INTEGRATED PLANNING TOOL FOR OPTIMISING BIOENERGY PRODUCTION FROM REGIONAL BIOMASS WASTE

AND ITS APPLICATION IN THE MURRUMBIDGEE IRRIGATION AREA, AUSTRALIA



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Challenges in managing regional biomass waste in Australia

Climate change

- Australia is the highest GHG polluter (per capita) in the world
- Key contributor in Australia is CO_2 from burning fossil fuels for power generation
- A modest Mandatory Renewable Energy Target (MRET) requiring generation of 9,500 GWh of ‘new’ renewable electricity per year (less than 2%) by 2010
- A number of State governments now have an additional renewable target; e.g. 10% in Victoria

Challenges in managing regional biomass waste in Australia

- **Nutrient management.**
- **Heavy metal contamination in food and biomass residue esp. Cd.**
- **Non-sustainable biomass waste management**

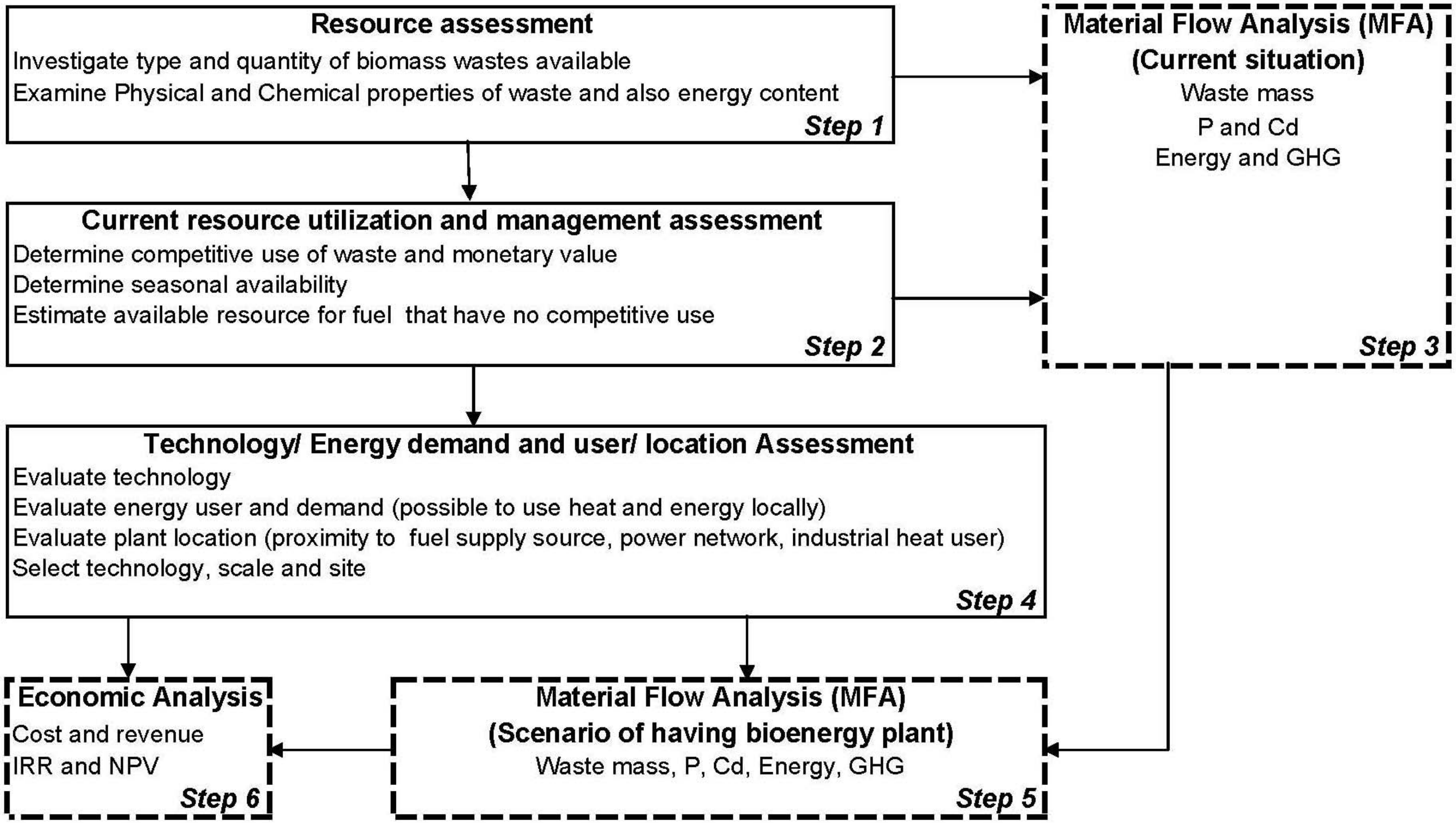
  - Biomass waste are spread on land without any pretreatment

  - Currently only small energy and nutrient recovery from biomass waste.

