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Overview of solid manure treatment options

Katherine E. Buckley and Francis J. Larney

Achieving Manure Phosphorus Balance in Manitoba
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Solid Manure Treatment Processes

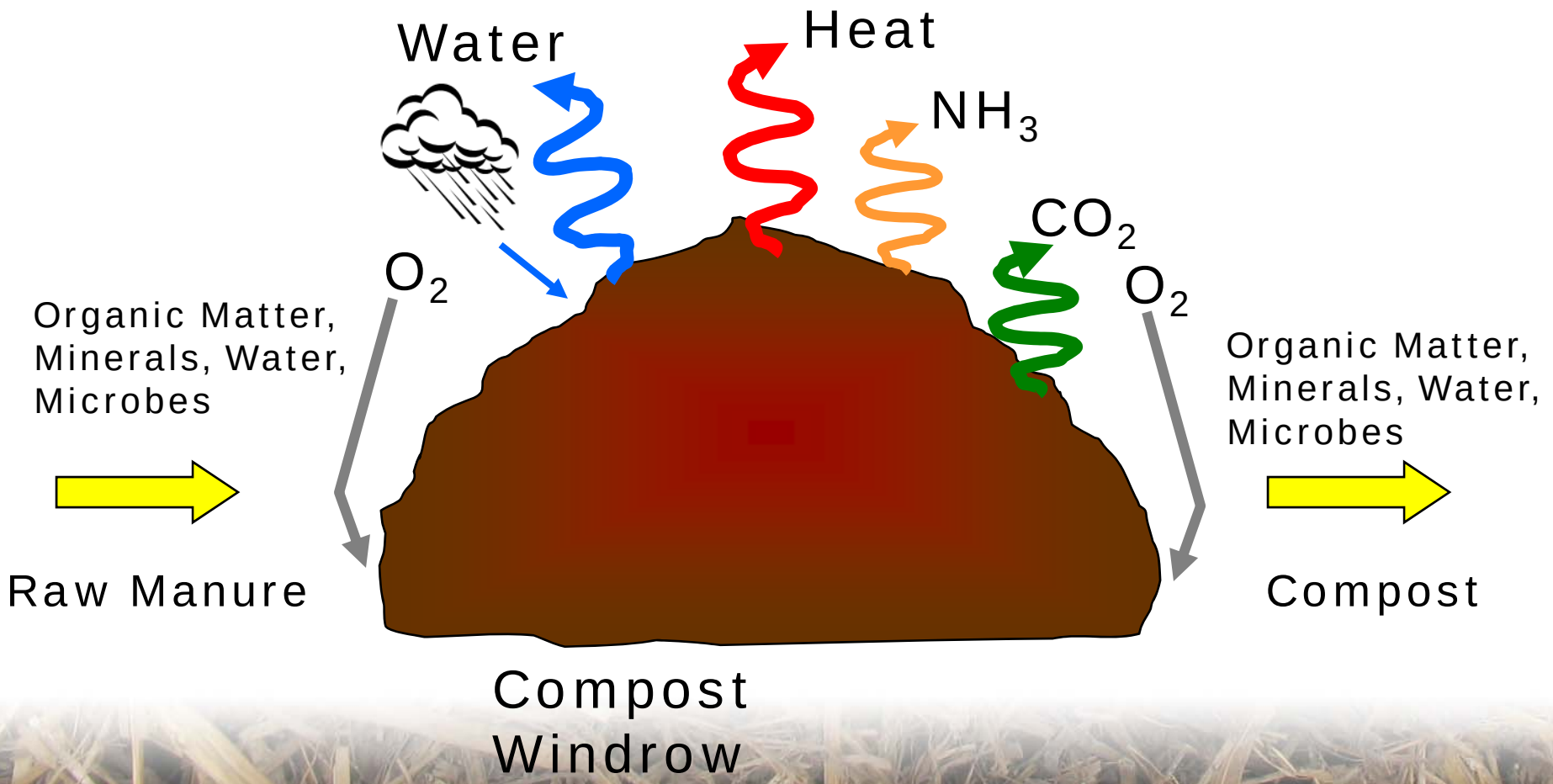
- **Biological**
- **Mechanical**
- **Thermo-chemical**

or any combination of these processes

Biological Processes

- **Composting**
- **Anaerobic Digestion**
- **Biomass Conversion**

Composting


Water
Heat
NH_3
CO_2
O_2
O_2
Organic Matter, Minerals, Water, Microbes
Raw Manure
Compost Windrow
Organic Matter, Minerals, Water, Microbes
Compost

