Safe and sustainable utilisation of coal / bagasse ash in agroecosystems as soil amendment and for crop protection

Dr. B. Lalljee

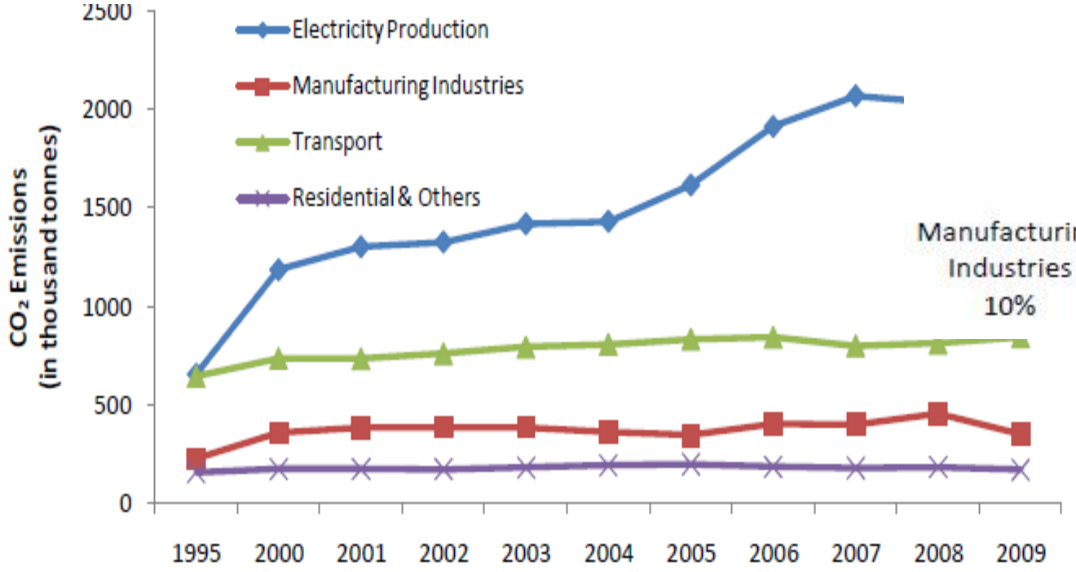
Director, CCRC

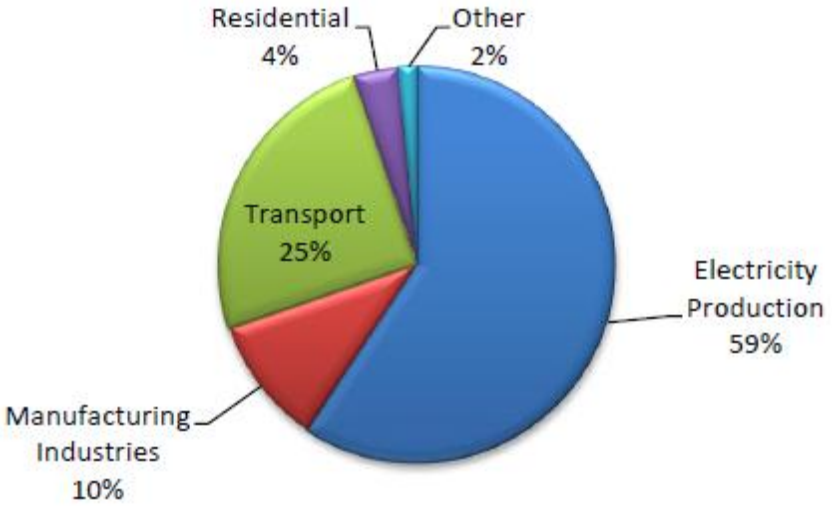
University of Mauritius

Background

Climate change is a global phenomenon affecting all countries, but with greater impact in Sub-Saharan Africa and the SIDS.