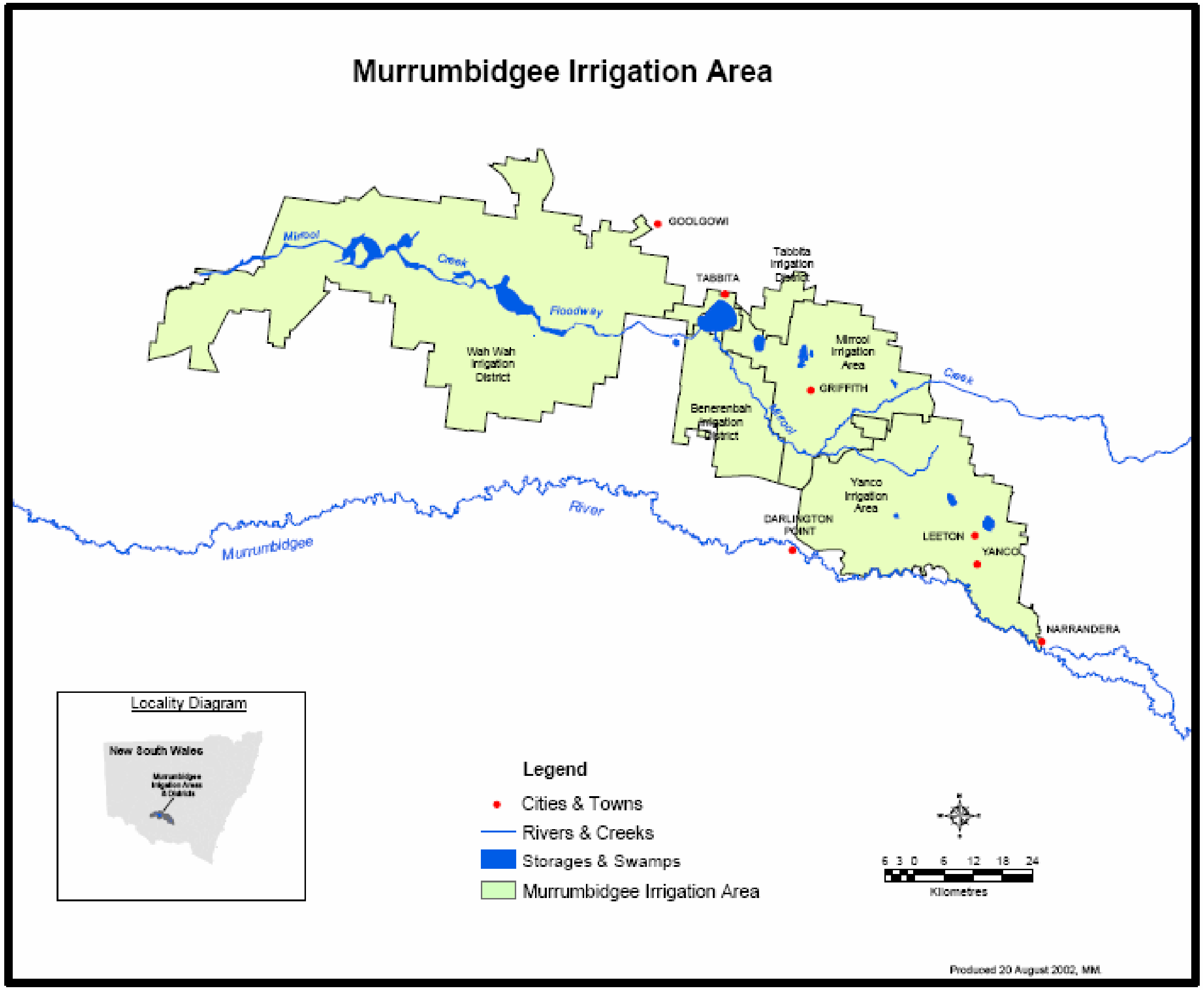
Aim

- To develop a Decision Support Tool to optimise nutrient and energy recovery from various kinds of biomass waste and also minimise cadmium contamination in Australian context.
- Key Issues
  - Material Flows (Types + Location)
  - Energy potential + Conversion
- Application to Murrumbidgee Irrigation Area (MIA)
  - Analysing current biomass waste management
  - Scenario for enhanced energy + nutrient recovery

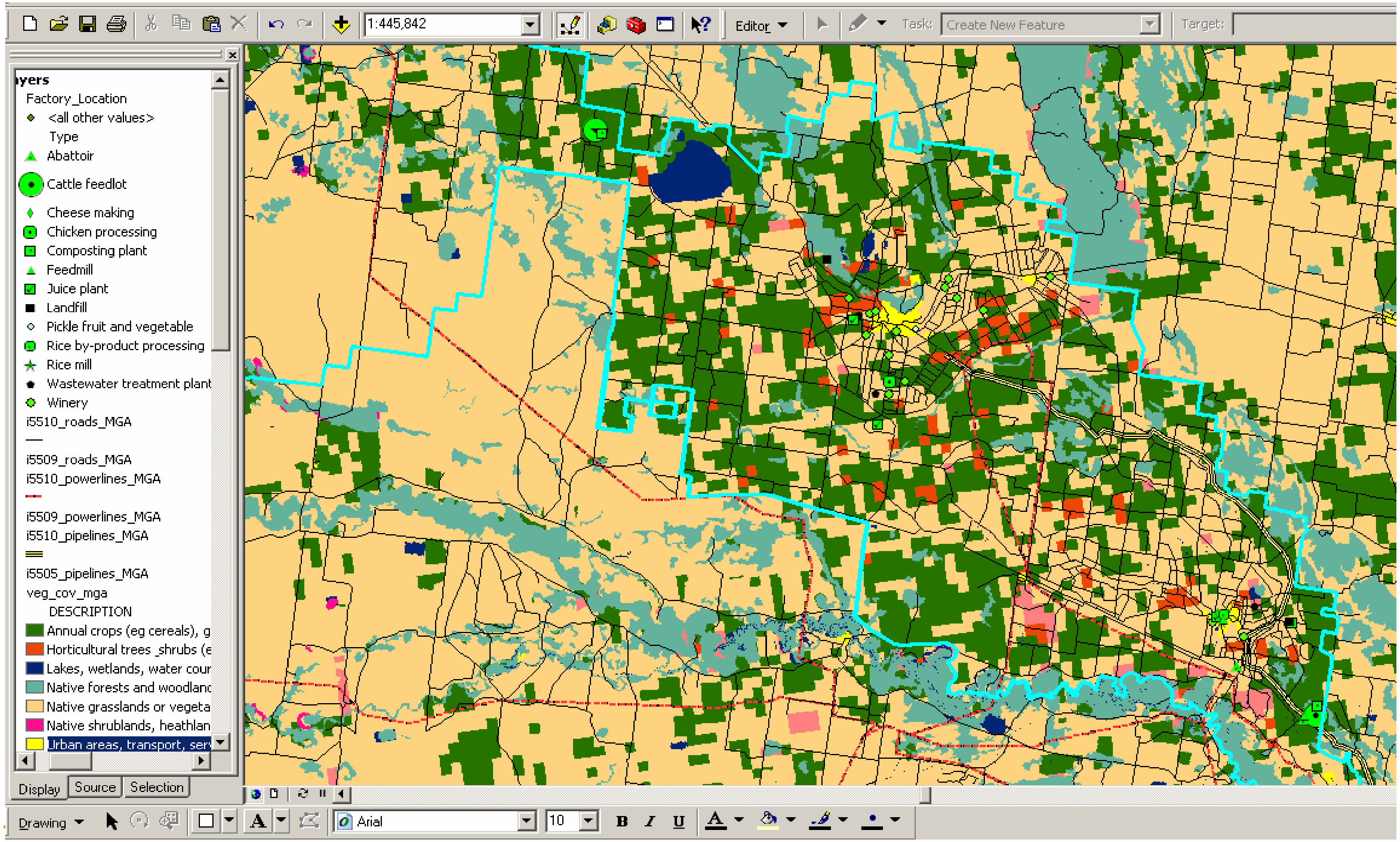
Methodology



Murrumbidgee Irrigation Area (MIA)



GIS model



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Layers
Factory_Location
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Cattle feedlot
Cheese making
Chicken processing
Composting plant
Feedmill
Juice plant
Landfill
Pickle fruit and vegetable
Rice by-product processing
Rice mill
Wastewater treatment plant
Winery
i5510_roads_MGA
i5509_roads_MGA
i5510_powerlines_MGA
i5509_powerlines_MGA
i5510_pipelines_MGA
i5505_pipelines_MGA
veg_cov_mga
DESCRIPTION
Annual crops (eg cereals), g
Horticultural trees _shrubs (e
Lakes, wetlands, water cour
Native forests and woodlanc
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Display
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Selection
Drawing
Arial
10

Biomass waste in MIA

- **Food industries by-products :**

  Grape marc, fruit peel and pulp, rice husk and rice bran, whey and meat processing by-products.