Composting

What we know

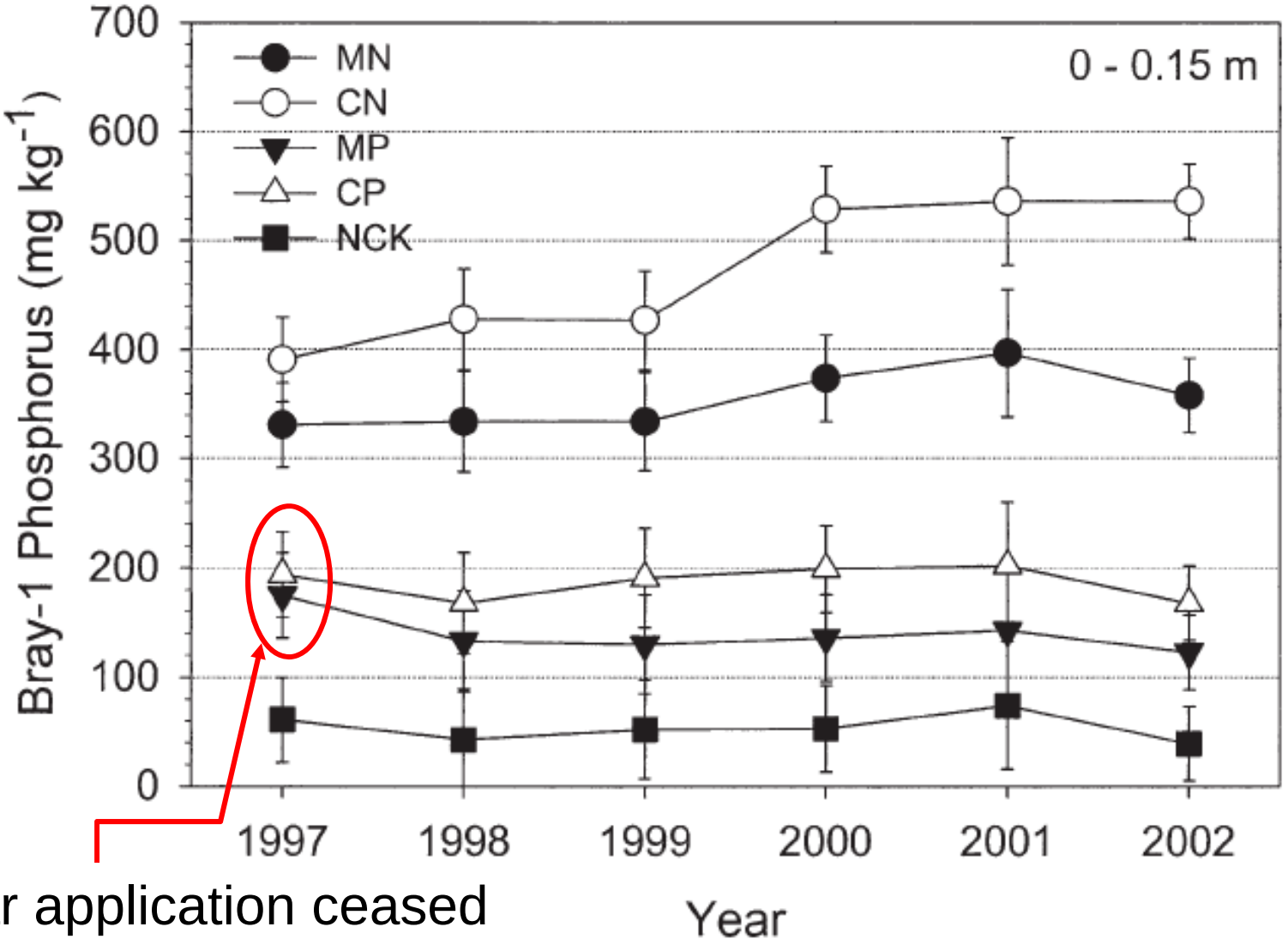
- Reduces mass, volume, odour, pathogens
- N loss may be high further unbalancing N:P
- Conserves P and K
- P is 70-90% available
- Increases biological activity in soil
- May result in release of soluble P depending on species or management

