OPPORTUNITIES TO ENHANCE WOOD FUEL YIELDS IN SEMI-ARID REGIONS OF INDIA USING WASTEWATER

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Funding and players

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- Funding
  - Department of Science and Technology, India
  - Engineering and Physical Sciences Research Council, UK (EP/E044360/1)
- Players
  - Aston, Coventry, Bristol, and Warwick Universities
  - IIT Delhi, Haryana Agricultural University, GB Pant University

Outline

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- Background to project
- Why combine wood fuel production and wastewater management
- Sites to demonstrate principle and provide data for Indian conditions

Background Issues

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- Need for reliable and economic energy supply in rural areas,
- Desire for energy from local resources to improve local economy,
- Production of added value producrs tod retention of wealth in agricultural areas,
- Provision of energy without increasing carbon footprint

Energy context

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- High dependence on imported fossil fuels
- India's installed capacity needs to double by 2017 to 300GW to meet current growth in demand
- Gap between supply and demand from those already connected to the grid of 84tWh or 10% to total national energy requirement
- Only 55% of households electrified - 400 million people without access to electricity

(Indian Renewable Energy Status Report 2010)

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Project

"Enhanced biomass production and energy conversion for use in water scarce areas of India"

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consisted of:

- Biomass production trials and demonstrations
- Biomass conversion using Tri-generation technology

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Tri-generation

- optimises energy value of fuel

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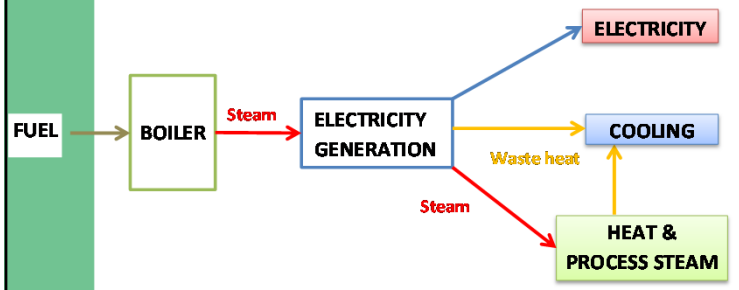

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Reasons for using wastewater in wood fuel crops

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- Potential to improve yield without using limited water supply,
- Yield benefits from nutrients,
- Increase economic yield from marginal land,
- Farmer income through providing a service to wastewater producer.

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Reasons for using wood fuel crops in wastewater management

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- Robust, low cost, low energy use,
- To bring more wastewater into proper management,
- Non-food crop - no health issues,
- Tolerates variable flow volumes and quality,
- Can operate at a range of scales and differing levels of engineering,
- Uses 'farming' techniques hence particularly appropriate for rural areas

Potential application in India

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- As a means of disposing of sullage water;
- As a final polish for N and P removal at wastewater treatment plants,
- At colleges, schools, training institutions, etc in rural areas with large wastewater flows but limited treatment,
- At small to medium industrial concerns that produce untreated wastewater & require fuel.

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Sullage pond

EPSRC project wastewater sites

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- Palwal – data collection
- Pantnagar – data collection & demonstration
- Surajgarh – demonstration

Monitoring

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- Soil moisture,
- Soil chemistry,
- Wastewater volume,
- Wastewater chemistry
- Standing biomass
- Harvested biomass,
- Plant chemistry – leaves & wood,

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Species selected for the project needed to meet some or all of the following criteria:

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- Rapid early growth,
- Previous use as wood fuel species in India,
- Ability to respond to coppicing,
- Existing cultivated species,
- Availability of planting material in sufficient quantities and of consistent quality

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Species planted

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- *Ailanthus excelsa* (Maharukh)
- *Eucalyptus tereticornis*
- ***Poplar* deltoides G48 & 54**
- *Eucalyptus* Clones AP7, I43
- ***Salix alba***
- *Alstonia scholaris*
- *Pongamia pinnata*
- *Melia azadirarch* (Bakain)

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Trial design (Palwal)

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- 2 x 2m (single stem)
  - *Ailanthus excelsa* (Maharukh)
  - *Eucalyptus tereticornis*
  - ***Poplar deltoides* G48**
- 2 x 1m (coppice)
  - *Alstonia scholaris*
  - *Pongamia pinnata*
  - *Melia azadirarch* (Bakain)
- Four spray irrigation treatments- 0, 25, 50, 100% of site net evapotranspiration potential,
- Three replicates, randomised complete block design (1.5ha)