- **Animal waste**:

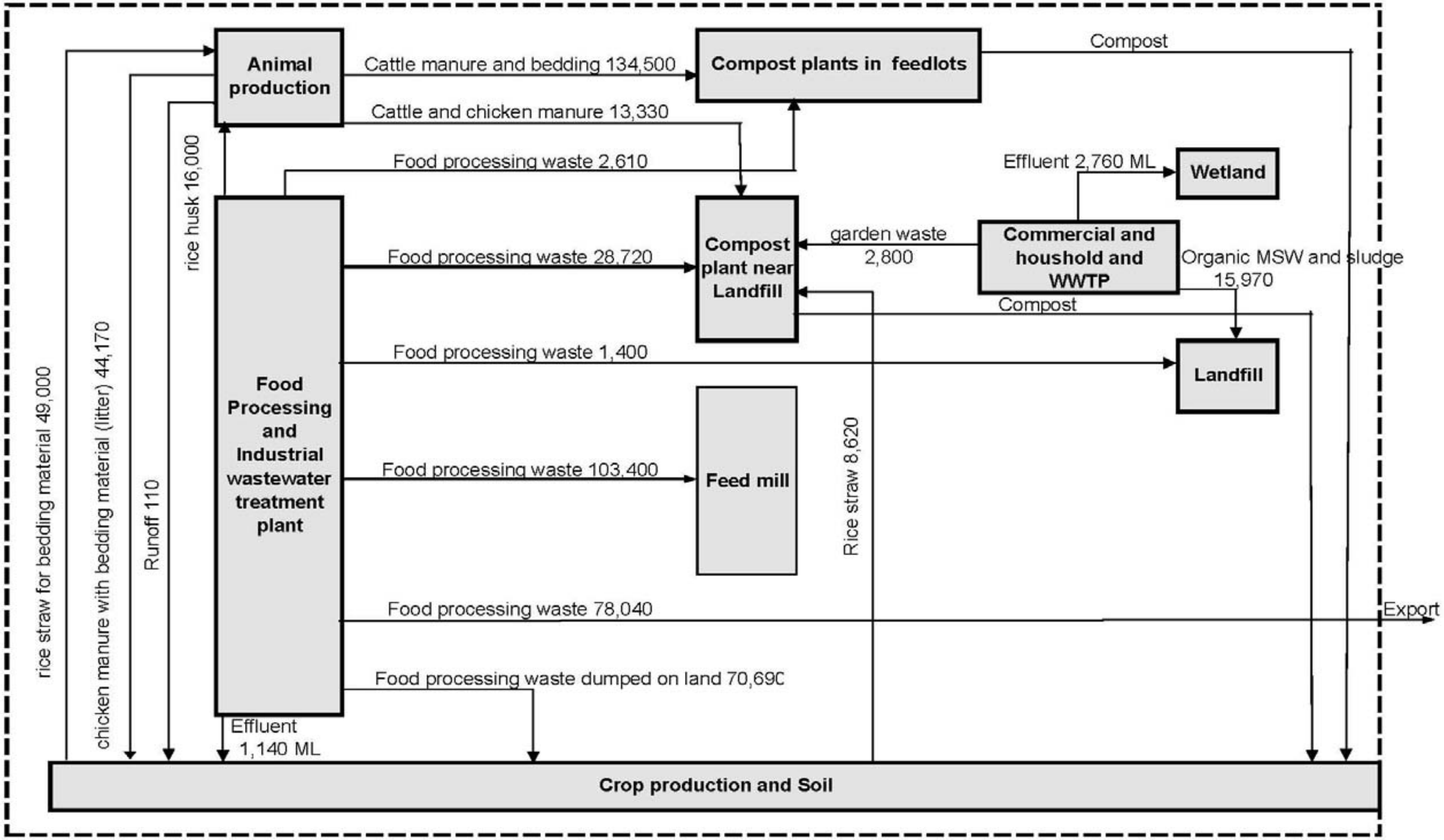
  Chicken litter, Feedlot cattle manure, Cattle abattoir by-products and Chicken processing by-products.

- **Municipal and commercial waste**:

