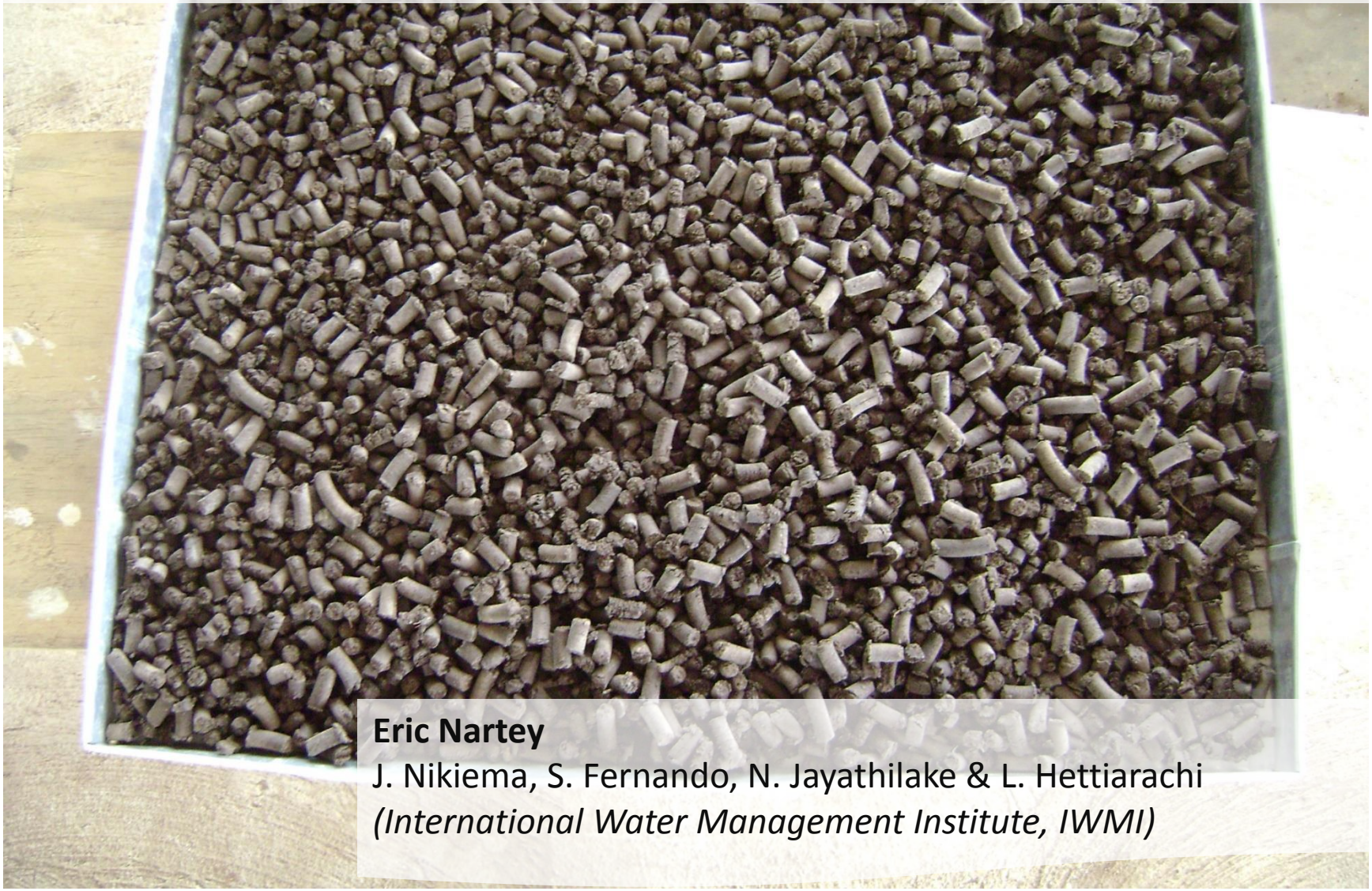
Technological options for fecal sludge pelletization: IWMI's experiences from developing countries