What we don't know

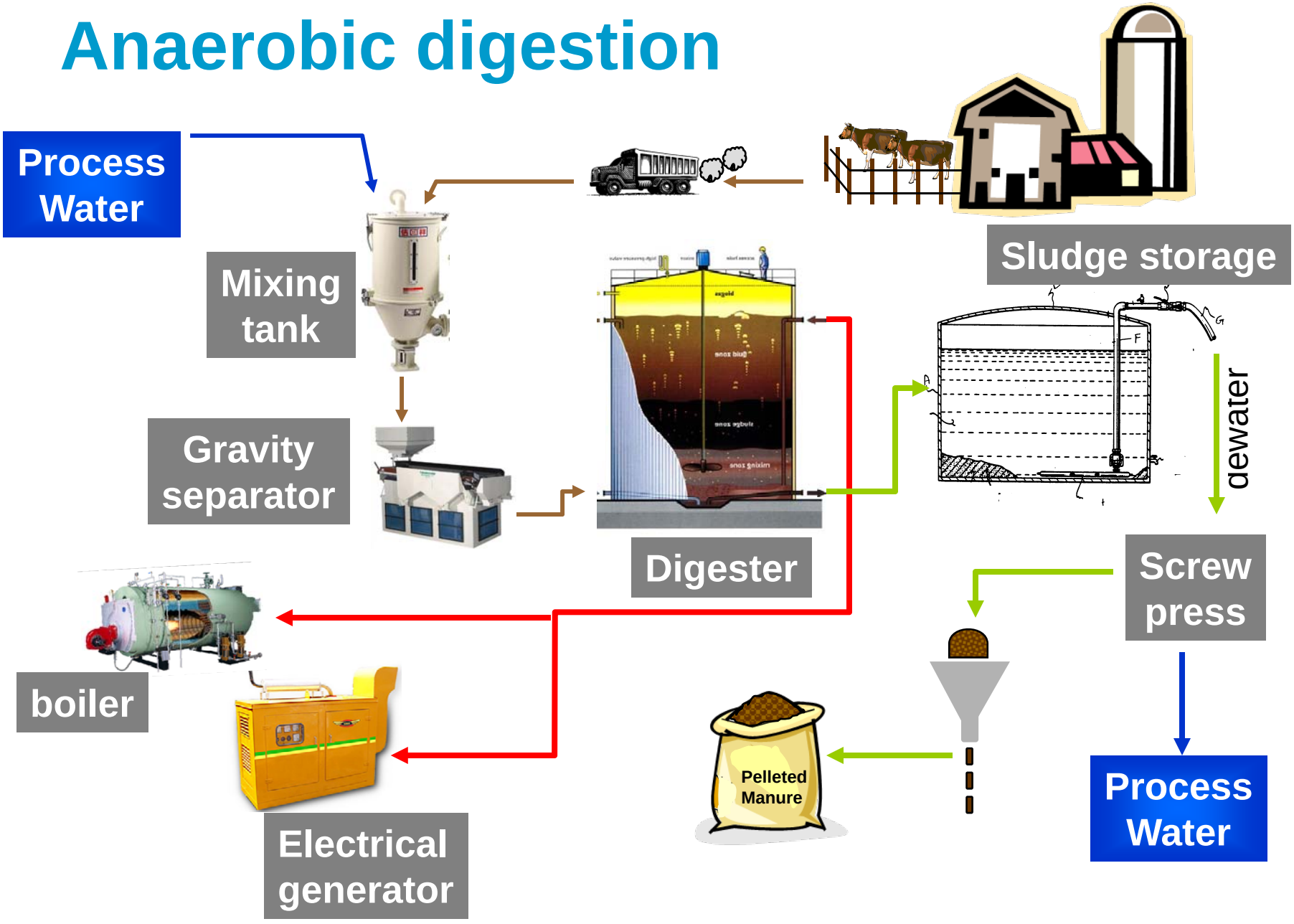
- Solubilization of P as a result of composting => greater environmental threat than raw manure?
- Combination of N fertilizer with compost to improve P use efficiency
- Optimum crop rotations on compost amended soil
- The right rate of compost, temporal and spatial

Sustained P release from compost after long-term annual application

Ferguson et al. 2005



Anaerobic digestion



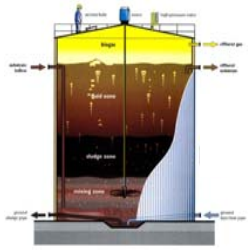
Solids from Anaerobic Digestion of Feedlot Cattle Manure

(Kotelko, 2006)

Values before and after digestion (+/- 20%)

Manure	C%	N%	P %	K%
Before	39	2.5	2.0	2.3
After	37	3.2	2.8	2.3

Anaerobic Digestion



What we know

- Economic model indicates that 30,000 head of feeder cattle is the minimum number
- Odour control technology
- Efficient biogas generation requires other sources of energy-rich biomass
- Potential for GHG reduction