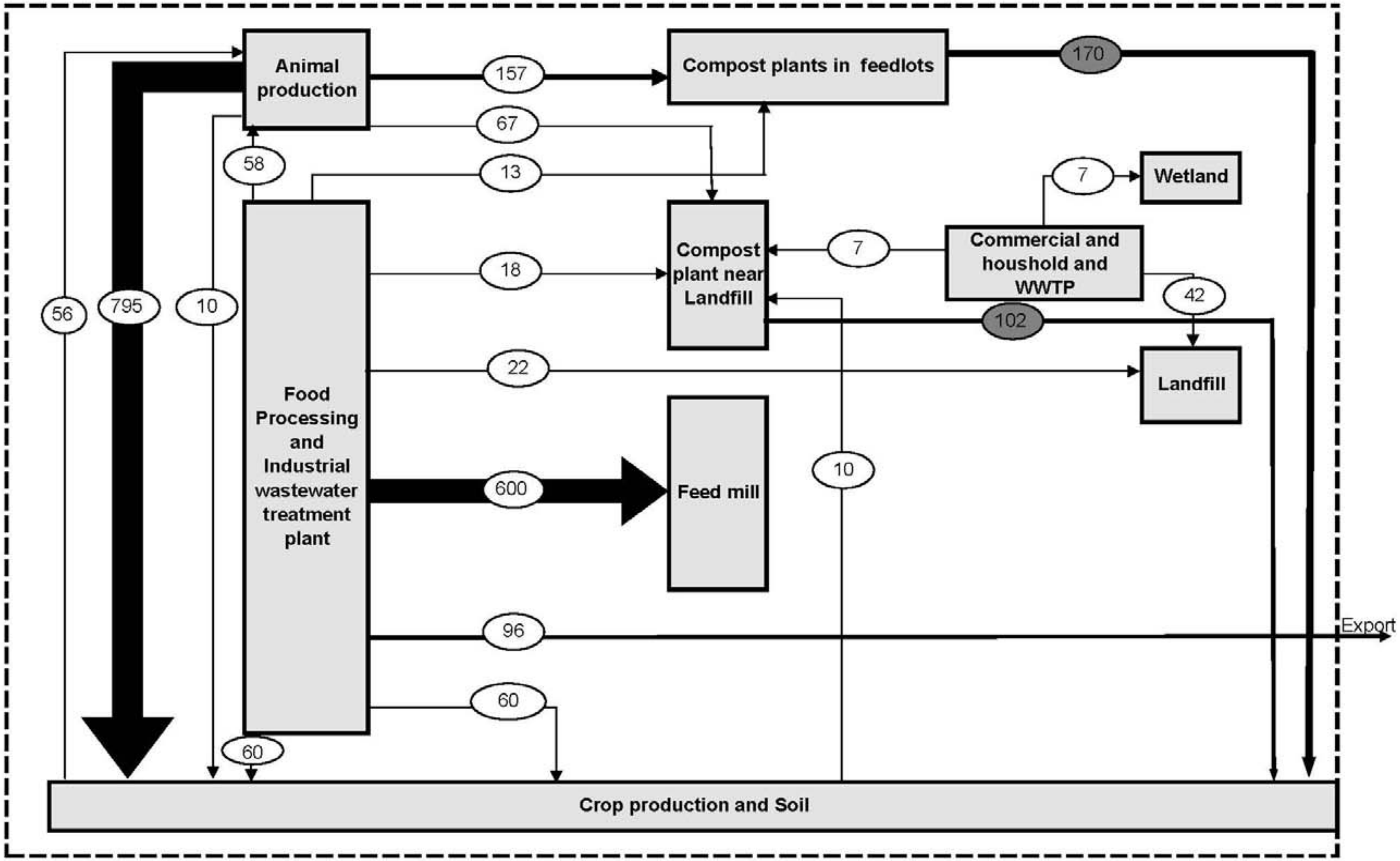
  Kitchen waste, garden waste, and sewage sludge.

Current biomass waste flow in 2006 (Tonnes/y)

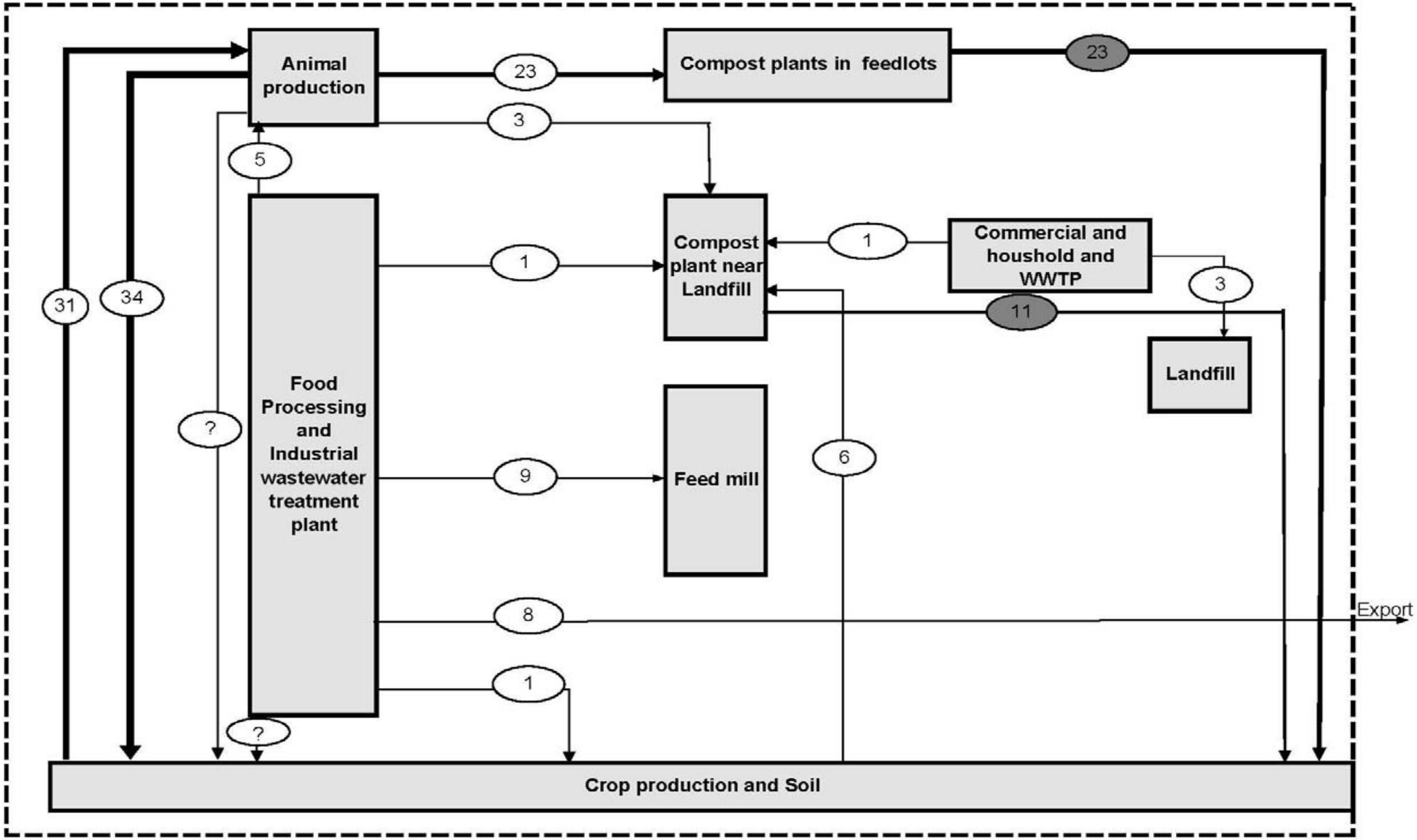
(Raw material inputs and product outputs not included in subsystem)



