

Anaerobic Digestion in Integrated Biosystems

Paul Harris

Lecturer,
Agronomy & Farming Systems
The University of Adelaide

Introduction

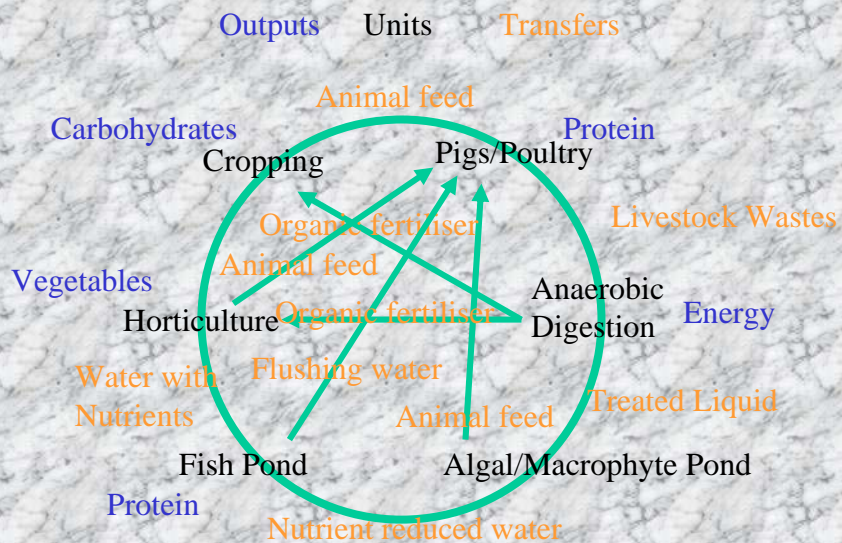
- We are facing difficulties with “waste” disposal, water supply, greenhouse gases and fuel supply as well as food production.
- Community attitudes are changing.
- “Integrated Biosystems” describes a system of inter-related components.

Integrated Biosystems

- Look at a supply/production/processing/use system
- Realise that the waste from one unit is a resource that can be utilised elsewhere
- Emphasise biological solutions to waste problems
- Can be applied in a wide range of situations

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Example Integrated Biosystem



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Small Scale - Backyard



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Village Scale - Montfort Boys Town, Fiji



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Commercial Scale - Berrybank Farm



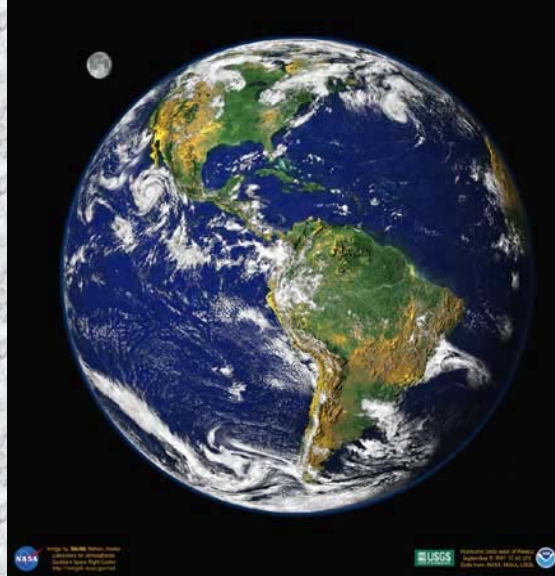
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Regional Scale - Bolivar



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World Scale - Planet Earth



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WASTE

- **A RESOURCE in the WRONG PLACE.**
- **By-product or Secondary resource.**

ETSAW

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Anaerobic Digestion

- Anaerobic digestion is a naturally occurring bacterial process
- Methane and Carbon Dioxide are produced from organic matter when no oxygen is present
- Methane is a fuel - the main constituent of natural gas

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Alternatives to Anaerobic Digestion

- Aerobic Digestion
 - aeration requires energy
- Composting
 - produces low grade heat
- Incineration
 - heat may be utilised
- Gasification
 - fuel gas from dry wastes