What we don't know

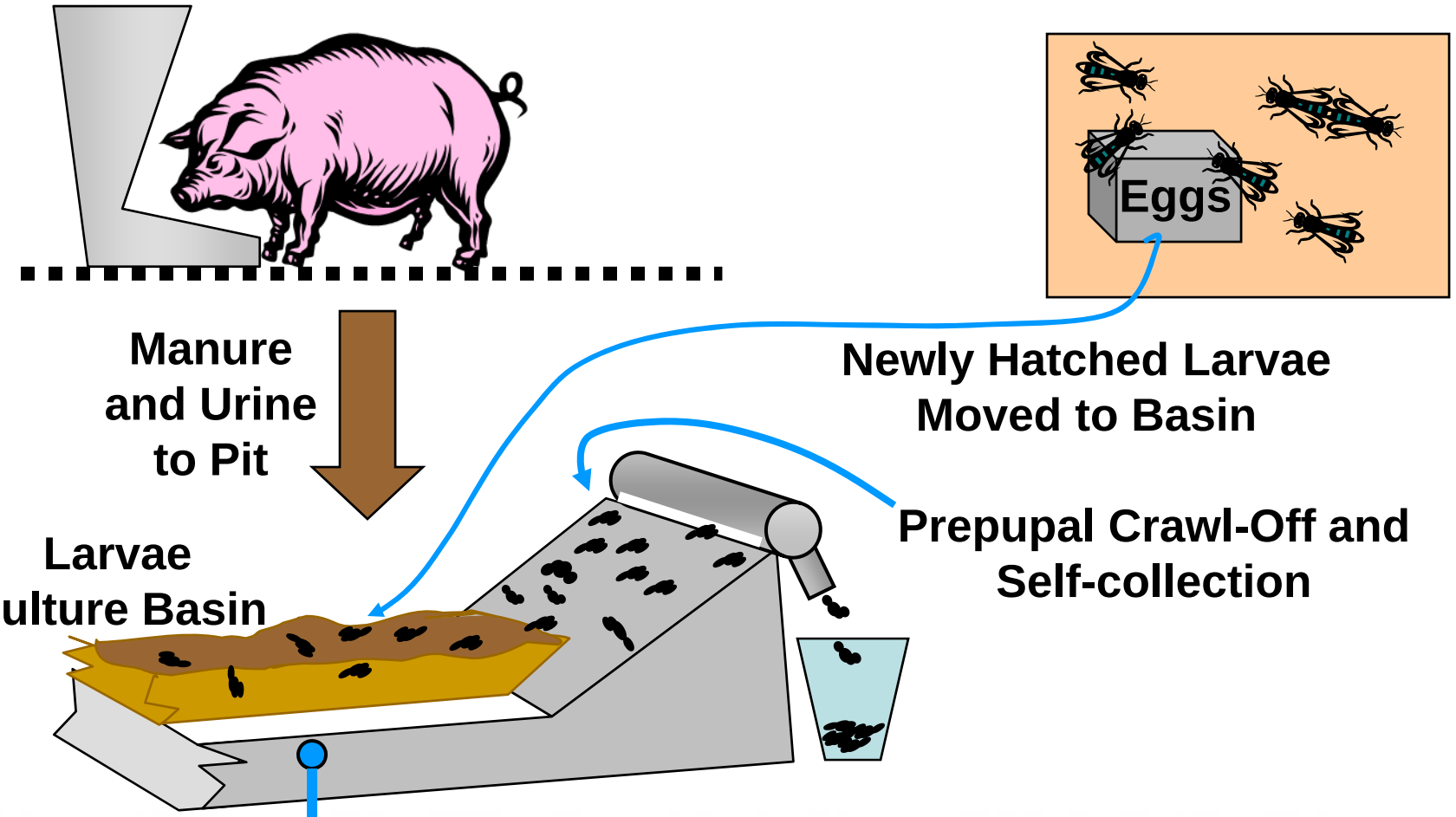
- How the C, N, P balance affects P utilization
- Best agronomic use of the product
- Best form for economic distribution
- Placement of the nutrient in crop production systems