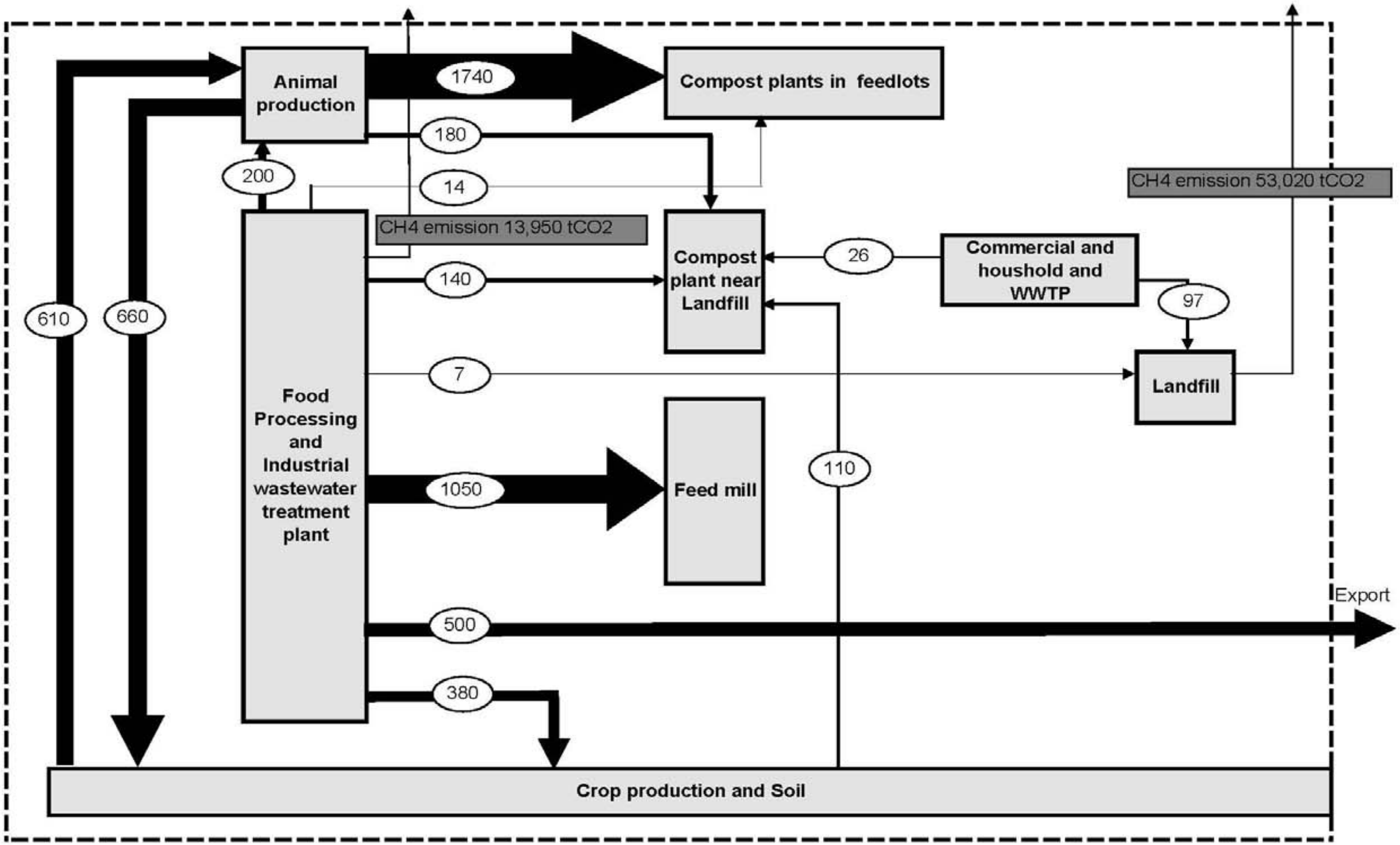
Current P flow in biomass waste in 2006 (Tonnes/y)



Current Cd flow in biomass waste in 2006 (kg/y)



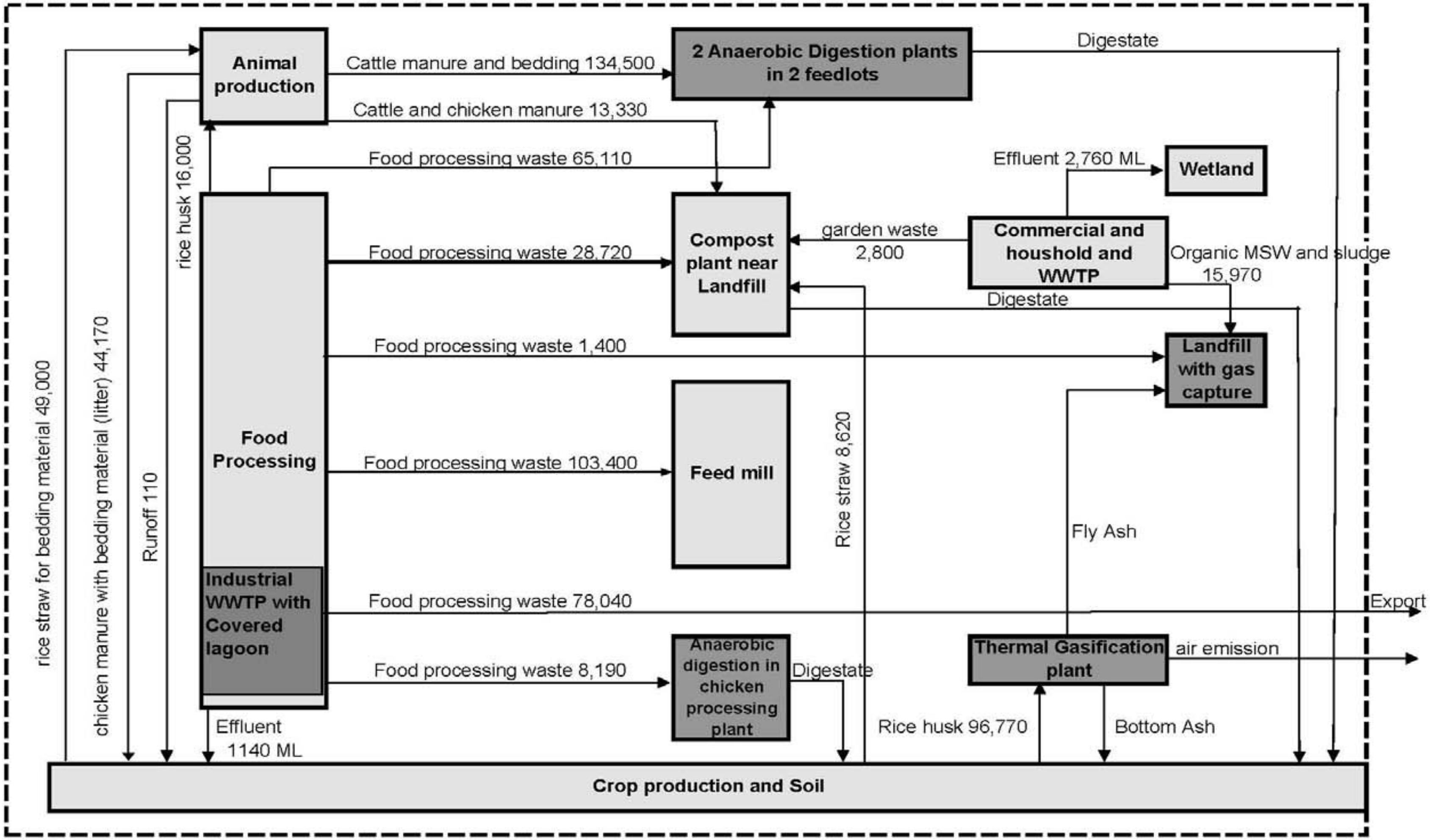
Energy content flow in unprocessed biomass waste in 2006 (TJ/y)



