



# Anaerobic Digestion: Sustainable Organics Management

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# Dr. Ann C. Wilkie Bioenergy & Sustainable Technology

Biogas

Biomass

Bioenergy



## *Research:*

Anaerobic digestion technology for renewable energy production from biomass and organic residues, including food waste, livestock waste, bioethanol and biodiesel by-products, and energy crops.

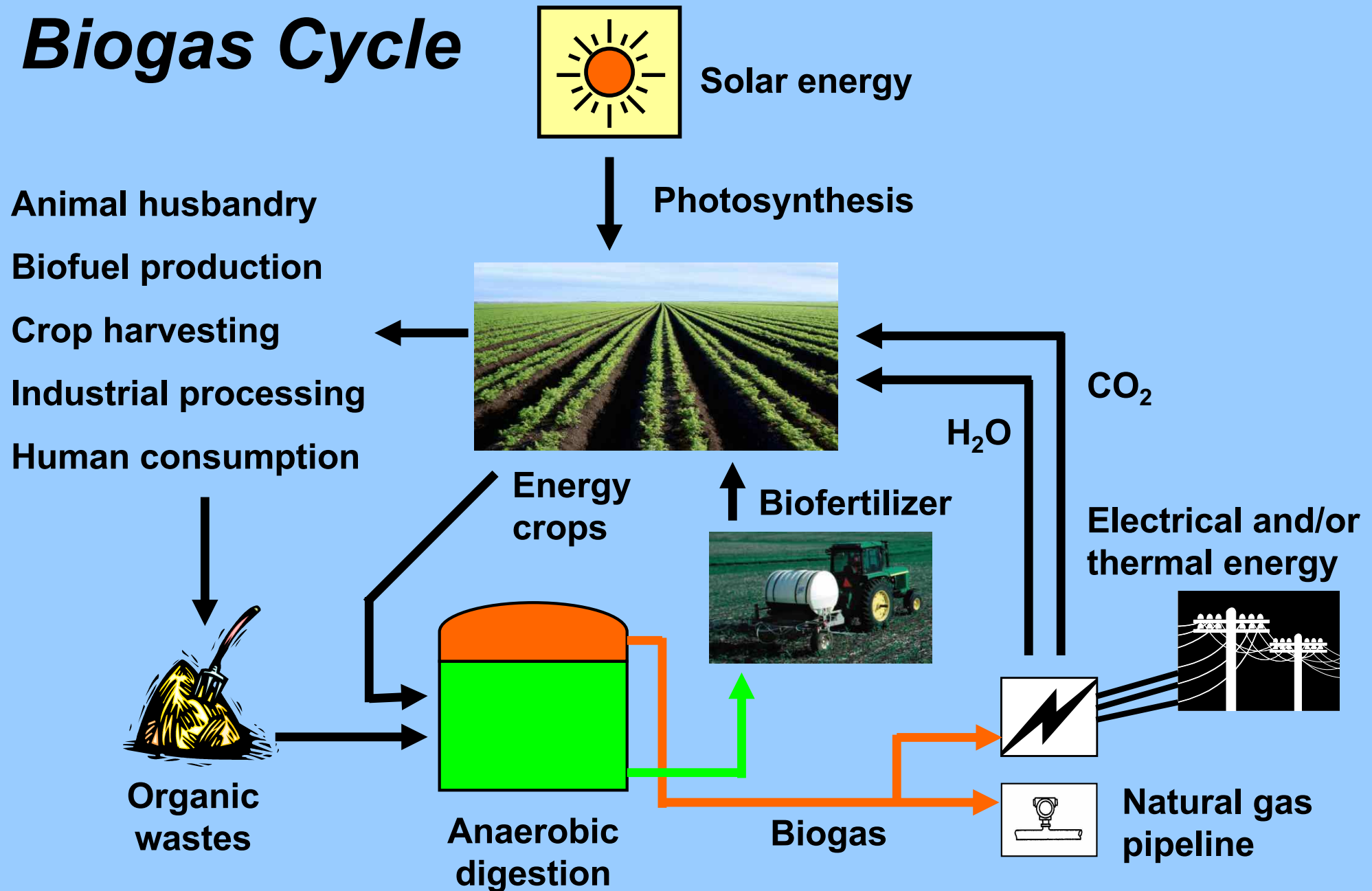
Bioprospecting for high-lipid producing algal strains and development of culturing techniques for lipid enhancement.