Barriers for small and large operations

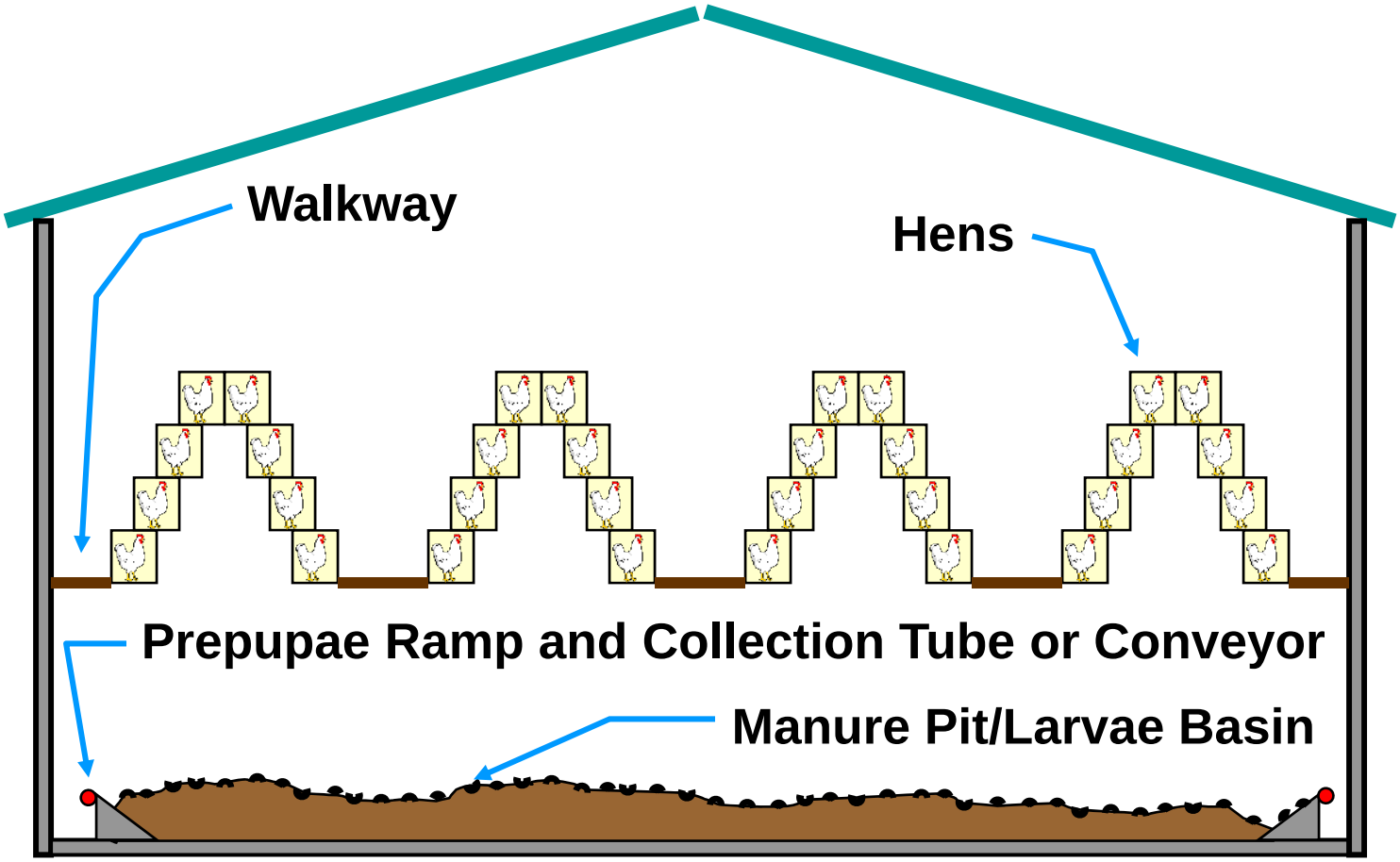
- High capital cost
- Lack of renewable energy pricing structure for those operations generating sufficient energy to put back into the grid
- High risk
- Undeveloped markets for co-products

Biomass Conversion (Newton et al. 2005)

Culture of Hermetia larvae directly beneath pigs



Biomass Conversion (Newton et al. 2005)



Hen house with Hermetia manure processing

Composition of pig manure compared to the residue remaining after Hermetia culture

	Pig manure		Hermetia residue		Change
Element	ppm	SEM	ppm	SEM	%
N	**923.7**	**44.4****	**414.5**	**6.17**	**-55.4**
P	**676.2**	**37.9****	**378.0**	**13.1**	**-44.1**
K	**358.7**	**19.8****	**169.3**	**7.07**	**-52.8**
Ca	**9689.3**	**62.5****	**425.0**	**19.4**	**-56.2**

Newton et al. 2005

Biomass Conversion

What we know

- Fly is a non-pest species
- Manure mass can be reduced by 50% in poultry and swine systems
- Prepupae accumulate large amounts of Ca and P in tissues.
- Tissues contain 40-42% protein and 28-36% lipids.
- The digested manure has reduced odour and moisture

