Material Flow Analysis and Resource Recovery Potential Analysis of Kenyan biowaste: Case study of banana, Irish potato and coconut wastes

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Introduction

In Kenya, and similarly to many other (developing) countries where agriculture is a key economic activity, a significant amount of agricultural by-products is generated. Currently, a large proportion**, is left to rot, burned** or disposed of in **land fill** thus pollutes environment and are of health concern. On the one hand, biowastes can be an environmental problem, but on the other hand, they might offer an opportunity for creating a sustainable bioeconomy, as these wastes contain high added-value chemicals, macro-compounds for food or technical materials and have bioenergy potential. The most frequently occurring waste streams in Kenya are generated from fruit, vegetable and nuts. Therefore, it is important to map the waste stream flows that occurs at each step during the food supply chain and to asses the feasibility of valorizing them

Objective

This study investigates the material flow of the most abundant Kenyan biowaste streams (Banana, potato and coconut) and the potential amounts of renewable bioresources that can be valorized for various applications.

Methodology

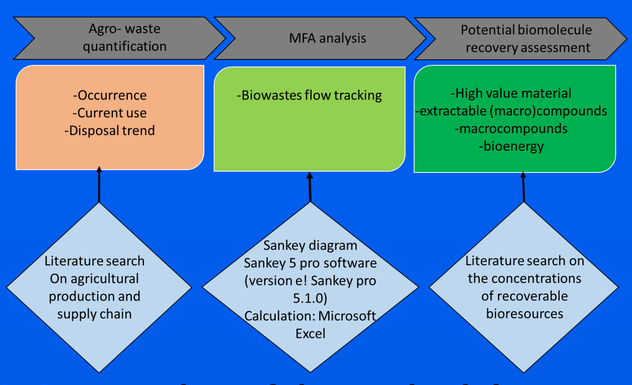

Fig. 1. An overview of the methodology used

The system boundary, was the spatial border of **Kenya**, the temporal boundary was the year 2018, while the functional unit was the total quantity of agricultural products in 2018.

Data Quality was checked by Assessment analysis approach similar to the pedigree-matrix and found to be of high to very high quality.,