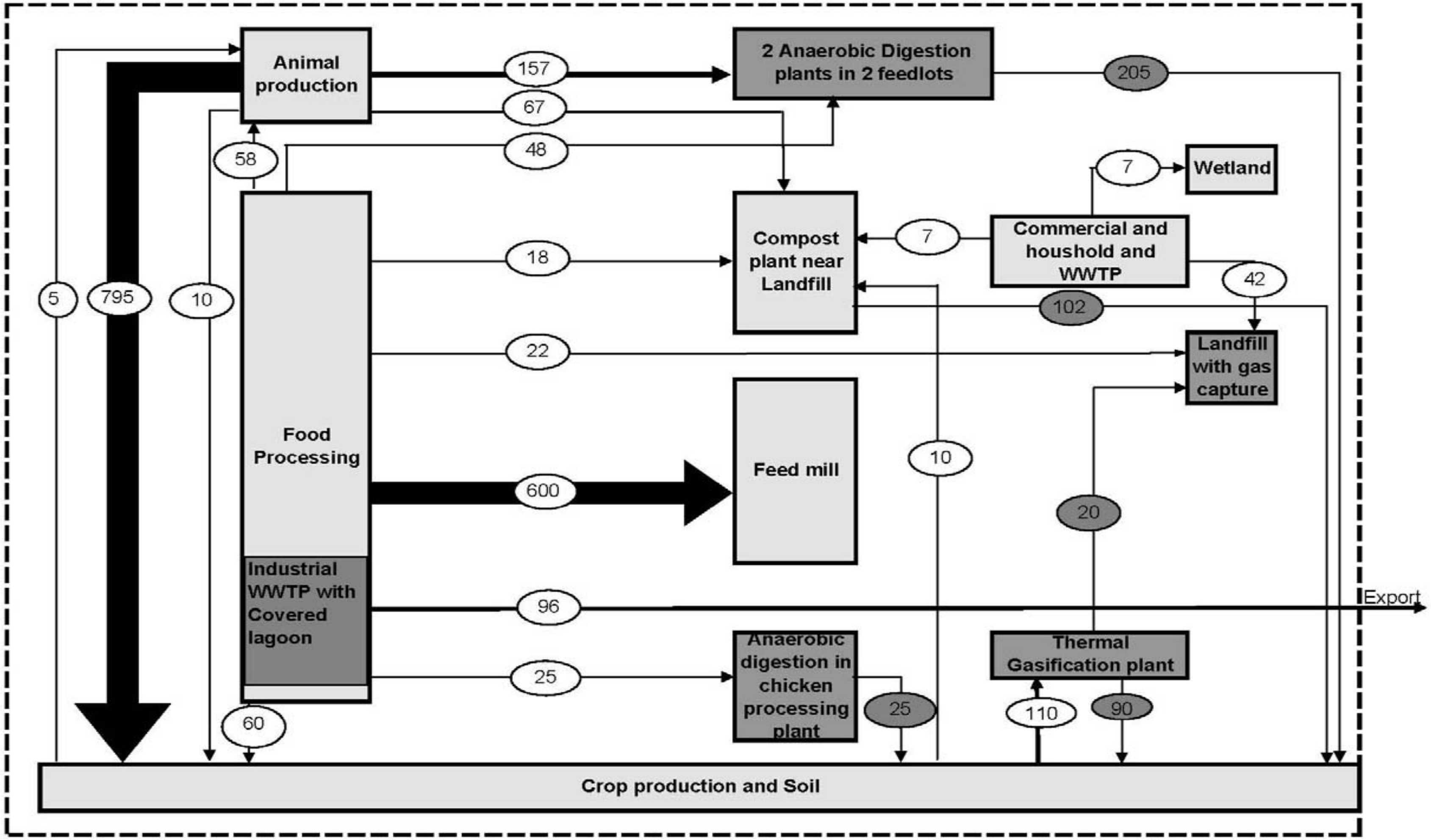
A scenario for greater recovery of both energy and nutrient from biomass waste in the MIA

- Change compost plants in feedlot to anaerobic digesters and produce electricity and recover heat and also anaerobic compost.
- Divert food waste dumped on land to anaerobic digester in feedlot.
- Have anaerobic digester to process DAF sludge from chicken processing plant and produce biogas to replace current natural gas use.
- Capture landfill gas and produce electricity.
- Capture gas from anaerobic lagoon and produce electricity.
- Have rice straw gasification plant to produce electricity and heat