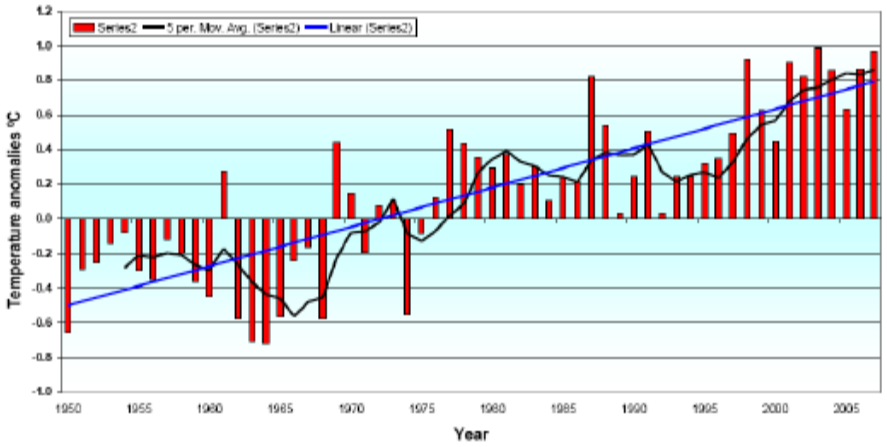
In Mauritius, the main GHG emitted is CO_2, which arises from the combustion of fossil fuels for electricity production, industrial processes and transport.



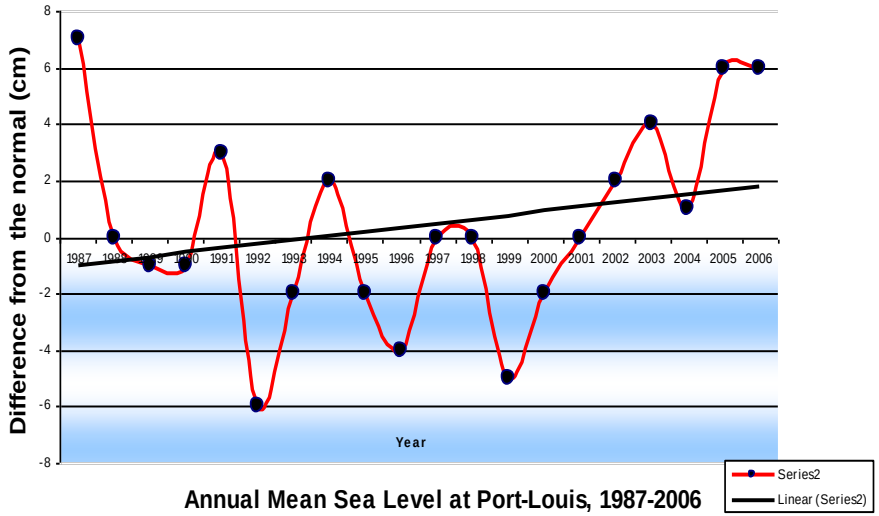


CSO - Digest of Environment Statistics, 2009

In Mauritius, the impacts of climate change are already apparent through increasing temperatures, reduced rainfall, rising sea levels, beach erosion, increase in frequency and intensity of extreme weather events, droughts, etc.



