretreatments for effects on Hydrolysis
  3) Isolation of microorganisms for pretreatment, methane production
  4) Pilot scale plant experiments (90L/day of slurry 10% TS)

they have $8m^3$ volume → 12-16 m^3 Biogas/~~PAY~~ $2m^3$ size = 3-4 m^3

Ultimate aim is to increase yield of Biogas from existing waste stream
  - Optimize process parameters
    - Temp, HRT, pH, VFA levels, etc

Micro scale augmentation by selected microorganisms completed but not at large scale

Community Scale Parameters to consider
- Waste volume (constistant?)
- market for gas (will they use it?)

1 kg volatile material = 400 L biogas
(biodegradable portion)

conservative!

1 kg VS (Organic matter) = 400 L Biogas @ 55-60%.

1000 kg = 1 MT (VS) ≈ 400 m³ —" —" —".

1 kg Waste - 20%. - 25%. Total solids. (DM)
65-70% DOM (Dry Organic matter).

1 kg - 25% DM & 70% ODM.
1 kg. - 17.5 gm ODM.

1 kg = 250 gm DM. & 175 gm ODM.

if 1 kg 1000 gm. ODM - 400 L Biogas.
175 —" — - & 70 Biogas.

these calculations aren't applicable for grass shrub, tree waste
- these need pretreatment because of lignen

1 m³ Biogas Plant = 3 m³ gas on 8-10 kg waste/day

? 10 m³ cost ??

Jared Stoltzfus

Interview w/ Sustainability Cell

Atin Tyagi — Masters in Env. Mangement from Forest Research Institute

Sustainability cell developed ~2010
3rd Sus. report coming up (Biannual Report)

- works with all other departments

Report highlights Biogas
- Farmers included: shared value
- Profits for farmers & company

Economic Sustainability for Farmers: Contract Farming with over 4000 Farmers for JUST ONIONS!

4000 Farmers w/ JAIN GAP (Good Ag Practices) → INSURED PRICE, but will pay Market if it is higher (BASE)
Unity Project w/ Coca-Cola India

Also provided organic manure, tissue culture plants, on field training for farmers in GAP

IF farmers aren't prosperous - neither will be Jain

Atin works on Carbon & Water (water footprint) Footprinting, and some energy management
IN 2010, study with IFC on dehydrated onion: 20th company in the world to do it.
1st company to also calculate social impact
- 2 major projects: 8.5 MW Grid tied + 1.6 MW Biogas
(2 Grids in India - NEWNE & Southern Grid)
6-7 MW use by whole JAIN valley (Doesn't include TC or Plastic Park) project
- large wind power (13.2 MW) Project in Southern India - sold to Gov

Additional project near Hyderabad:
- replacing coal w/ dried mango stones
- one boiler runs only on mango

Emission reductions from project = 60,000 tons CO_2e/year
↑ conservative!

Carbon Footprint accounting of Jain HQ:
Plaster Park: only manufacturer w/ this range of capacity
- next door PVC sheets (to replace lumber)

How does PVC rate in terms of Sus?
- emissions from production, VOC's
- 100 year lifespan - look at LCA

- Report from Civil Engineer society (He'll send paper!)
- replacement of U.S. pipelines will cost ~$1 Trillion
  - what are alternatives? Steel? (40 year life)

"The subjects follow their King" - Hindi Quote

Plaster Park is NOT energy intensive, so wouldn't ~~be~~ required to conduct energy audit - but they do it anyway.

1st in Irrigation sector to implement ISO 50,000 - since 2012
Plaster + food Divisions — certified 2013

Projects registered w/ Clean Development Mechanism (Kyoto Protocol)
- but no benefits from them...

Corporate Carbon Footprinting for ENTIRE Jain company

Carbon Development Project - International NGO

By 500 investors get their info from CDP

- Jain is 1st company to complete corporate accounting w/ ISO 14064
  - greenhouse gas accounting
  - Scope 1, 2, & 3 emissions

1- direct emissions from premises

2- Indirect: electricity 65-70% of Grid is coal

3- Other indirects (15 - sub categories!)

- Raw material extraction, transport, etc
- employee commuting (9,000 Associates!) All had to fill a questionaire distance traveled, type of vehicle, etc..
- business travel: Distance, type of vehicle
- travel expense reimbursement not given till report turned in!
- IndiaGHG & World Resource Institute & TERI - The Energy Resource Institute run by IPCC chairman
  Confederation of Indian Industries

≠ 8,000 suppliers just for Plastic Part

Jain wants to incorporate GHG accounting upstream & down.

Mission: Leave the world better than you found it.

70% of water & Energy used in Ag sector

- Using drip irrigation would drastically reduce water use & improve yield

- Drip irrigation for RICE being developed!

Using recycled plastics: plant scraps all re-used (~10-12%)

- using other recycled plastics is difficult: ISO standards must be met
- Quality promise to consumer makes using recycled plastic hard
- Bioplastic research working on new products