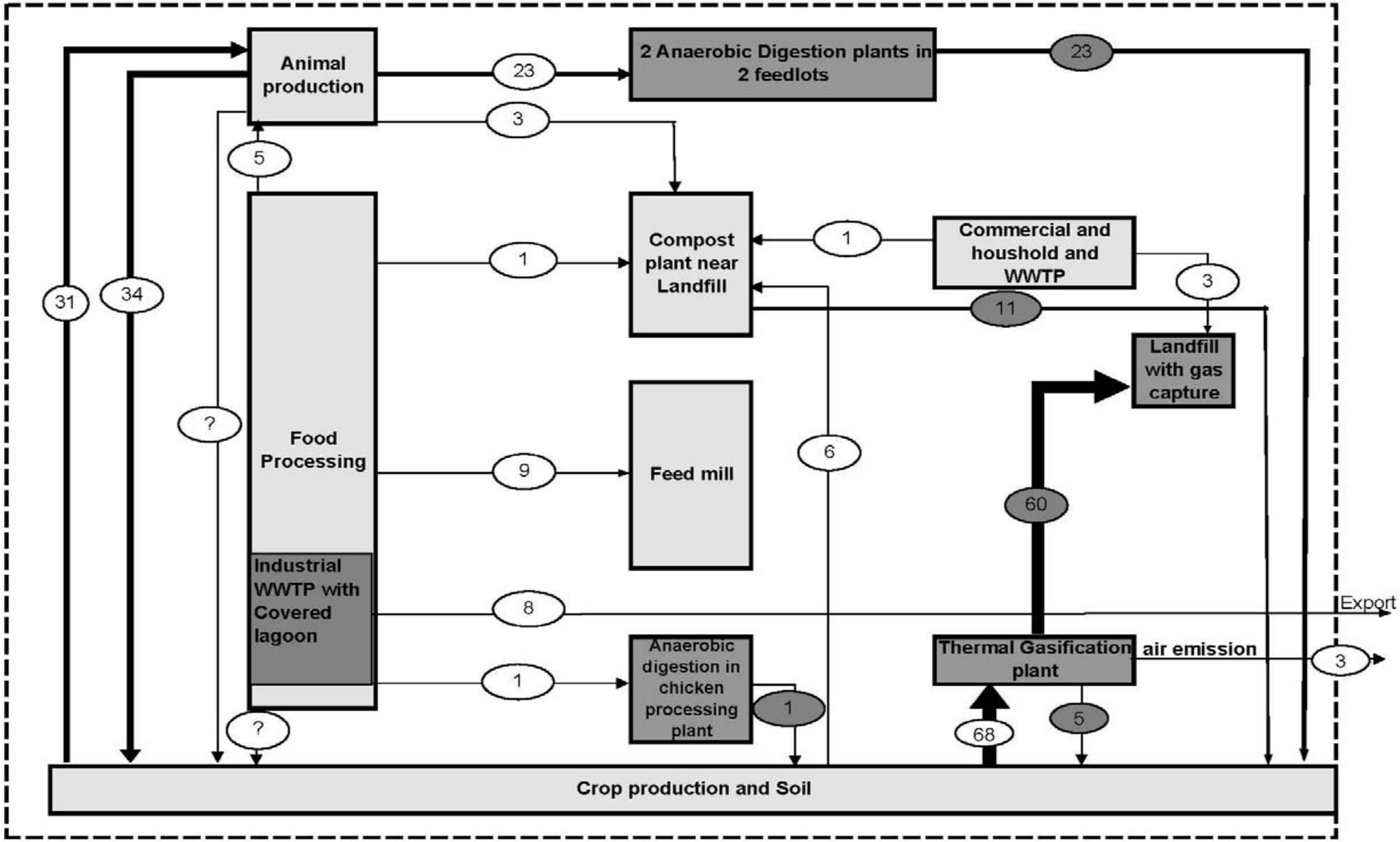
Biomass waste flow (Tonnes/y) according to the scenario



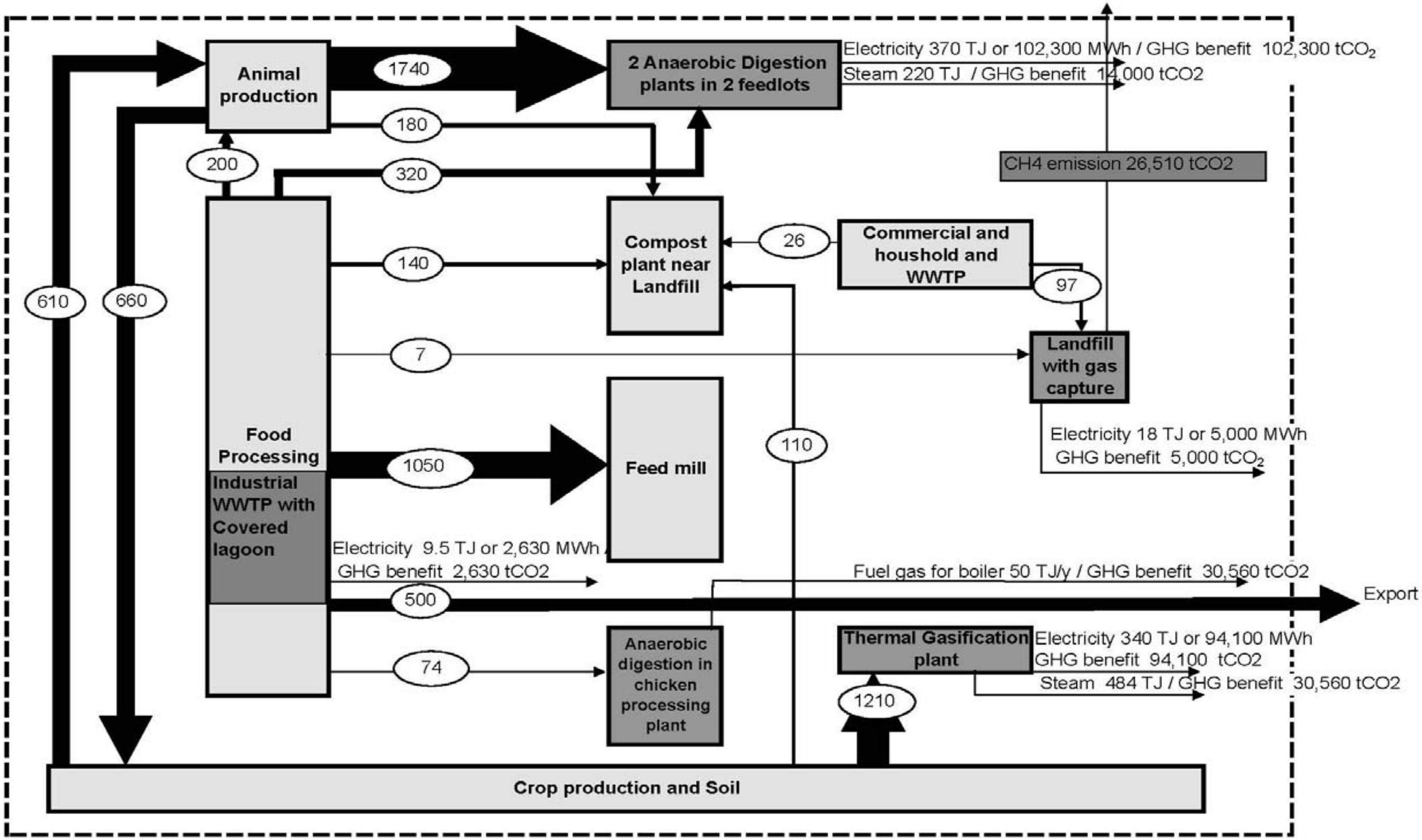
P flow in biomass waste (Tonnes/y) according to the scenario