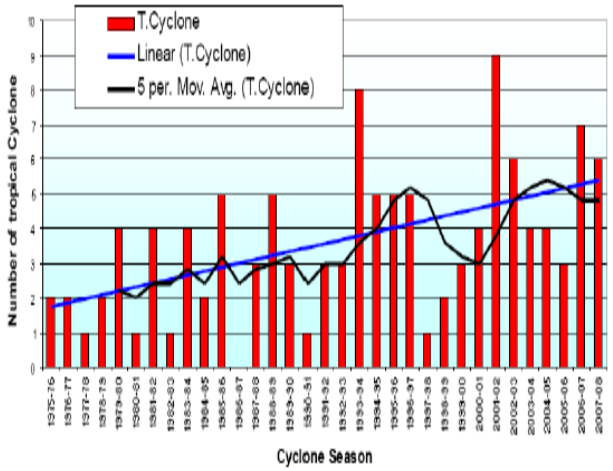
Temperature variation at Plaisance



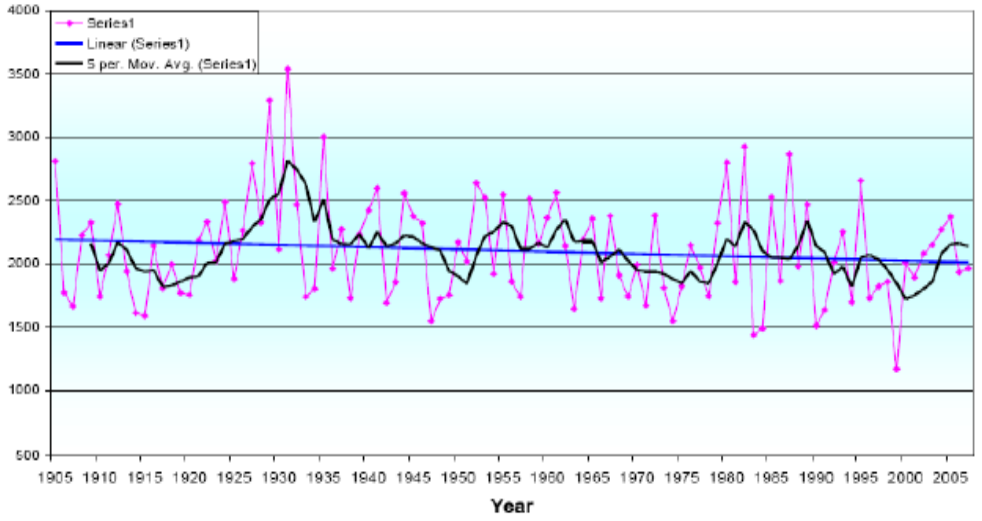
Annual Mean Sea Level at Port-Louis, 1987-2006

Source: Meteorological Services, March 2009

Sea level rise



Cyclones with gusts over 165km/hr *Source: Meteorological Services, March 2009*



Mean annual rainfall

Source: Meteorological Services, March 2009

Climate Change Adaptation and Mitigation

- Government is investing in activities that reduce the country's vulnerability, and increase resilience, to climate change.
- These measures include adoption of renewable energy, improving energy efficiency, adaptation projects in various sectors, and increasing carbon sinks.
- One such programme is being funded by the Govt of Japan under the Africa Adaptation Programme on Climate Change (AAP).
- One aspect of the AAP is research aimed at integrating and mainstreaming climate change adaptation into the national institutional framework and into core development policies, strategies and plans.
- One area of such research is the development of sustainable methods for:
  - energy production, including increased use of renewable sources of energy (e.g. bagasse, wind, solar), and
  - utilisation of the by-products from coal-based energy production.
- Both coal and bagasse produce large amounts of ash, which must be reutilised, or disposed of, in a sustainable manner.

Extent of the Problem

- Total fuel inputs in Mauritius : 50.4% coal, 27.7% bagasse and 21.4 % fuel oil (Long Term Energy Strategy, 2009).
- Energy from coal and bagasse produces fly ash and bottom ash.
- Up to 30% ash can be produced depending on origin and quality of the coal.
- 70,500 t/yr coal ash generated in Mauritius.
- Will increase in coming years with increase in energy demand.
- The disposal of ash represents a potential environmental and health problem, if not done properly.

Ash

- Fly ash is the fine powder formed from mineral matter in coal (noncombustible matter & small amount of carbon) that remains from incomplete combustion.
- Bottom ash is a coarse, granular, incombustible byproduct at the bottom of the furnace that burns the coal.

- Some farmers in Mauritius practice adding ash to their fields.
- However, it is not advisable to do so indiscriminately without regard to the type of soil, composition of the ash, soil biodiversity, climatic conditions, land use, etc.
- Hence there is a need to conduct site-specific investigations, to enable optimum and safe use of ash in agriculture.

