Fuel Value Indices of selected woodfuel species in Masindi and Nebbi districts of Uganda

By
Samuel Ojelel (PhD Fellow)
Makerere University, Uganda
Email: samojelel@cns.mak.ac.ug/samojelel@gmail.com
Mobile: +256(0)772188705/ +256(0)756188705

Introduction Uganda's biomass sector

- Biomass accounts for 94% of energy
  - Woodfuel (80%),
  - Charcoal (10%) and
  - Crop residues (4%)
- Firewood to GDP: $48M
- Charcoal to GDP: 26.8M (MEMD 2016)

- Other sources: HEP, Solar, Biogas, LPG, Kerosene.

Introduction Uganda's biomass sector

- Sector features
  - Poor organization
  - Inadequate enforcement of regulations
  - Inefficient technologies (Traditional Kilns)
  - Lack of standards
  - Unsustainable production

Introduction

Study objectives

1. To identify the woodfuel species commonly used in Masindi and Nebbi districts of Uganda

2. To determine the Fuel Value Indices (FVIs) of ten (10) selected tree species from basic properties namely; moisture content, density and gross calorific value

Methods

Study area

- Uganda is located in Africa (East Africa)
- Masindi and Nebbi districts
- Woody biomass stocks & supplier

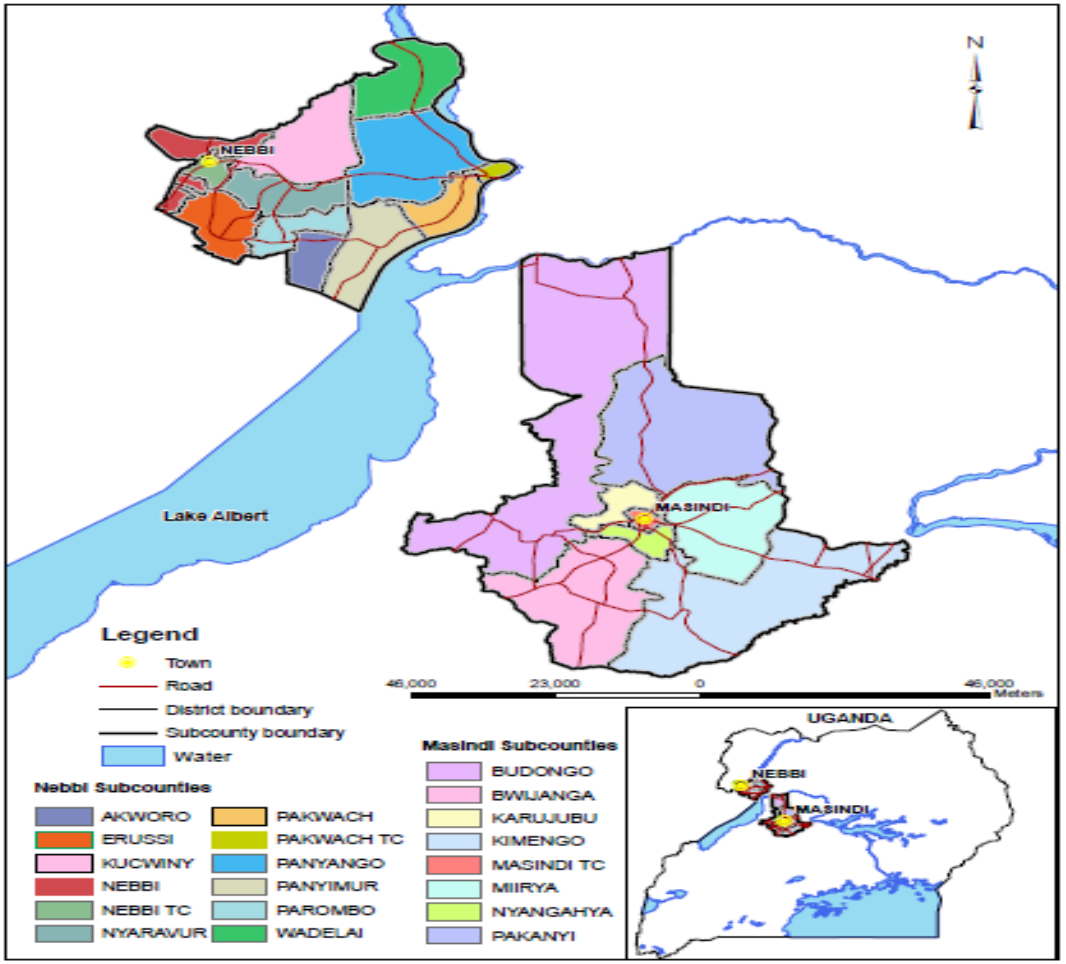


Figure 1: Location of Masindi & Nebbi districts

Methods Sampling procedure

- Multistage sampling to locate sampling area
