Influence of feedstock on bio-slurry quality in Kenya

Hans Langeveld, Tomas Heijnen, Manisha Lamichhane, Laura Laroche, Golaleh Gaffari

Introduction

The newest energy crisis is adding to the need to transform fossil energy systems into more sustainable alternatives. Anaerobic Digestion (AD) is an important alternative to fossil fuels that can be used to recycle solid waste and organic residues to generate biogas and bio-slurry. At present, the development of AD in Africa is focusing on small (3 to 8 m^3) household units almost exclusively fed with cattle or pig manure. Upscaling AD implementation and biogas production will require the adoption of medium-scale (20 to 100 m^3) units, fed with a range of feedstocks including household waste and organic residues from food industries. The OFVI project, part of the African Biodigester Component (ABC) aims to evaluate alternative feedstock use and to stimulate markets for bio-slurry production, trade and application.

Method

A literature review was conducted to evaluate Kenya's primary (agricultural), food industry (secondary), and tertiary (post-consumer) biomass resources (Table 1). Based on the inventory, seven feedstock mixture options were selected. Biogas potential and bio-slurry composition were calculated for a digester of 100 m^3, with a daily feed volume of 4 m^3, giving a retention time (HRT) of 25 days. Most options contain a minimum of two feedstocks, in many cases including at least one primary feedstock (manure).

Table 1: Main organic residue steams in Kenya

Resource	Supply *(mln ton)*	Dry matter *(%)*	Dry matter *(mln tons)*
Primary			
Maize stover	3,8	29	1,1
Banana stems	19	5	0,1
Cattle manure	47	8	3.8
Chicken manure	42	55	22.8
Secondary			
Sisal pulp	0,6	2	0,01
Coffee pulp	0,6	29	0,2
Slaughterhouse waste	0,06	21	0,01
Tertiary			
Cereal food waste	2.2	88	1,9
MSW (Nairobi)	1	30	0,3

Feedstock availability

In Kenya, a total of 3.2 million tonnes of field crop residues and 300 million tonnes of animal manure are estimated to be generated each year. Considering nine waste streams in Table 1, a total of 98 million tonnes of residues are available. Over 29 million tonnes of this is of dry matter, most of which originates in chicken manure.

Biogas potential

Biogas potential of the feedstocks varies between 13 (banana) and 560 m^3 methane per ton of Volatile Solids (VS). This gives a VS content ranging from 0.2% for banana to more than 90% for maize stover and cereal food waste.

Table 2: Biogas potential of selected biomass resources

Resource	Volatile Solids *(% of fresh)*	Methane yield *(m3 per ton of VS)*	Methane yield *(mln m3 per year)*
Primary			
Maize stover	90	288	982
Banana stems	0,2	13	0.05
Cattle manure	9	192	595
Chicken manure	19	277	2.184
Secondary			
Sisal pulp	10	330	20
Coffee pulp	50	244	67
Slaughterhouse waste	12	560	4
Tertiary			
Cereal waste	91	265	526
MSW (Nairobi)	18	260	47

Feedstock mixtures

Cattle manure is the dominant feedstock used in options 1, 2, 3, 4 and 6 while option 5 and 7 considerable shares of chicken manure. Field residues have been included in option 2 (banana stems) and 6 (maize stover). Food industry residues include coffee pulp (option 3), sisal pulp (option 7) and slaughterhouse waste (option 4). Other waste streams include cereal food waste and MSW. Most option require dilution of the mixtures with water. In the calculations, equal amounts of water are added to options 1, 5, 6 and 7. Options 2 and 3 require less water.

Methane production

Theoretical methane production varies between 20 and 80 m^3 per day. The highest yields are generated by mixtures containing cattle manure and maize stover. Pure cattle manure is the least productive option (Figure 1).

Nutrient concentration of feedstock mixtures

Figure 2 depicts nutrient concentrations of bio-slurry generated by feedstock mixtures. Highest nitrogen concentrations are found in mixtures with sisal pulp and chicken manure. Bio-slurry made from anaerobic digestion of pure cattle manure contains the lowest nitrogen concentration (less than 2 kg/m^3). Potassium concentrations are high in feedstock mixtures containing cattle manure and banana stems.

