Use of bioslurry as organic fertilizer

’Clean fuels, *better soils* and more food’

NATIONAL BIOSLURRY EXTENSION CONFERENCE

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Sustainable Development Goals

	SDG	Key wording	Driver	Safe guard	Land relevance
	2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture	✓	✓	high
	7	Ensure access to affordable, reliable, sustainable and modern energy for all	✓	(✓)	high
	12	Ensure sustainable consumption and production patterns	✓	(✓)	high
	13	Take urgent action to combat climate change and its impacts	✓	✓	high
	15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss	✓	✓	high

Source: Fritsche et al. (2017). GLO report UNCCD

Contents

- Soils quality in Africa
- Improving soils
- Digestate or bioslurry
- The role of feedstocks
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Soils in Sub-Saharan Africa

- Land under pressure from population growth and overexploitation
- Result: biodiversity loss, decreased resilience and degradation of agricultural soils
- African soils are often inherently poor
- Unpredictable weather patterns increase risks for cropping

Source: UNCCD GLO report (2017); Gilbert (2012); van Ittersum et al. (2017) PNAS; Vanlauwe etal. (2014)

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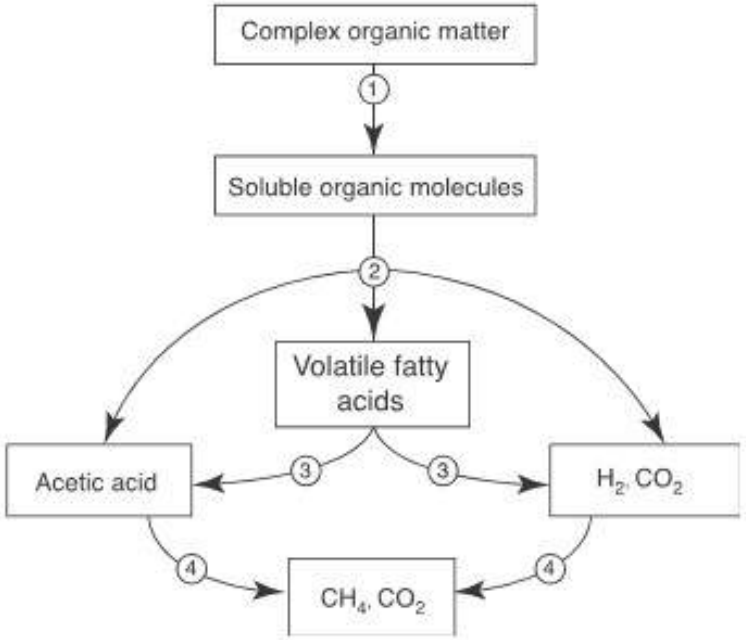
Crop nutrition

- Soils in SSA often are underfertilized and mined
- More nutrient inputs are needed, but access to fertilizers often is limited
- Nutrient and water retention must be improved
- Nutrient application and Good Agricultural Practices are key

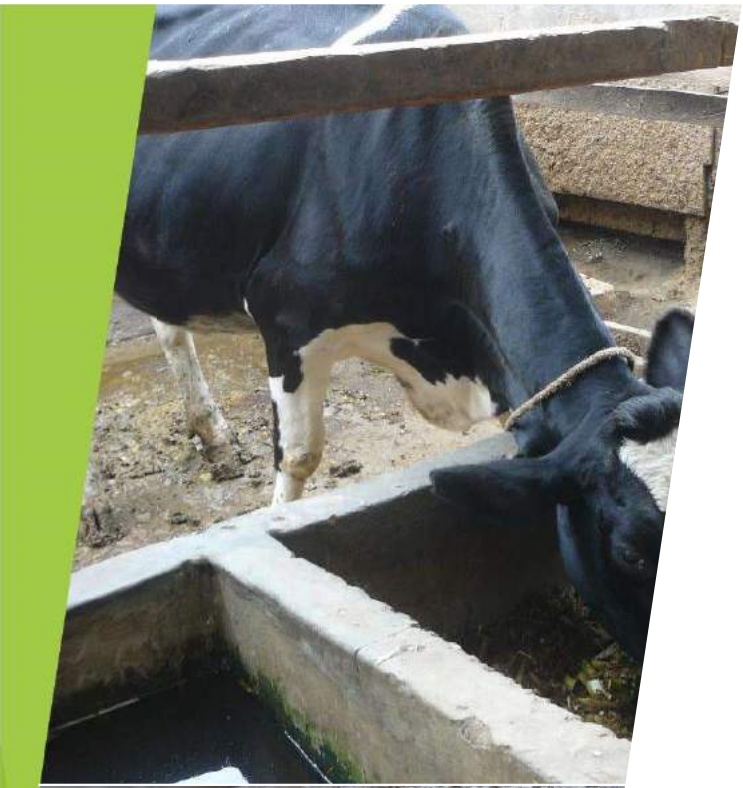
Source: Gilbert (2012); van Ittersum et al. (2017); Vanlauwe etal. (2014); Tittonel and Giller (2013)