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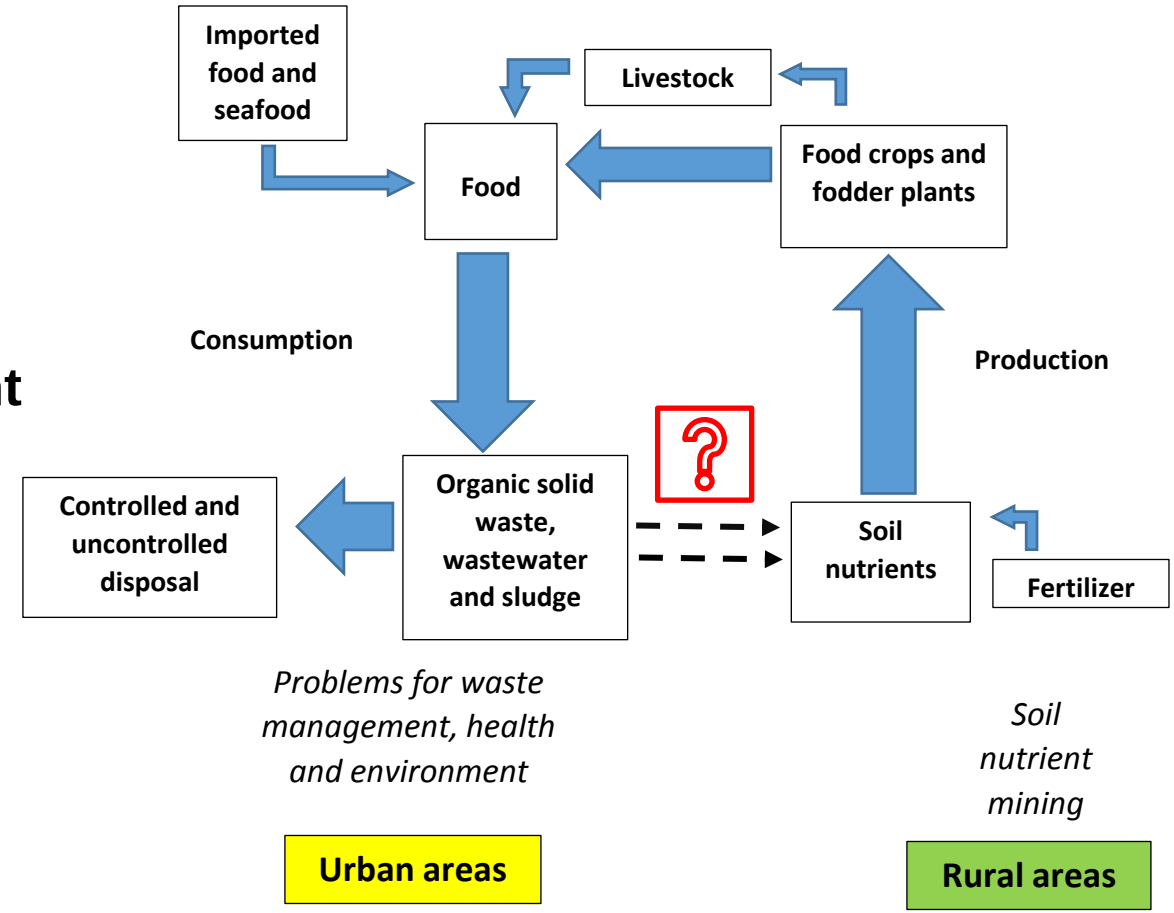
Outline

- Introduction
- IWMI's experiences
- Our observations
- Pointers for selecting a pelletizer