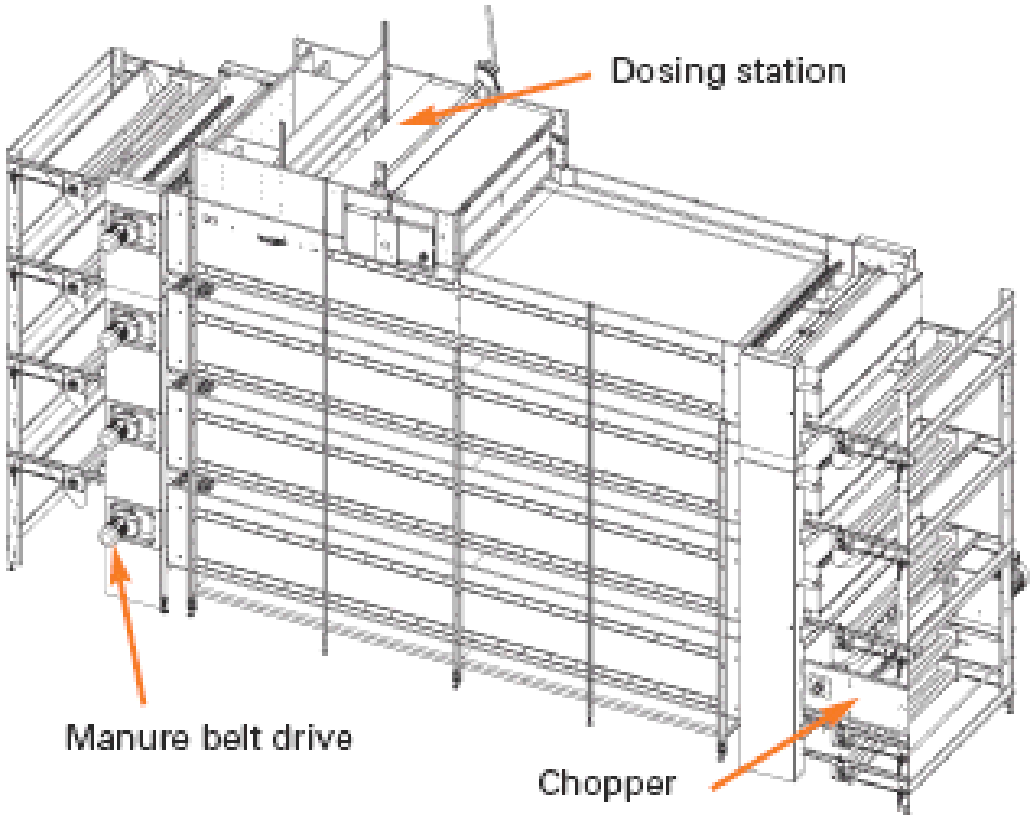
What we don't know

- Can this management system be used under Canadian conditions?
- Do the prepupae harbour parasites and pathogens?
- If so, can they be destroyed by a heat treatment that will not reduce feed value?
- Potential as a feedstuff for various species of livestock, farmed animals, aquaculture
- What effect do anthelmintics, antibiotics, growth promotants, etc have on larvae survival?
- Potential as a source of refined lipids and meal.

Mechanical Processes

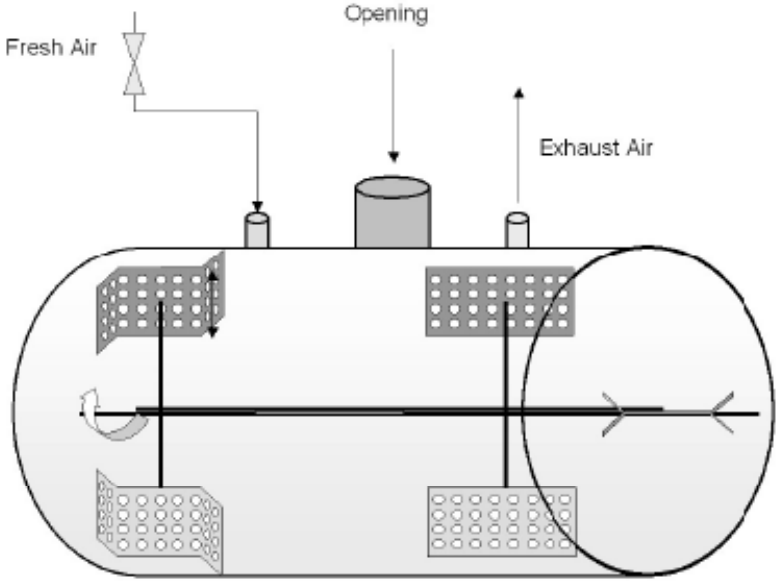
- **Mechanized air drying**
- **Granulation**
- **Pelleting**

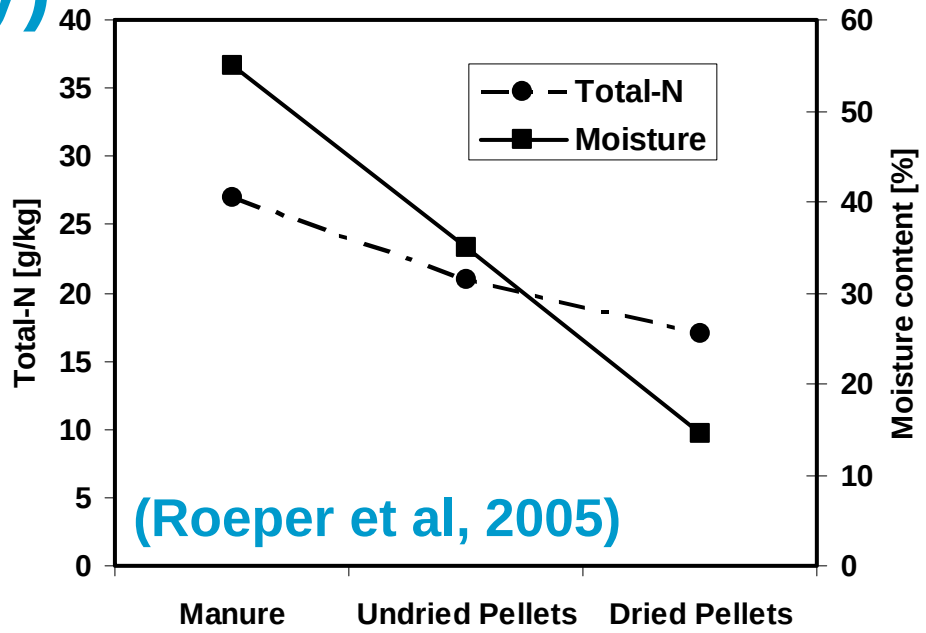
Mechanized drying



- Primarily for laying operations but can be applied to other manures and dewatered sludges
- To reduce moisture for storage, bagging, pelleting or energy recovery
- Warm exhaust air is pushed into the pressure corridor at four m^3 per hour per bird