Anaerobic digestion (AD)



- Decomposition of complex organic molecules
- Four steps, involving different groups of micro-organisms
- Each group has specific preferences, condition requirements
- Result is a delicate compromise

Source: Zupančič and Grilc (2012).

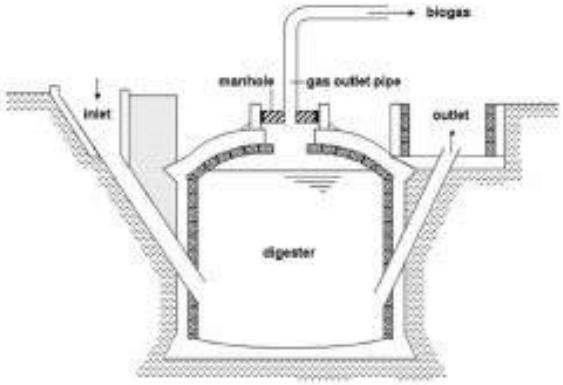


Co-digestion

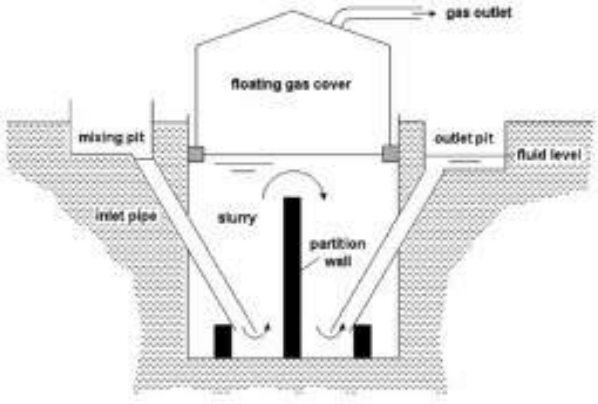
- Synchronous decomposition of crop material, household waste or residues with animal manure

- Major advantages for smallholder families
  - Increased nutrient input
  - More constant feedstock availability
  - Better digestion quality
  - Higher pH

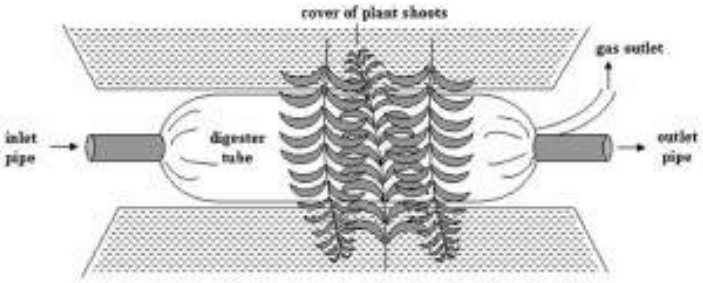
Small-scale biogas reactors



(Chinese) fixed dome reactor



(Indian) floating cover reactor



Tubular digester

Source: Bonten et al. (2014)

Farmyard manure vs bioslurry

Parameter	Value	Change[a)]
Dry matter, DM (%)	1.5-13.2	-1.5 to -5.5
Organic matter (as % of DM)	63.8-75.0	-5 to -15
Total N (% of DM)	3.1-14.0	b)
Total N (g/kg FM)	1.5-6.8	≈ 0
NH4 (% of total N)	44-81	+10 to +33
Total P (g/kg FM)	0.4-2.6	≈ 0
Water soluble P (% of total P)	25-45	-20 to -47
Total K (g/kg FM)	1.2-11.5	≈ 0
Total Ca	1.0-2.3	≈ 0
Total Mg	0.3-0.7	≈ 0
pH	7.3-9.0	+0.5 to +2 units

Source: Moeller, K. & Mueller, 2012

[a] in comparison to undigested liquid manure, absolute values.
[b] increase with degree of degradation.
DM = dry matter.
FM = fresh matter.