Introduction

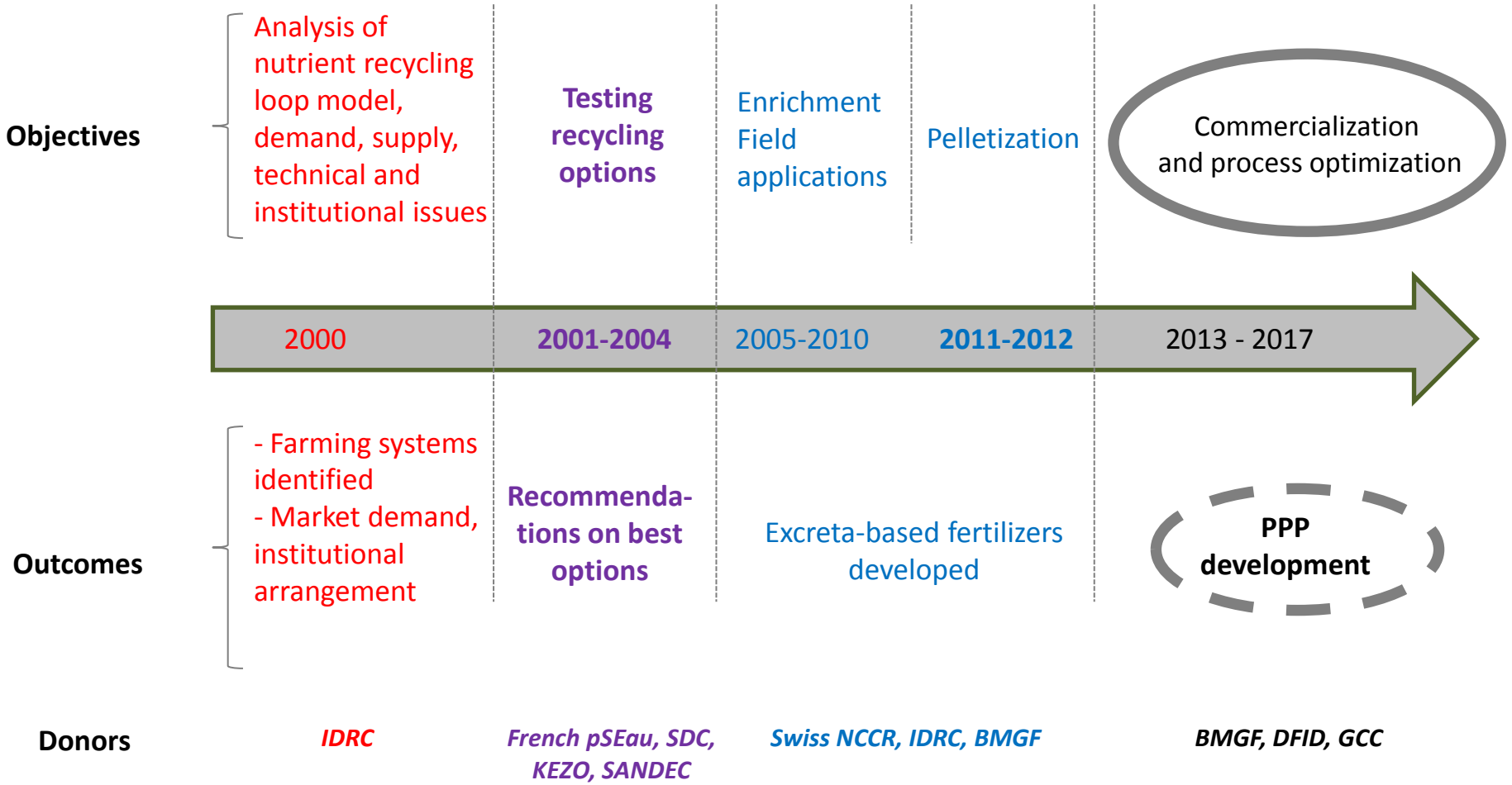
Many cities are rapidly transforming into vast nutrient sinks

Agriculture, especially in the rural-urban interface, could benefit from **nutrient recycling**.



Source: Drechsel et al., 1999

History of fecal sludge (and organic solid wastes) recycling at IWMI



Why pelletization?

- To improve logistics
  - More storage capacity (reduced transport cost)
- To facilitate application of compost
  - Reduce the formation of dust
  - Enable the use of mechanized equipment for land application
  - Minimize the nutrient loss following land application
    - Steady release of nutrient
    - Higher residual benefit

	Disk Pelletizer			Extruder Pelletizer
	Roller Disk die type	Roller Ring die type	Double die type	
Design	Die with many holes and a roller or 2 disks			Have a barrel and a screw
Input method	Compost is fed between disks and roller			Fed into the barrel and forced by a screw
How Pellet Form	Disk or roller turns and compost is forced into the holes to form pellets			Material compressed into the die installed at the end of the machine by the screw to form pellets

Our first experience with pelletization

- Pelletizer locally fabricated in Ghana, by the Council for Scientific and Industrial Research (CSIR)

Specifications: 380 V, 1.5 - 4 KW motor
Pelletizer type: Screw and die
Production capacity: 60 – 100 Kg/h