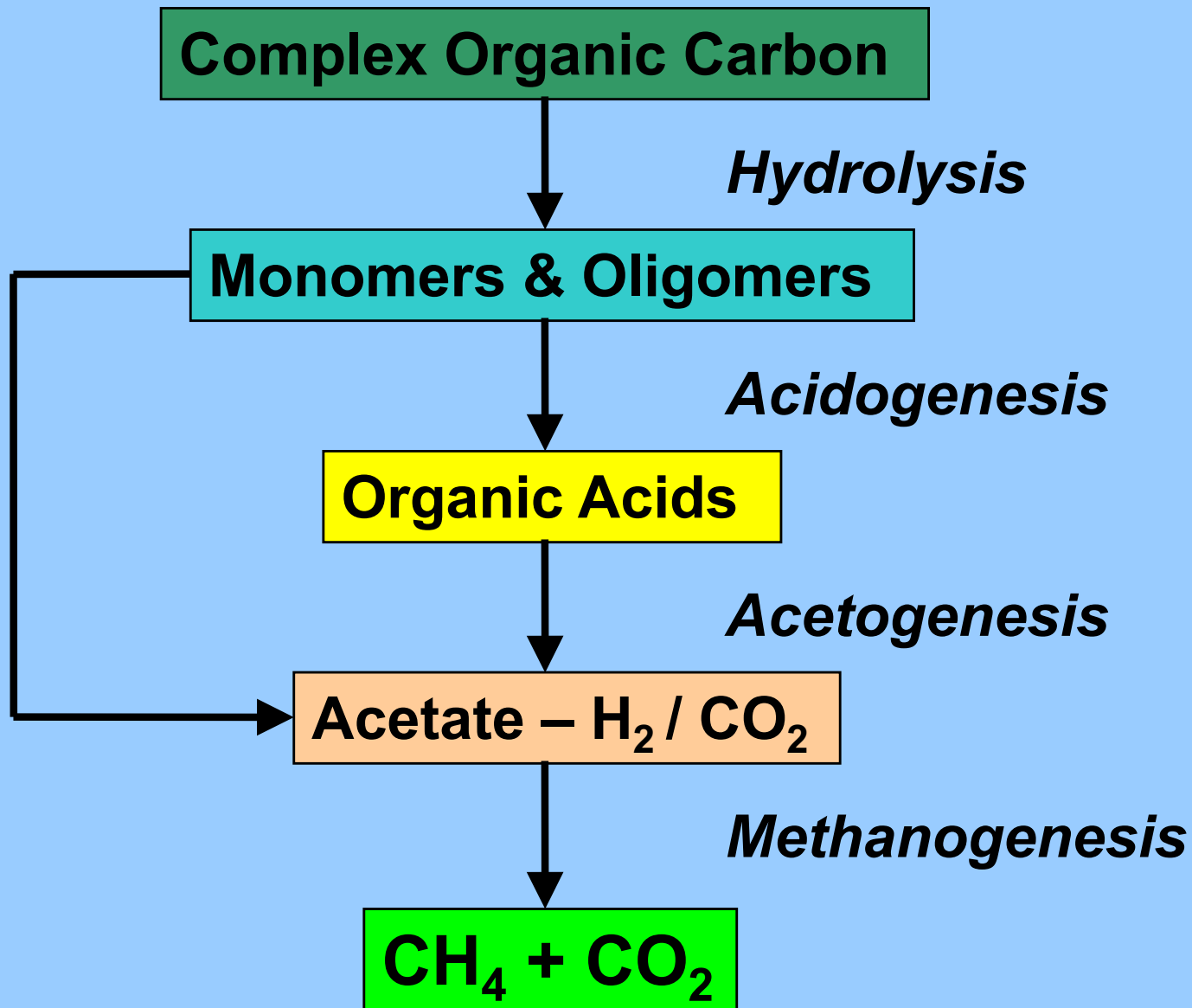
**Biodiesel  
from  
Algae**



# Biogas Cycle



# Anaerobic Digestion



# ***Feedstocks***

- **Animal manures**
- **Agro-Industrial wastewaters**
- **Municipal wastewaters**
- **Municipal solid wastes**
- **Biofuels by-products**
- **Energy crops / crop residues**