- 80 respondents identified by systematic random sampling
- Semi-structured questionnaire
- Free listing technique (Lykke 2000)
- 10 species using Familiarity Index (Tabuti *et al.* 2003)

Methods Moisture Content (MC)

- Samples from 10 select species
- 30cm length and 2.5cm thick*
- Subdivided into triplicates of 10cm
- Marked and weighed** immediately in the field
- Each triplicate analyzed for % moisture content, density and calorific value

■ % moisture content (Valter *et al.* 2008)

$$MC = \frac{Ww - Wd}{Ww} x100\%$$

* Using a vernier caliper; ** using a pocket scale

Methods Wood Density

- Density determined as ratio between oven-dry weight (g) and volume (cm^3) (Marcelo et al. 2008)
- → Volume determined by Immersion* technique
- → Re-dried to constant weight
- → Density:

$$Volume = \frac{\pi D^2 L}{4}$$

$$Density = \frac{DW}{SV}$$

Methods Gross Calorific Value

- Gallenkamp Autobomb calorimeter (SG96/02/536, Gallenkamp & Company Ltd, England UK)
- 1g of each sample pelleted & burnt (Agea *et al.* 2014)

$$GVC = \frac{\{(FT-IT)x10.82]-0.086]\}}{\text{Weight of sample}}$$

- 10.82 = Heat capacity of the calorimeter in kJ/K;
- 0.086 = Combined energy value of nickel wire and cotton in kJ/g.

Methods Fuel value Index (FVI)

- FVI was computed following Abbot *et al.* (1997)