Key operating factors

- Moisture content
- Binding material concentration
- Type of feedstock

Selected results

- Density increased by 20 to 50% (depends on raw materials)

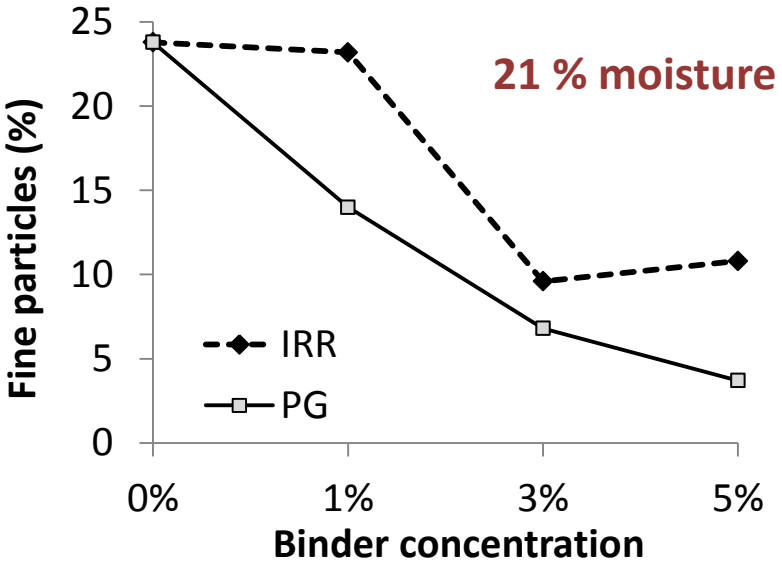
Gamma irradiated DFS (I-DFS)		DFS compost (C-DFS)			Co-compost with sawdust (C-SDFS)		
Powder	Pelletized	Raw	Ground/ enriched	Pelletized	Raw	Ground/ enriched	Pelletized
0.58	0.88	0.71	0.77	0.91	0.37	0.39	0.47

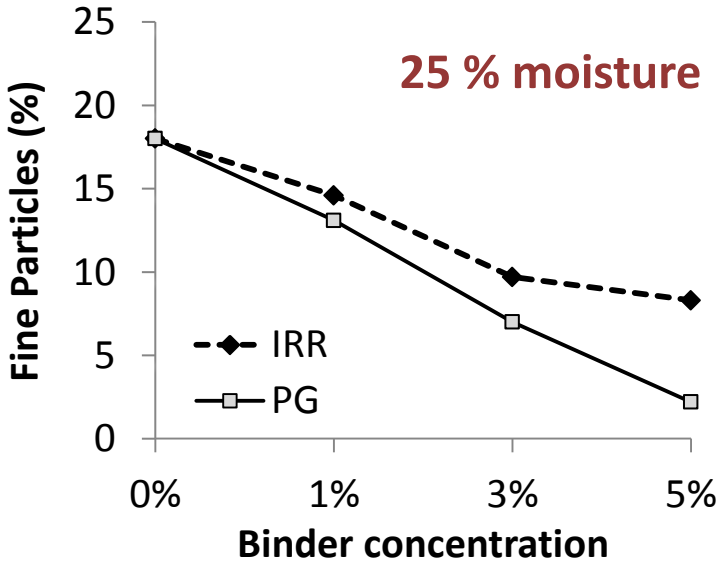
Source: Nikiema et al. 2013

- DFS: dewatered fecal sludge
- IRR: Gamma irradiated
- PG: pre-gelatinized

- A binder (e.g. cassava starch) was needed
  - Formation of fines during the process