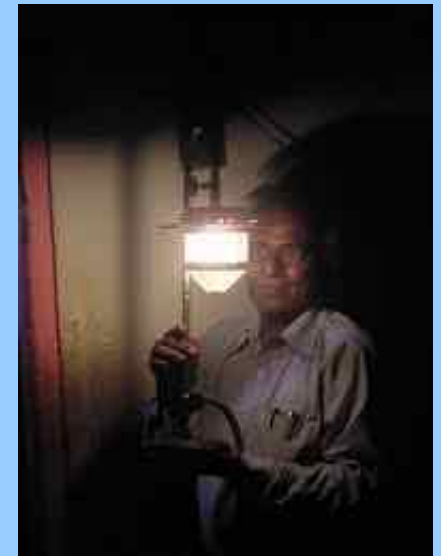
# ***Benefits of Anaerobic Digestion***

- **Renewable energy**
- **BOD/COD reduction**
- **Odor reduction**
- **Pathogen reduction**
- **Nutrient conservation**
- **Greenhouse gas reduction**



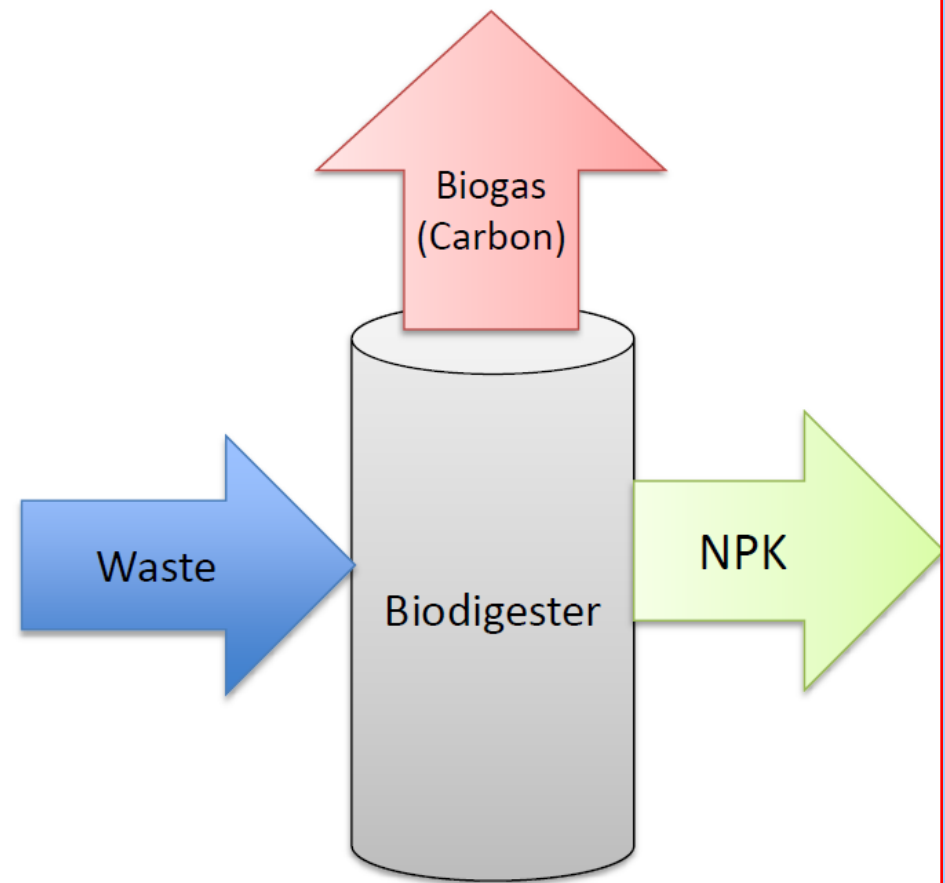
# Biogas Use

- Cooking
- Heating (water/space/greenhouse)
- Electricity
- Lighting
- Vehicle fuel



# Renewable fertilizer from anaerobic digestion

- Microbial degradation of organic matter
- Recycles plant nutrients and produces energy (biogas)
- Offsets the need for synthetic fertilizer





# NUTRIENT MANAGEMENT

- **Land application is the most sustainable option**
- **Nitrogen**
  - **Haber-Bosch process is energy intensive**
- **Phosphorus**
  - **Finite resource**

# Integration with Composting

- Biofertilizer can be incorporated into existing composting systems
- Low C:N ratio of biofertilizer improves biodegradability of high carbon material (e.g. woody waste, paper)
- Helps return carbon to soil





# ***Food Waste in Florida***

- **1.75 million tons generated annually**
- **Only 3% is recycled**
- **Most is currently landfilled**



# Food Waste

- Food waste is generated throughout the community

- Farms
- Food processors
- Grocery stores
- Restaurants
- Schools
- Hotels
- Prisons
- Households