- Ash is composed of a large number of minerals, including some trace elements needed for crop growth – Fe, Zn, Cu, Mn and Mo, Si (Lalljee, 2006, 2008).
- The physical abrasiveness of ash enables its use for controlling soft-bodied, crawling pests (Facknath and Lalljee, 2005).
- Mauritian soils are acidic, and given its ability to increase the pH of soils, ash can be a potentially good soil amendment.
- Its multivalency improves soil structure for better aeration and percolation.

Present Project

- Investigate the potential of using coal/ bagasse ash safely :
  - For improving physical, chemical and biological properties of soil for crop growth;
  - For controlling pests such as snails, slugs, millipedes, and insects;
  - As a soil conditioner to increase plant availability of some essential nutrients.
- Duration : 2 years as from 2012.
- Test Crops : potato, maize, cabbage.

Activities

- Analyses of the chemical, physical, biological and biochemical properties of ash, soil, ash-amended soil, and plants grown in ash-amended soil.
- Study of the pest control potential of ash addition to soil through direct, soil-mediated and plant-mediated impacts.
- Analyses of leachate and crop harvest for environmental effects.
- Development of metabolic profile of ash-amended soils using community level physiological profiling (CLPP).
- Modeling of experimental and economic data for sensitivity and risk analysis.

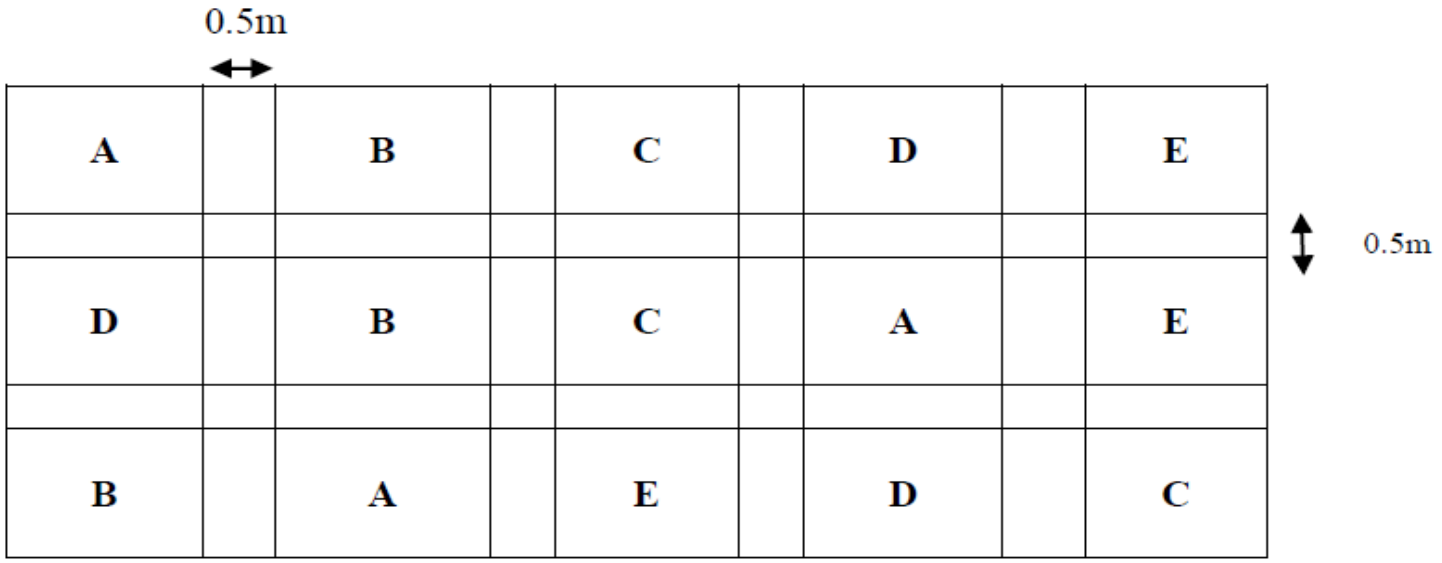
Experimental Work

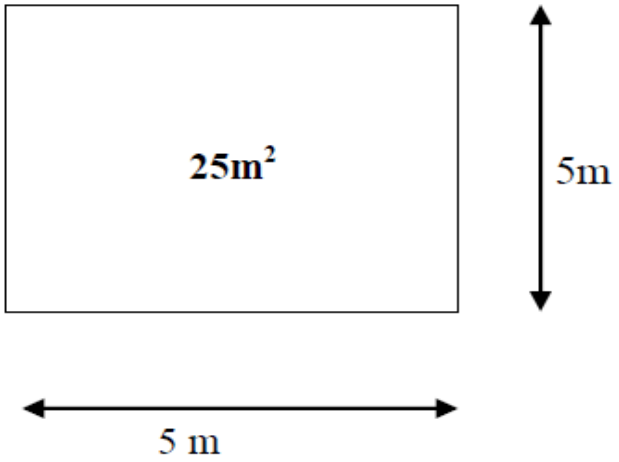
- Potted experiments
- Field trials on University Farm

Potted Experiments