Cd flow in biomass waste (kg/y) according to the scenario



Energy content flows (TJ/y) and GHG flow (tCO_2/y) according to the scenario



Economic Analysis

Items	1.Anaerobic digestion plant in feedlot 1	2.Anaerobic digestion plant in feedlot 2 (co-digestion with food waste)	3. Rice straw gasification plant and gas turbine	4.Anaerobic digestion plant in chicken processing plant
Total waste input quantities (t/y)	87,600	112,000	96,800	82,00
Type and quantities (t/y) of waste input	Manure-85,000	Manure-49,500	Rice straw-96,800	DAF sludge-8,200
	Paunch material 2,600	Food waste-62,500		
Energy / GHG benefits				
Electricity potential (MW)	6	5	10	n.a.
Electricity production (MWh/y)	54,500	47,800	94,100	n.a.
Heat recovered (GJ/y)	117,000	104,000	535,000	53,000
GHG abatement(t CO_2)	61,900	54,400	125,000	3300
Cost				
Capital cost ($ millions)	40	54	37	1
Annual O&M ($ millions/y)	2	2.7	1.3	0.04
Fuel cost($ millions/y)	0	0	1.9	0
Fuel collection and storage cost ($ millions/y)	0	0	4.2	0
Revenue				
Electricity sale ($ millions/y)	4.3	3.8	7.5	n.a.
Stream sale ($ millions/y)	0.7	0.6	2.9	0.3
Renewable energy credits($ millions/y)	1.6	1.4	2.8	0.03
Digestate sale ($ millions/y)	0.4	0.6	n.a.	0.02
Gate fee ($ millions/y)	0	3.8	0	0
Economic analysis				
Pay back period (years)	10	9	7	3
NPV($ millions)	2	4	11	1
IRR(%)	14	15	21	54

n.a. : not applicable

Scenario outcomes

- More phosphorus recovered.
- No additional Cd contamination.
- Useful energy recovered (20%+ of energy consumption in MIA) plus addition GHG benefits.
- Large P flow are in agricultural good exports to other regions for consumption (when looking at the whole system of materials flows).
  - Need to capture this P and return it to MIA without Cd contamination.

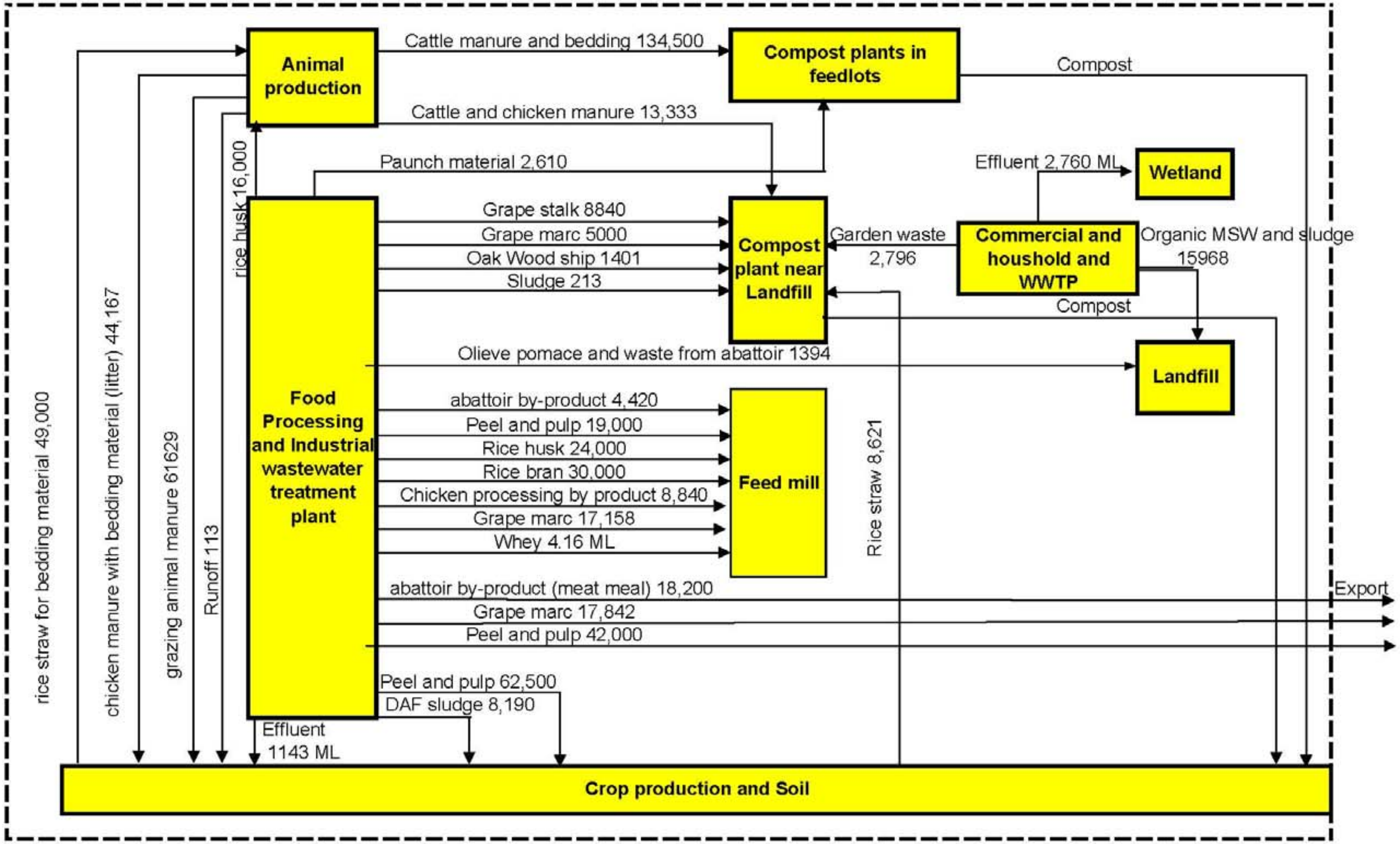
Conclusion

- Development of a tool that can explore and analyse multiple objectives and tradeoffs in biomass waste management
- Applied to the MIA in regional Australia wrt current context and a possible scenario of enhanced energy and nutrient recovery
- This scenario yields number of benefits wrt:
  - Renewable energy production.
  - Greenhouse gas emission reductions.
  - Increased Phosphorus cycling into land.
  - Better managed Cadmium contamination in soils.

Thank you

Question?

Biomass Flow detail



Whole system of materials flows containing P and Cd