Volume of wastewater applied
(April 2009-February 2010)

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Irrigation treatment (% of Potential Evapotranspiration)	Volume applied ($m^2\ ha^{-1}$)
0	453
25	872
50	1110
100	2066

Loading of wastewater constituents (kg $ha^{-1}yr^{-1}$)

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Treatment	0	25	50	100
COD	522	1085	1343	2575
BOD	128	269	332	638
Oils & Grease	28	53	66	123
Total N	121	254	318	609
Total P	24	49	62	118
NH_4-N	74	157	198	380
NO_3-N	14	29	36	69

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Loading of wastewater constituents (kg ha^{-1} yr^{-1})

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Treatment	0	25	50	100
K	214	422	531	1000
Na	426	819	1037	1932
Cl	1966	3764	4761	8860
S	2	3	3	6
Mg	312	586	746	1379
Ca	395	753	956	1776

Palwal STW

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Untouched site 09/2007

Ground cleared & planted 04/2008


Late August 2008
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October 2008


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Mid September 2009


Mid September 2009


Deer damage and shoot regrowth

Overview of trial outcomes

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- Melia generally consistently high survival but biomass highly variable between plots,
- Ailanthus very consistent survival, and good biomass yield
- Pongamia good survival and biomass but growth form very lax on short rotation

EPSRC workshop Delhi 22-23 September 2009

Overview of trial outcomes

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- Poplar and eucalyptus both suffering manganese deficiency and deer damage; survival & biomass variable,
- Metal loading from wastewater extremely low – most below LOD
- Salinity of wastewater, Cl and Na loading potentially problematic in long term

EPSRC workshop Delhi 22-23 September 2009

Pantnagar
Grey water trial

Trial description

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- Grey water from campus direct to neighbouring river used for crop irrigation downstream
- Double row planted, serpentine ditch irrigation and final settlement pond
- Groundwater irrigated block for comparison
- Species (planted Feb 2009):
  - *Eucalyptus* I43
  - *Salix alba*
  - *Populus deltoides* 54
  - *Melia azedarach*

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Mid September 2009

Overview of results

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Renovation achieved
Annual average in trees alone

(mg/l)	In	Out	% reduction
BOD	56	29	48
COD	214	115	46
N	35	17	51
P	8.5	5.7	34
K	3.9	3.3	15

Yield increase from grey water over control

	% over control	Dry biomass t/ha (18 months)
Poplar	54	22.1
Eucalyp	143	18.2
Melia	321	21.2
S. alba	274	9.4

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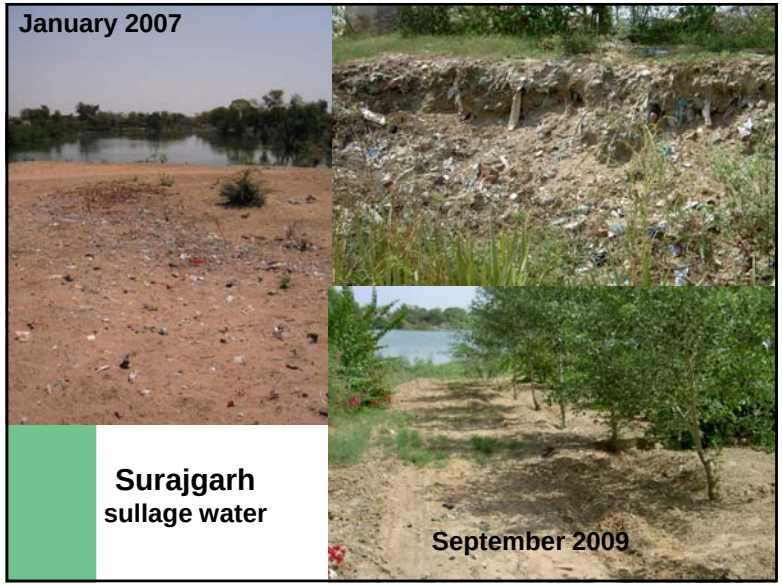

Closing comments

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- Combining wood fuel production with wastewater reuse addresses two problems common across India – energy & water quality
- Native species are more robust where management input is likely to be limited
- High yielding species may yield better returns where time investment can be made and the fibre market targeted
- High end user acceptability of the approach

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Thank you

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