Pelletization with enriched DFS compost





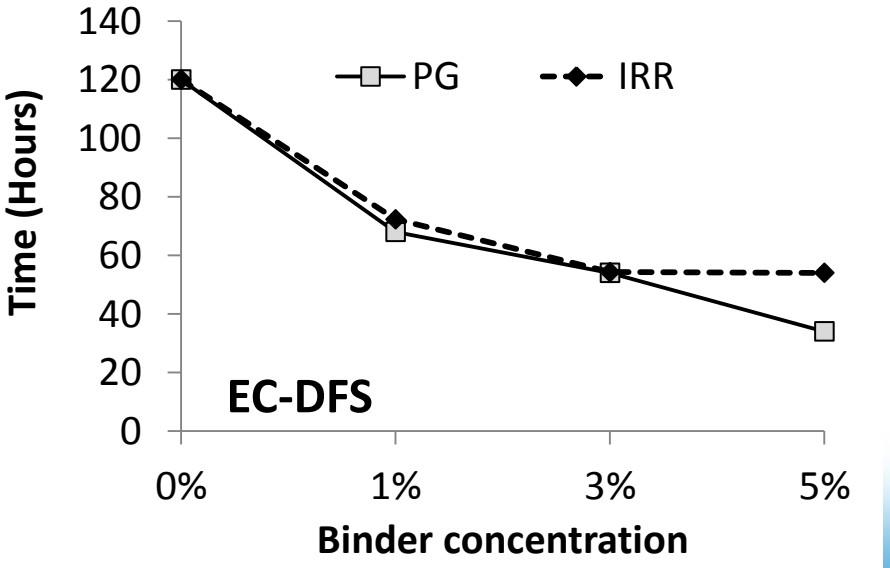
Selected results cont'd

- Binder affects also the stability of pellets

During transportation

	Enriched C-DFS		I-DFS	
PG starch Concentration (%)	Moisture content			
	21%	25%	27%	31%
0	89.0	91.0	85.4	91.6
1	93.2	95.4	89.6	93.3
3	93.8	98.9	91.1	93.3
5	99.3	97.2	90.2	91.6
	0.5		0.5	

After land application, in the presence of water



Pellet particle size

- Not much difference in the diameter (7.5-7.7 mm, for a die hole of 8 mm)
- Pellet length (after sieving 5mm) ranged from 5 mm to 40 mm
  - Affected by the feedstock and the binder type
  - Not affected by the moisture content and the binder concentration

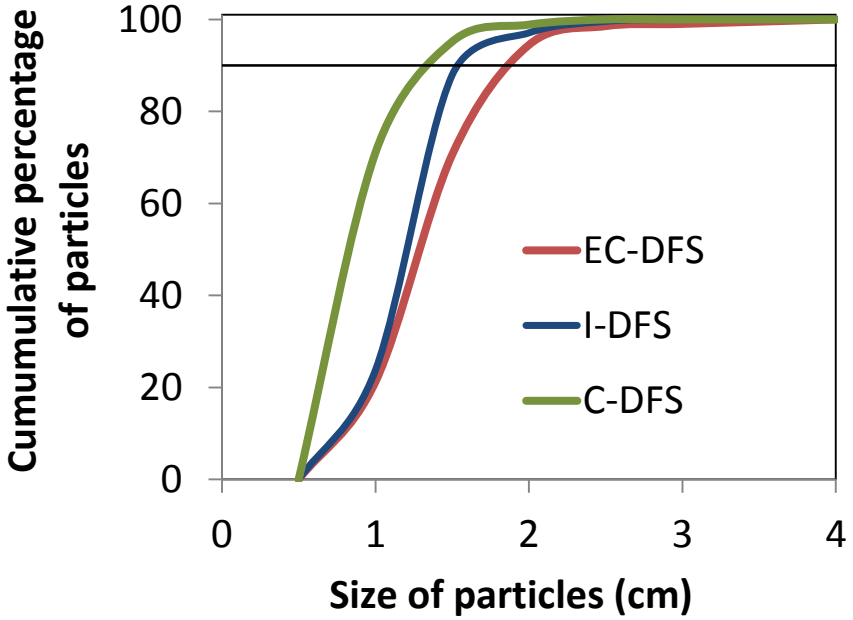
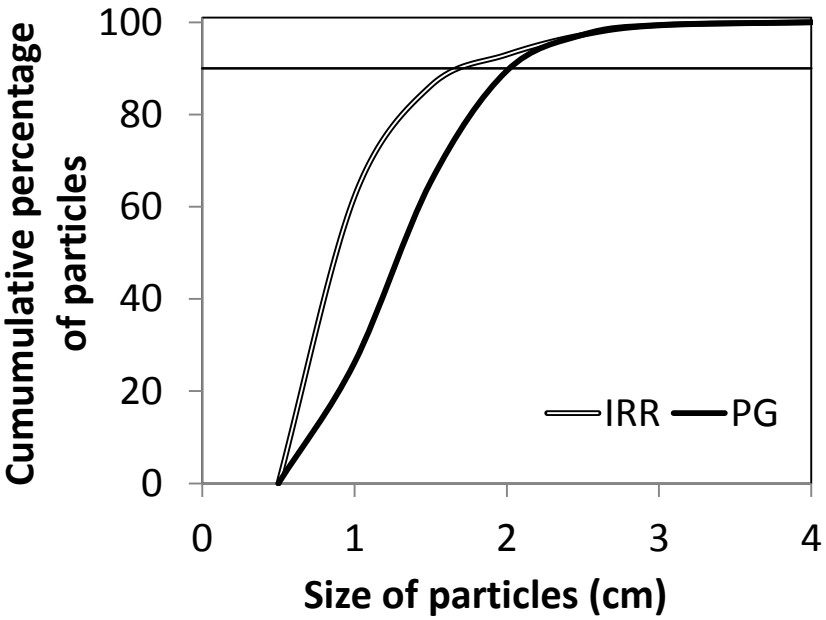