- 2 kg soil per pot.
- With and without NPK fertilisers.
- Amended with ash at 0 t/ha, 5 t/ha, 10 t/ha, 20 t/ha, 30 t/ha, and 40 t/ha.
- Planted with potato/ maize.
- Same amount of water in all.
- Analyses of selected soil and plant parameters.

Field Layout





Treatments:

A – Ash (no fertiliser)
B – Fertiliser + 0 t/ha ash
C – Fertiliser + 10 t/ha ash
D – Fertiliser + 20 t/ha ash
E – Fertiliser + 40 t/ha ash

Ash Analysis

pH	Molybdenum
Particle size	Boron
Phosphorus	Aluminum
Potassium	Carbon
Zinc	Mercury
Copper	Chromium
Iron	Cadmium
Manganese	

Soil Physical Properties

Bulk density	Aggregate stability
Particle density	Colour
Porosity	Texture
Water holding capacity	Structure
Infiltration rate	Aggregate size index

Soil Chemical Properties

pH	Zinc
Electrical Conductivity	Iron
Redox Potential	Manganese
Available N	Chromium
Available P	Cadmium
Available K	Lead
Copper	Aluminum
Mercury	

Soil Biological Properties

BOD	COD
Total bacterial and fungal counts	Earthworms
Insects	Snails and slugs
Nematodes	Mites
N-fixing bacteria	Microbial biomass
P-solubilising bacteria and fungi	Respiration rate
C-mineralisation	N-mineralisation

Crop Protection

Pest incidence	Pest abundance
Pest response and behaviour	Extent of crop damage

Crop Growth and Yield

Shoot growth and biomass	Root growth and biomass
Plant nutrient uptake	Quantitative and qualitative yield
Dry matter content	Keeping quality

Community Level Physiological Profiling (CLPP)

Microbial community structure analysis using Density Gradient Gel Electrophoresis (DGGE)	Functional diversity information (from published literature)