Results & Discussion

Biowaste current use and disposal trend

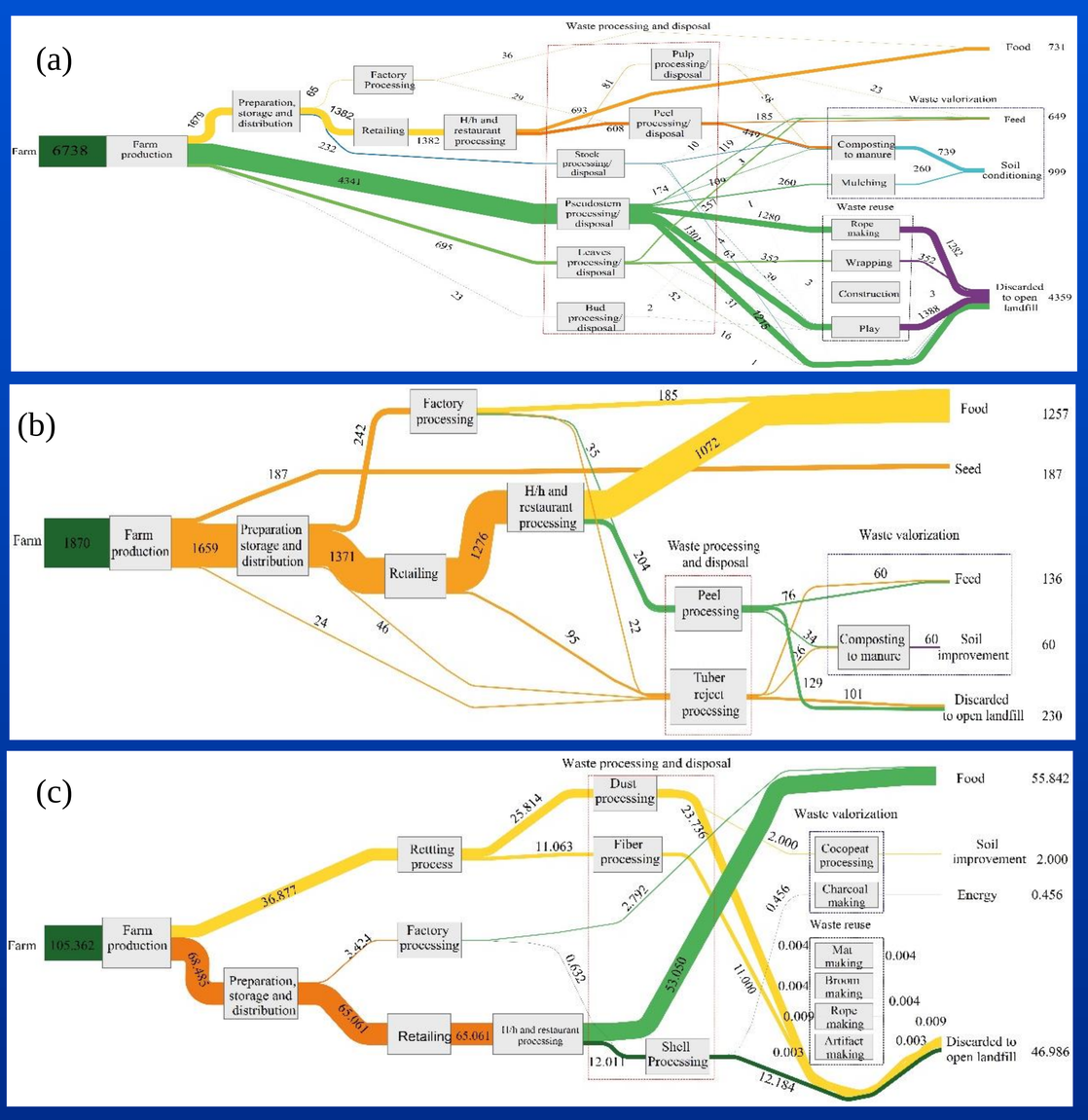

Figure 2.: MFA diagrams of by-products in fresh weight basis (a) banana (kt), (b) potato (kt) and (c) coconut (t)

Bioresource Recovery

Table 1. Summary of the potential of biomaterial recovery from bio-wastes

Biomass	High value compounds (kt)		Extractable (macro)compounds for use in feed and food (kt)			Macrocompounds used as technical materials for industrial applications (kt)			Bioenergy potential (GWh)	
	Flavonoid	Tannin	Starch	Protein	Sugar	Fiber	Cellulose	Lignin	Biogas* (GWh)	Bioethanol** (GWh)
Banana Peel	34.9	8.3	71.2	13.4	2.1	limited	23.3	24.9	305.4	34.4
Pseudostem	33.9	limited	241.0	31.0	113.3	476.1	1670.4	250.5	981.7	189.7
Stock	1.5	0.9	0.8	5.9	limited	9.8	15.3	9.2	70.7	26.8
Leaves	3.8	limited	1.2	1.5	6.5	2.8	247.3	73.5	91.6	28.8
Banana pulp	0.1	0.2	26.6	1.5	1.4	limited	limited	limited	69.0	19.2
Male bud	limited	limited	limited	0.7	1.4	limited	2.4	0.6	6.8	0.7
Potato peel	0.4	limited	11.0	5.1	0.2	limited	0.7	9.6	79.2	11.6
Potato mix	limited	limited	25.2	5.1	0.2	limited	13.6	2.8	77.4	34.4
Coconut shell	limited	0.4	limited	limited	limited	limited	8.5	3.9	56.0	limited
Coconut husk	limited	1.8	limited	limited	13.7	11.1	19.2	15.5	19.2	10.3

Table 2. Summary of the potential of biomaterial recovery from bio-wastes

Waste Parts	Occurance	Main Current destination	Potential future destination	Overal potentiaal
Banana Peels	Mainly dispersed	Compost, feeding	Flavonoid, starch, lignin, biogas	Medium
Pseudostem	Central	Play, rope, discarded (rotting/burned)	Flavonoid, starch, cellulose, biogas	High
Stock	Central	Compost, discarded, play	Flavonoid, protein, cellulose, biogas	High
Leaves	Central	Wrapping, feeding	Flavonoid, Sugar, cellulose, biogas	High
Banana Pulp	Mainly dispersed	Compost, feeding	Tannin, starch, biogas	Medium
Male bud	Central	Play	Sugar, cellulose, biogas	High
Potato peel	Mainly dispersed	Discarded, feed	Flavonoid, starch, lignin, biogas	Medium
Potato mix	Mainly dispersed	Discarded, feed	Starch, cellulose, biogas	Medium
Coconut shell	Mainly dispersed	Discarded, soil improvement	Tannin, cellulose, biogas	Medium
Coconut husk	Central	Discarded, soil improvement	Tannin, sugar, cellulose, biogas	High

Conclusions

- ✓ About 6007 (73%), 426 (54%) and 50 kt (95%) of banana, Irish potato and coconut biomass respectively is wasted.
- ✓ All waste streams occur centrally except, banana pulp and peal, potato peel and mixt waste and coconut shell that occur mainly dispersed
- ✓ All the wastes can be biorefined, offering potential towards recovery of; flavonoids (74 kt), starch (377 kt), cellulose (2001 kt) and biogas (1757 GWh), being the total potential of the main bioresources from the three waste streams
- ✓ This study therefore, generally concludes that, with proper waste collection, sorting and valorisation, there is a huge potential for bioeconomy in Kenya, at the same time reducing waste management problems

Acknowledgement

The authors would like to express appreciation for the support of the VLIR-UOS, Belgium for financial support to this research through Project No. KE2018TEA464A103