Granulation (poultry)





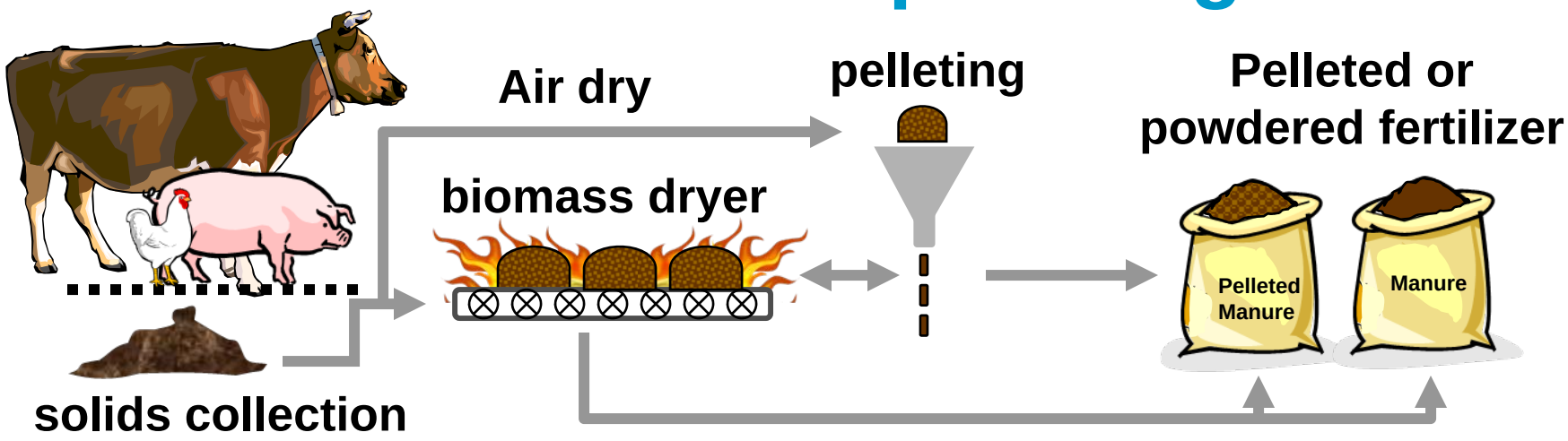
What we know

- Inexpensive
- 75% of total N remains in granule
- Granule does not resist crushing as well as formed pellet

What we don't know

- Fertilizer value of the granules
- Feasibility of capturing volatilized ammonia

Pasteurization and pelleting



What we know

- Method to reduce bulk and weight
- Value added
- Pathogen free
- Conserves P, contributes to N loss during pelleting and perhaps N loss after application to soil

What we don't know

- Importance of product placement on P utilization
- Performance under dry land farming
- Suitable crops
- Environmental risk
- Biological activity

Characterization of N mineralization of pelleted and ground manure in sandy soil (Hadas et al. 1983)

Manure	Max. NH_3 conc. soil mg/kg	Persistence of elevated NH_3 (days)	Mineral N in soil	
			1 week	60-90 d
			% added N	
Poultry, ground	300 b	>90	34 b	48 a
Poultry, pelleted	456 a	>30	42 a	50 a
Dairy, ground	124 c	>14	18 c	27 b
Dairy, pelleted	164 c	>7	23 c	27 b