Environmental Effects

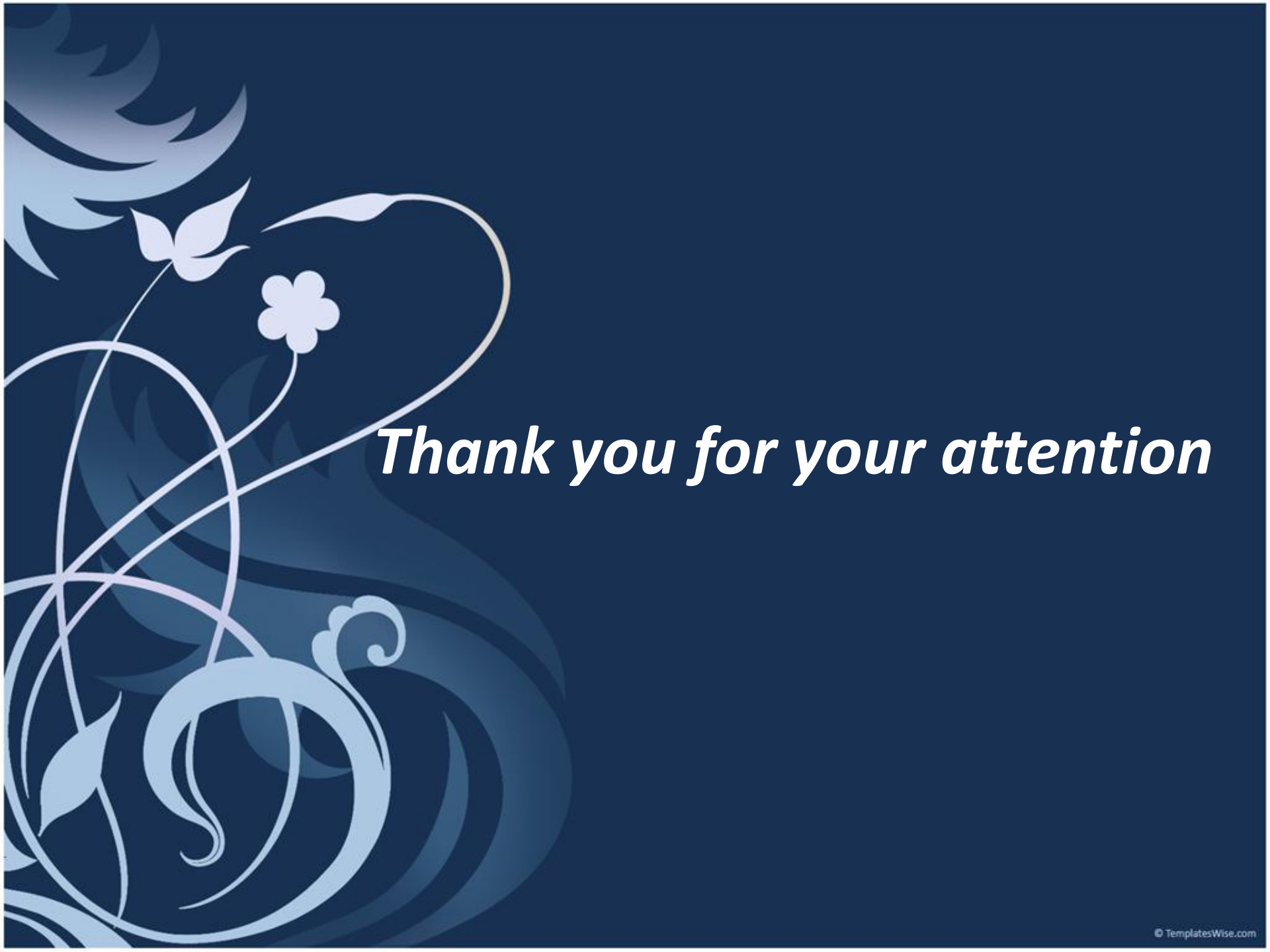
Heavy metal levels in leachate	Heavy metal levels in harvested produce
Dissolved organic C in leachate	

Completed/Ongoing

- A Project Assistant has been recruited.
- Ash has been obtained from FUEL.
- Ash has been analysed.
- Soil has been analysed.
- Potted experiments have been laid out.
- Field plots have been laid out.
- Analytical data obtained so far is being analysed.

In conclusion, the project will provide:

- A quantitative/statistical analysis of the economic and environmental effects of ash use.
- An avenue to convert a waste/by-product into a valued product having significant economic and market value.
- A potential avenue for increase in revenue of flexi-factories and the CEB from the proceeds of sale of the ash.
- An avenue for an economic linkage between flexi-factories, farmers, and SMEs.
- A solution to the problem of ash disposal
- A contribution towards Government's commitment for sustainable development in line with the principles of MID.
- A contribution towards Government's commitment to satisfy its obligations under the various conventions it is party to, e.g. the Kyoto Protocol, the UNFCCC, UNCCD, MDGs, etc.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