# ***Composition of Food Waste***

- **High moisture content**
- **Contains valuable plant nutrients**
- **Potential feedstock for biofuels**

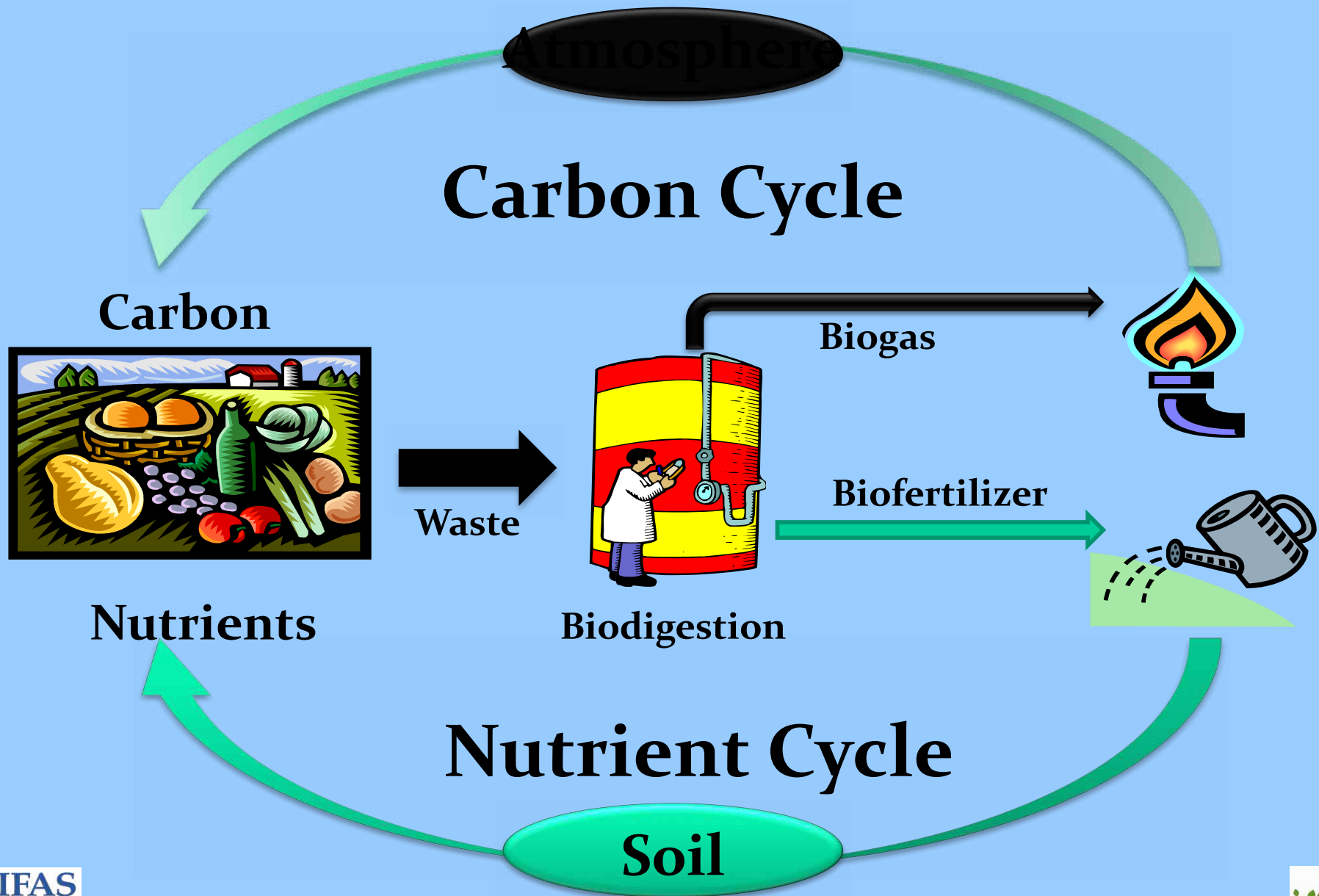


# ***Benefits of Anaerobic Digestion of Food Waste***

- **Diverts waste from landfills**
- **Reduces landfill GHG emissions**
- **Reduces pollutants and total volume of leachate**
- **Produces renewable energy ~ biogas**
- **Recovers valuable nutrients**
- **Reduces transportation costs and emissions when food waste is digested locally**