Co-financed by:
Ministry of Foreign Affairs of the Netherlands
MINISTRY OF FOREIGN AFFAIRS OF DENMARK
Danida
Co-ordinated by:
Netherlands Enterprise Agency
In partnership with:
endev

Influence of feedstock on bio-slurry quality in Kenya

Hans Langeveld, Tomas Heijnen, Manisha Lamichhane, Laura Laroche, Golaleh Gaffari

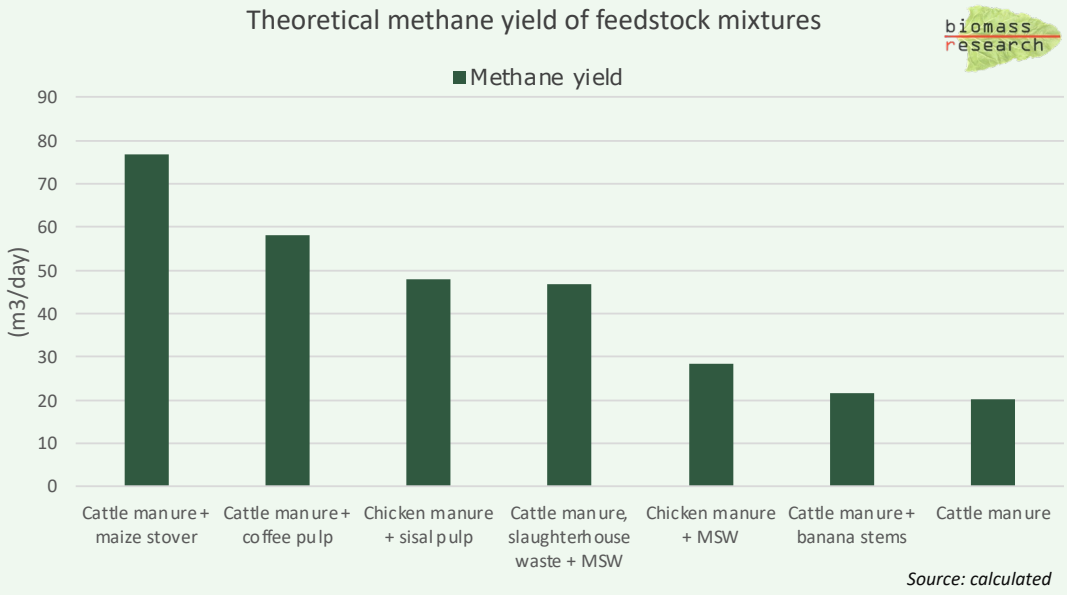

Figure 1: Theoretical methane yield of feedstock mixtures

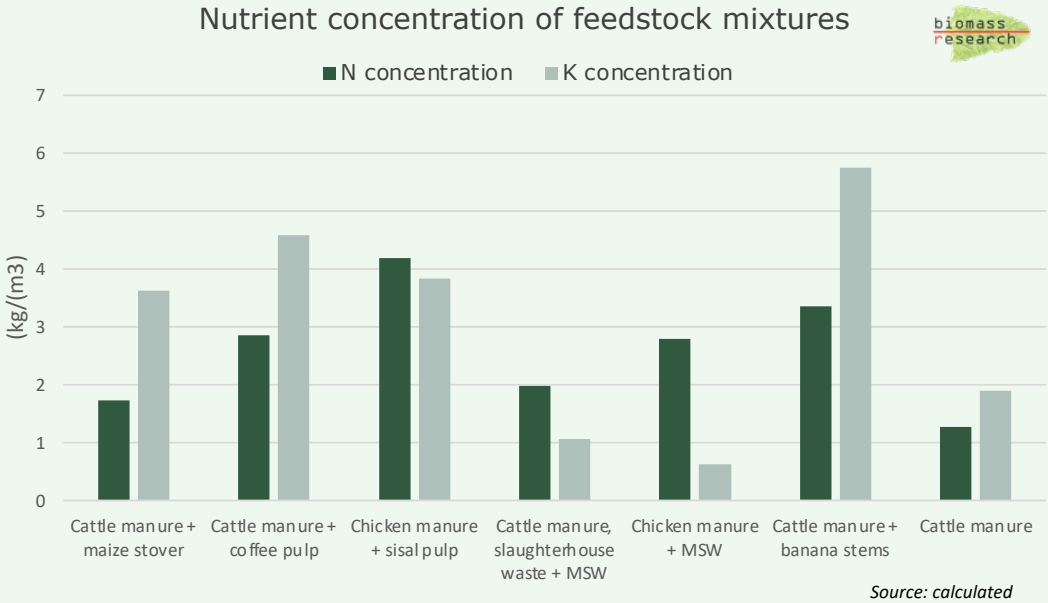

Figure 2: Bio-slurry nitrogen and potassium concentration

Conclusion

The evaluation of feedstock mixtures that can be used in medium-scale biodigesters suggest high potentials for methane production and nutrient availability. More work is needed to evaluate feedstock and mixture performance in practice. It is recommended to develop a test program for medium-scale biodigesters, which can provide valuable information on feeding options to be used in the development of the biogas and bio-slurry markets in Kenya and beyond. Current developments in countries like India and Brazil provide interesting examples for policies and market development that can serve as a point of reference.

Co-financed by:
Ministry of Foreign Affairs of the Netherlands
MINISTRY OF FOREIGN AFFAIRS OF DENMARK
Danida
Co-ordinated by:
Netherlands Enterprise Agency
In partnership with:
endev