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Anaerobic Digesters

- Many types of digester are available
 - Upflow Anaerobic Sludge Blanket

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Anaerobic Digesters

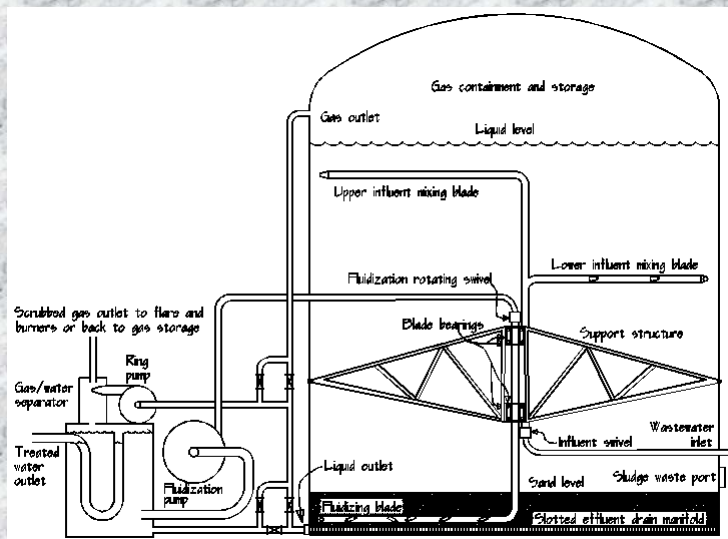
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 - Upflow Anaerobic Sludge Blanket
 - Continuous Flow Stirred Tank

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Continuous Flow Stirred Tank Digester at Roseworthy Campus.

Heated and stirred for high rate operation.



High Rate Digester by "NewBio"

Anaerobic Digesters

- Many types of digester are available
 - Upflow Anaerobic Sludge Blanket
 - Continuous Flow Stirred Tank
 - Plug Flow

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Plug Flow poly digesters

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Plug Flow Digester by “Practically Green”

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Anaerobic Digesters

- Both high tech and simple versions of some types are possible
- The main emphasis may be on waste treatment, energy production or both

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Advantages and Disadvantages of Anaerobic Digestion

- + Pathogen reduction
- + Improved handling
- + Better for direct land spreading (odour and crop damage)
- + Reduced sludge production
- Slow growth rate - larger system
- Poor breakdown of cellulose and lignin

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Design Philosophy

- A simple system will be easier to build, maintain and operate
 - every extra bit added should be easily justifiable
- The harder a system is pushed the more unstable it will become
 - a lightly loaded (natural) system will need little operator intervention

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Anaerobic Digestion

- Anaerobic Digestion is a biochemical reaction carried out in a number of steps by several types of bacteria.
- There is no oxygen present and methane gas (a fuel) is produced.
- The amount of gas produced varies with the amount of organic waste fed to the digester.
- The rate of decomposition (and gas production) is influenced by temperature. ²³

Applications of Anaerobic Digestion

The anaerobic digestion process has been applied to many agricultural and processing wastes, for example:

- Piggery effluent
- Poultry manure
- Beef and dairy cattle manure
- Olive oil mill waste
- Potato processing waste