# Closed-loop process



# ***AD OPTIONS***

- **On-site Digester**
- **Regional or Centralized Digester**
  - **Economies of scale**
  - **Co-digestion**
  - **Nutrient recovery and sales**
  - **Community involvement**



# Anaerobic digesters







## National Biodigester Programme Cambodia (July 2010)







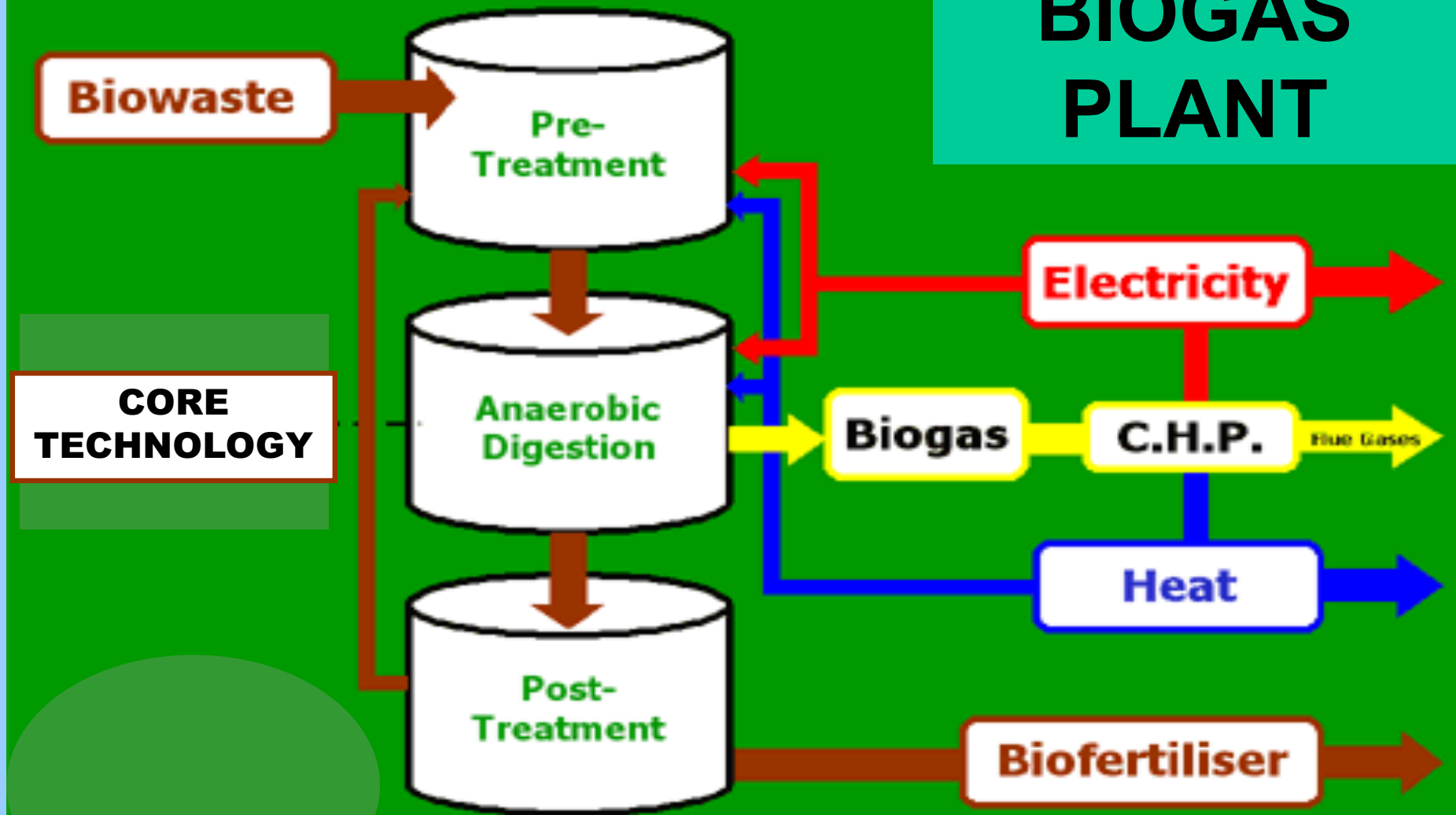






**Onions grown with ADE as the sole fertilizer source yield large full bulbs.**

# BIOGAS PLANT





# East Bay Municipal Utility District Oakland, California



EBMUD's wastewater  
treatment plant, Oakland



Anaerobic Digesters

# ***Food Waste Delivery***

## **East Bay Municipal Utility District**















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