Bioslurry (digestate) compostion

Product	Unit	Value
Total Solids	% of Fresh Matter	**1.5 - 45.7**
Volatile Solids	% of Total Solids	**38.6 - 75.4**
pH		**7.3 - 9.0**
N Total	% of Dry Matter	**3.1 - 14**
idem	% of Fresh Matter	**0.12 - 1.5**
Nitrogen NH_4	% of total N	**35 - 81**
Total phosphorus	% of Dry Matter	**0.2 - 0.35**
idem	% of Fresh Matter	**0.04 - 0.26**
Total potassium	% of Dry Matter	**0.19 - 4.3**
idem	% of Fresh Matter	**0.12 - 1.15**

Source: adapted from Nkoa (2013; cattle manure)

Comparing biosslurry wth fertilizers

Comparison between yields of crops and vegetables with bioslurry (B) and different organic fertilizers (OF) (undigested liquid slurry (ULS), farm yard manure (FYM), vermicompost (VC), fly ash (FA), precomposted manure (PCM)): higher yield (=); lower yield (-); equal yields (=).

	B	OF					References
Yield		**ULS**	**FYM**	**VC**	**FA**	**PCM**	
Winter wheat, rye, spelt	=	=	=				Möller *et al*, 2008
Spring wheat	+	-	-				Möller *et al*, 2008
Potato	+					-	Garfi *et al*, 2011
Wheat	+				-		Garg *et al*, 2005
Cassava leaves	+		-				Chau, 1998a
Duckweed	-		+				Chau, 1998b
Sugar cane	-			+			Singh *et al*, 2007
Sugar cane	+		-				Singh *et al*, 2007

Source: De Groot and Bogdanski (2013). FAO

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Pathogens

Decimation time T90 (killing 90% of pathogens) in AD systems and untreated animal slurry

Bacteria	AD system		Untreated slurry system	
	35 ^{0}C (days)	53 ^{0}C (days)	18-21 ^{0}C (weeks)	6-15 ^{0}C (weeks)
Salmonella typhimurium	2.4	0.7	2.0	5.9
Salmonella dublin	2.1	0.6	-	-
Escherichia coli	1.8	0.4	2.0	8.8
Staphylococcus aureus	0.9	0.5	0.9	7.1
Coliform bacteria	3.1	-	2.1	9.3
Group D streptococci	7.1	-	5.7	21.4
Streptococcus faecalis	2.0	1.0	-	-

Source: Compiled after Bendixen (1994, 1995, 1999). **In:** Al Seadi et al. (2013)

Contaminants

- Biological contaminants (pathogens and weed seeds)
- Physical contaminants (inert materials or larger digestible pieces)
- Chemical contaminants (heavy metals and persistent organic pollutants (POP))

Source: Drosg et al. (2015)

The impact of feedstock on bioslurry

Substrate	Total Solids (% of Fresh Matter)	Volatile Solids (% of Total Solids)	Availability
Cattle slurry	11	82	7.3 tonne/head/y
Pig slurry	7	86	1.8 tonne/head/y
Cattle manure	25	76	7.3 tonne/head/y
Maize straw	93	97	Same yield as cereal
Food residues	20	92	55 kg/person/y
Coffee pulp	55	91	55 kg/tonne of berries
Grass silage	50	92	-

Source: Langeveld and Peterson (in press).

Feedstock composition

Co-digestion can have major advantages

Substrate	Impact on digestate	Comments
Organic waste	Low Total Solids (TS), low share of organics in TS	Organic waste often high in readily degradable materials
Meat, fish waste	High in nitrogen (N), high share of ammonia in N	
Manure	Low Total Solids (TS), considerable nitrogen (N) concentration	Pig manure is low in TS, cattle manure high in TS
Energy crops, straw, woody crops	High Total Solids (TS), high share of organics in TS	

Source: Drosg etal. (2015); Al Seadi et al. (2013)

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Feedstocks and digestate quality

Effect	Liquid manure	Crop residues, green manure	Dedicated crops
Manure handling	+	+ + +	+ + +
NH4+/total N ratio	+	+ + +	+ + +
pH	+ +	+ +	+ +
Nitrogen availability	0	+ +	+ +
Nitrogen use efficiency	0 +	+ + +	-
Phorphorus availability	0	0	0
Heavy metal availability	0 -	0 -	0 -
Crop growth	0	+ +	+ + +

Adding residues:

- Better manure handling
- Increased nitrogen availability
- Improved nitrogen use efficiency
- Good for crop growth

Source: Moeller, K. & Mueller, 2012

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Conclusion

- Soils in Sub-Saharan Africa are often inherently poor
- Digestate make good organic fertilizers
- Feedstock composition affects quality of the digestate
- Adding other feedstocks to manure allows more efficient manure handling and more efficient nitrogen use

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Thank you for your attention

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