Figure obtained for the lowest moisture content and 0% binder



Pellets formed from EC-DFS with 3% of starch (IRR or PG) and 21% of moisture content).

Source: Nikiema et al. 2013

Our second experience

- Pelletizer acquired from local dealer in India to pelletize a co-compost (municipal solid waste and DFS) produced by a municipality in Sri Lanka

Specifications: 415 V, 22.4 KW
Pelletizer type: Die and roller
Expected production capacity: 300 kg/h

No extra water addition

- Moisture content was 21-25%

No starch addition

No grinding

Selected results

- Production capacity: 30 – 130 kg/h, instead of the expected 300 kg/h
- Bulk density increased by 20-30%
- The pellets survived a 50 km distance transportation and remained unharmed
  - This study confirmed the high influence of moisture content and particle size on physical properties of pellets.
  - Pellets made of less than 3.5 mm particles displayed approximately 25% more strength than higher (< 5 mm) and lower (< 2.5 mm) pellet sizes
  - Pellets produced with co-compost having 30% and 35% moisture contents were slightly longer compared to lower and higher moisture contents

Source: Hettiarachi et al. 2017

Our third experience

- Industrial pelletizer acquired (Italian manufacturer)

Specifications: Pellet Mill IOTA 25, 400 V
Pelletizer type: Die and roller
Production capacity: 500 kg/h

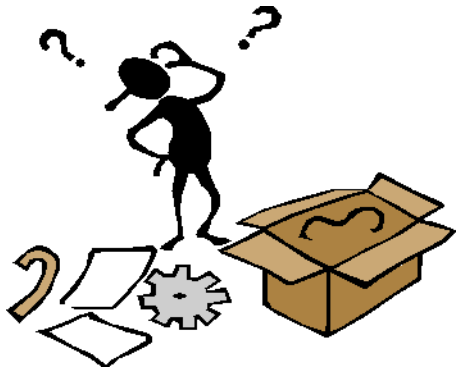
Results are similar to those of our previous experience (especially the 2nd case)

Our observations

	Extruder pelletizer (Ghana)	Roller Disk die type (Sri Lanka	Roller Disk die type (Ghana)
Source	Locally fabricated	Local manufacturer	Imported from Europe
Price (USD)	2,000-4,000	10,000	40,000
Operation facts	• High failure rate • Could barely process some materials • Binder/grinding required • Pellets quality affected by binder type/ concentration • Moisture content is critical, and dependent upon type of feedstock	• Production rate only much lower than expected • No binder required • No grinding required • Roller maintenance is an issue • Low sand level is essential	• No binder required • Sand level must be below 5% • Seems able to produce pellets from various feedstock (fines: 5-15% for dry products) • Required trained labor to install and operate • *Yet to test it locally*
Production rate	60-100 kg/h	30-130 kg/h	300-330 kg/h
Energy: kWh/MT	36-57, excluding drying	172-740	67-73
Pellet dimension	Varied with feedstock and binder type; did not vary with moisture content and binder concentration	Effect is negligible with moisture content variation	Moisture content can be auto-adjusted (injector of water vapor)

Pointers for selecting a pelletizer

- Test the prospective machine with material intended to be pelletized
  - Or be cautious not to select pelletizers meant for fish feed production
- Avoid local construction, though cheaper, especially in countries where related expertise is limited



Thank You

Dhanyavaad!