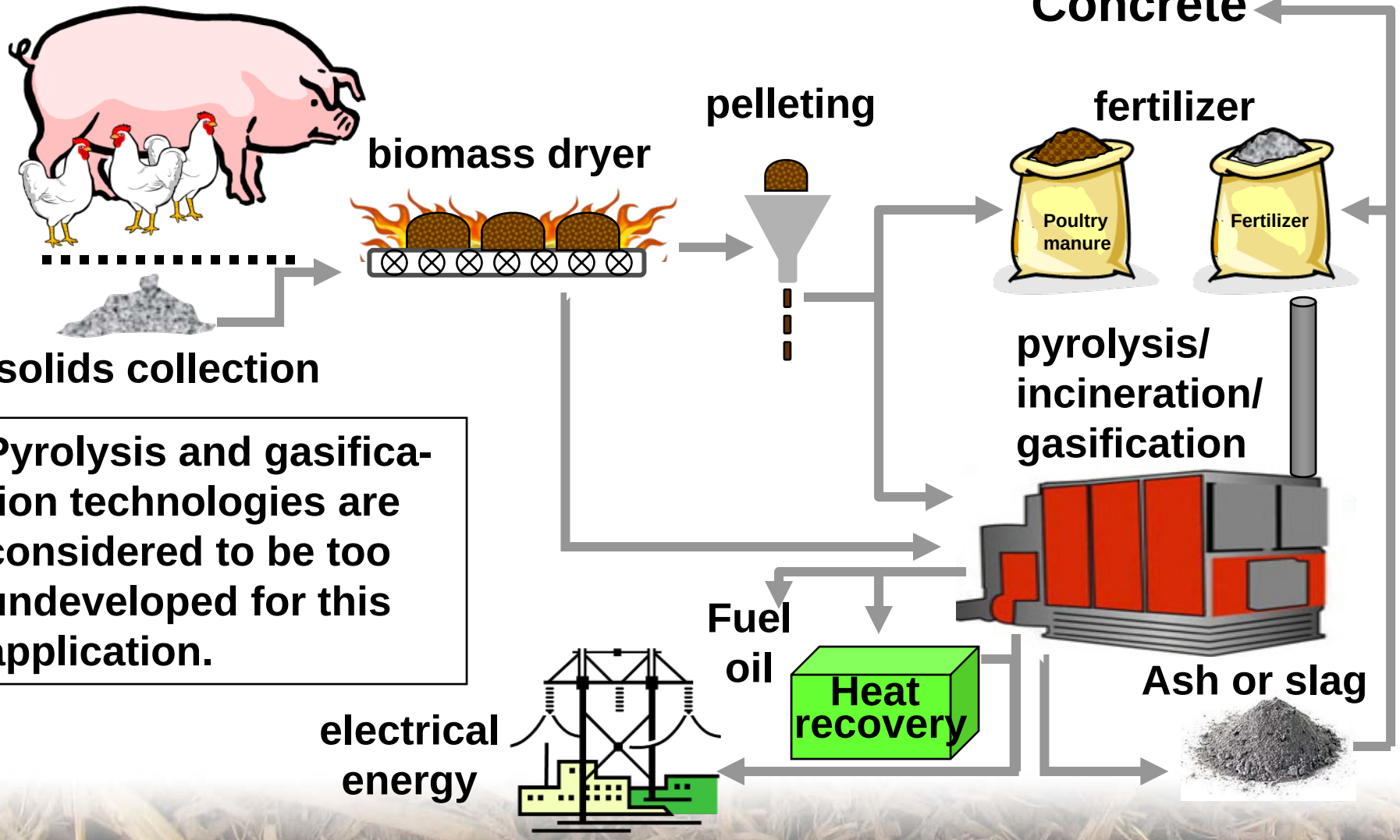
Thermo-chemical Processes

- **Direct Combustion - incineration**
- **Gasification – limited air, gas reforming**
- **Pyrolysis – no air, gas condensation to oil**

=> Converts manure to energy + by-products

- **Syn-gas**
- **Oil**
- **Ash**

Thermo-chemical/mechanical Process



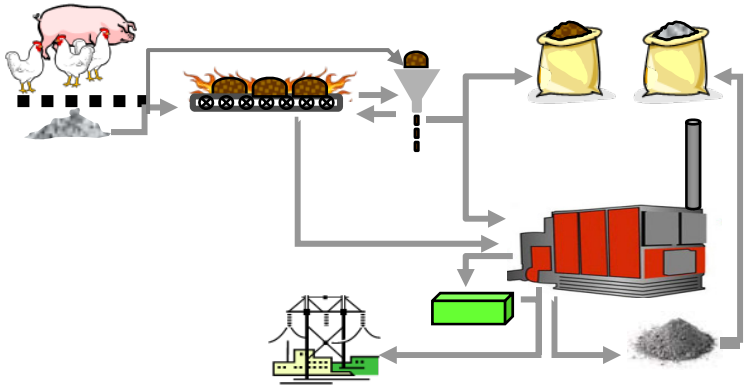
Pyrolysis and gasification technologies are considered to be too undeveloped for this application.

Poultry ash – composition of concentrated slag

Centre Europeen d'Etudes des Polyphosphates (CEEP) 1998

Component	Form	%
Phosphate	P_2O_5	24
Potassium	K_2O	12
Magnesium	MgO	1
Sulphur	SO_3	5
Calcium	CaO	23

Incineration Process



What we know

- Technology is well developed
- Not considered for use with residues from feedlot cattle due to high ash content of manure (soil contamination)
- Loss of nitrogen
- Potential to release NOx
- P is concentrated in bottom ash
- Potential to reduce environmental loss of poultry litter P by 90% (Cuttle et al. 2007)

What we don't know

- Solubility and availability of P – formation of apatite in bottom ash
- Feasibility of chemical extraction of P for use as fertilizer (Katsuya et al. 2009)
- Best application for the ash
- Optimum size of operation for the application of this technology

P Utilization from Manure

What we need to do:

- **Seek more support for research investigating organic amendments**
- **Establish and maintain long-term field trials**
- **Pilot and greenhouse studies**
- **Share analytical samples**
- **Work collectively to share resources**
- **Work more closely with producers with full-scale treatment systems**

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