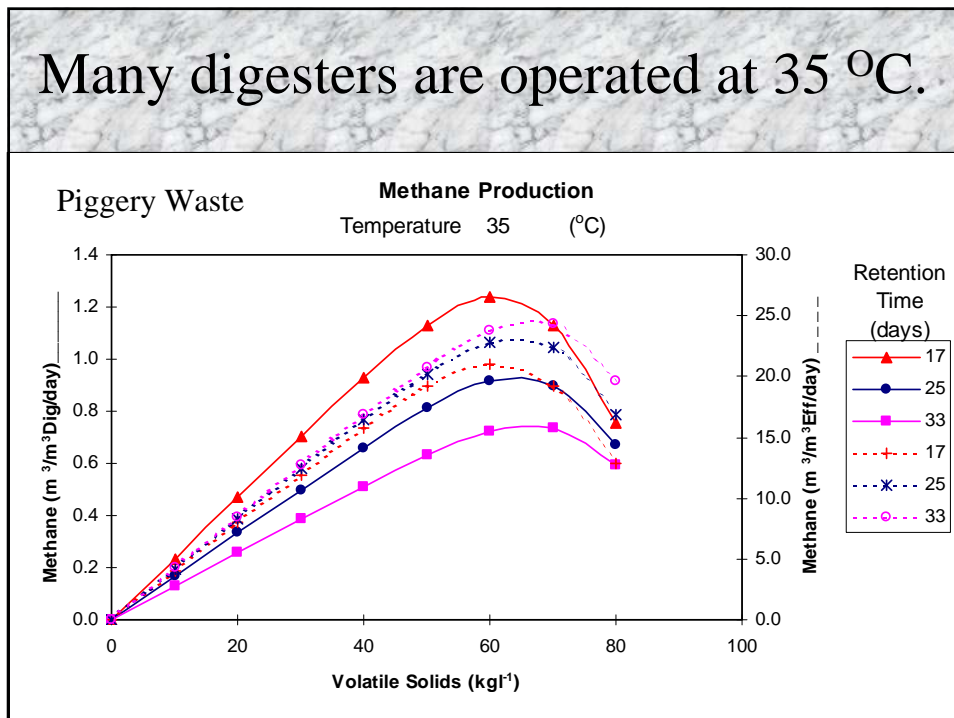
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Anaerobic Digestion Models

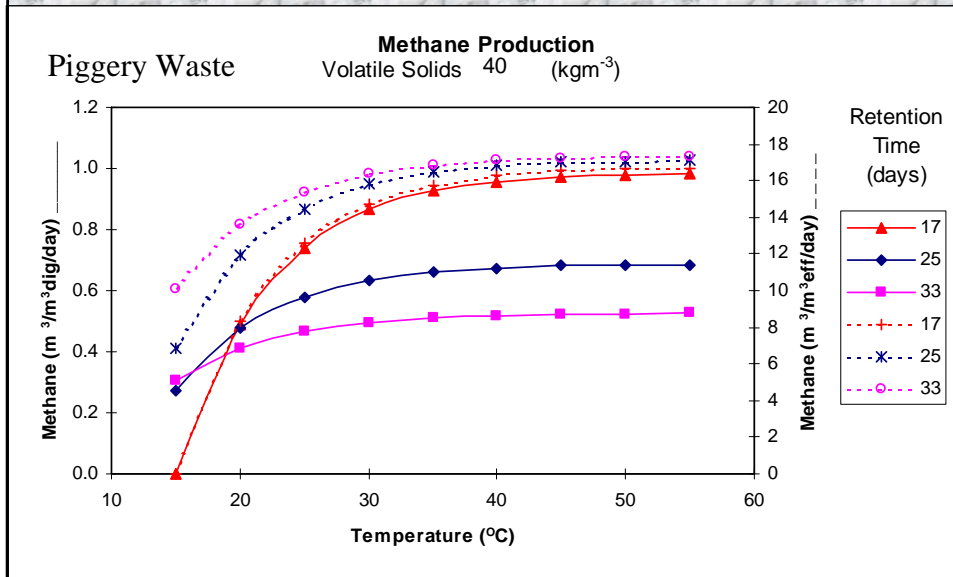
- Chen and Hashimoto proposed a simple model for continuous flow digesters which predicts the gas production rate at different temperatures for different loading rates.
- VS (volatile solids) is the amount of organic material in the waste.
- HRT (hydraulic retention time) is how long the waste is in the digester.

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Many digesters are operated at 35 °C.



For a given waste the VS is known, say 20 g l^{-1} .



Anaerobic Digester Sizing

- The temperature determines the HRT and hence the size of the digester.
- There is a trade off between temperature (complexity of heating) and size (cost).
- A run at ambient temperature ($12 \text{ }^{\circ}\text{C}$) and 30 day HRT gave 8 m^3 of biogas per day from the 60 m^3 digester.

Conclusions

- Anaerobic digestion can provide a reasonably low technology waste treatment process which provides both energy and organic fertiliser
- Integrated biosystems provide solutions to some of the problems facing society today, in both the developed and emerging nations
- Integrated biosystems are also very scalable, both in size and technological complexity