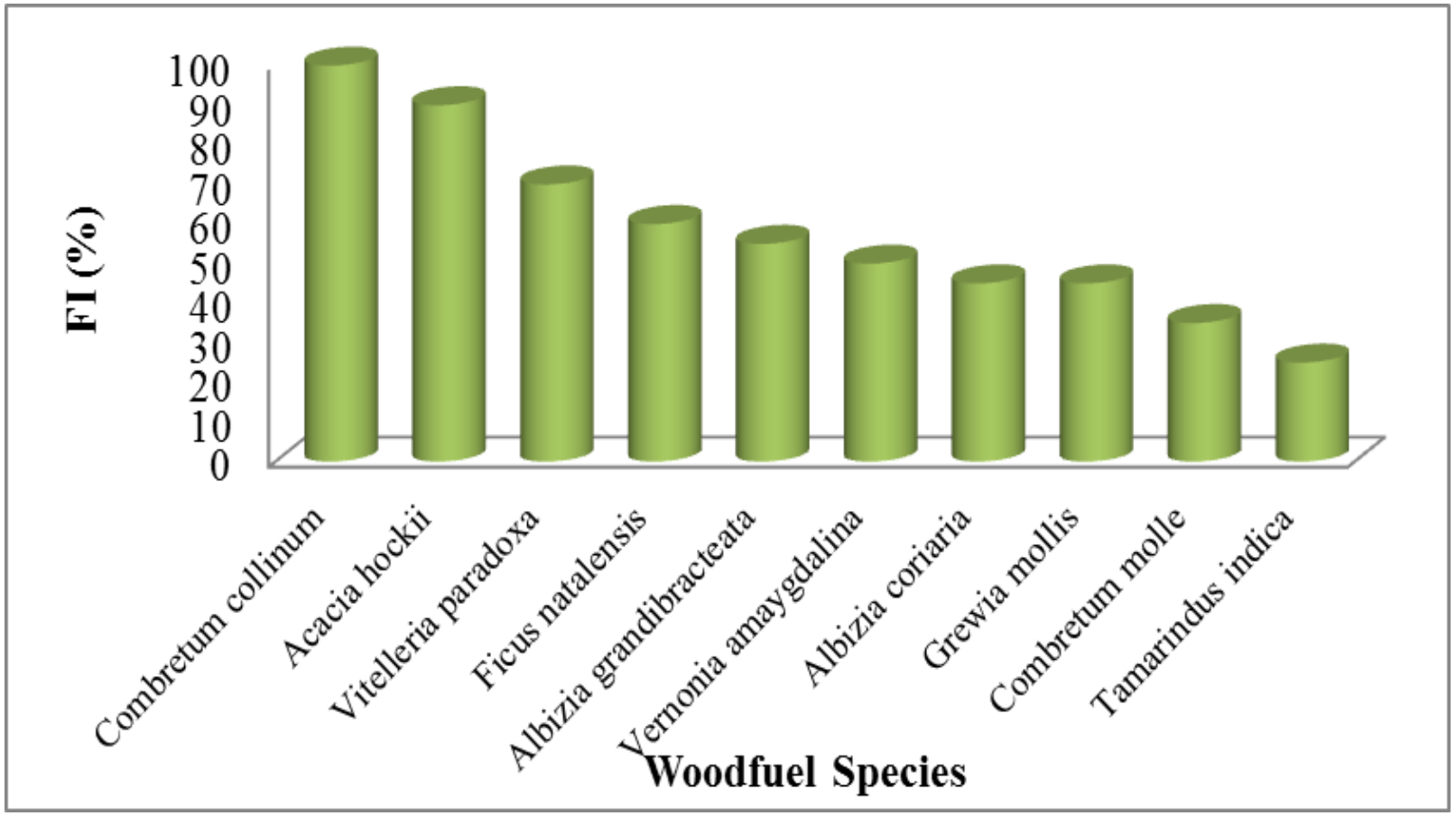
$$FVI = \frac{CalorificValue(KJg^{-1}) x Density(gcm^{-3})}{MoistureContent(\%)}$$

Results Selected woodfuel species

Species	Family
Combretum collinum Fres	Combretaceae
Acacia hockii De Wild	Mimosaceae
Vitellaria paradoxa C.F. Gaertn	Sapotaceae
Ficus natalensis Hochst	Moraceae
Albizia grandibracteata Taub	Mimosaceae
Vernonia amaygdalina Delile	Compositae
Albizia coriaria Welw.ex Oliver	Mimosaceae
Grewia mollis L.	Tiliaceae
Combretum molle R.Br.ex G.Don	Combretaceae
Tamarindus indica Linnaeus	Caesalpinaceae

Results

Familiarity Indices of Woodfuel species



Results Woodfuel species parameters

Species name	% Moisture Content	Density (gcm^{-3})	Gross Calorific value (KJg^{-1})	FVI
Combretum collinum	47.19	0.47	23.49	5.50
Albizia grandibracteata	36.18	0.65	20.95	13.09
Vernonia amaygdalina	54.04	0.52	24.79	6.06
Albizia coriaria	51.87	0.59	23.14	7.60
Combretum molle	50.42	0.49	24.64	5.93
Vittelaria paradoxa	48.97	0.45	22.79	4.87
Grewia mollis	37.47	0.47	25.77	7.61
Tamarindus indica	41.92	0.41	24.71	5.00
Acacia hockii	48.61	0.38	25.21	3.63
Ficus natalensis	69.41	0.23	29.46	1.10

Results Variability of parameters

Parameter	Variation
% moisture content	$F_{(d.f=9)}=92.927$, $p=0.0001$
Density	$F_{(d.f=9)}=11.528$, $p=0.0001$
Gross calorific value	$F_{(d.f=9)}=1.400$, $p=0.253$

Results Parameter correlations*

Parameter 1	Parameter 2	Relationship
% moisture content	Gross Calorific Value	r= -0.518, n=30, p=0.003
Density	Gross Calorific Value	r= 0.895, n=30, p=0.001

* Pearson product-moment correlation coefficient

Results

Conclusions

- Moisture content and density are vital properties in woodfuel selection since they vary significantly
- The Fuel Value Index (FVI) offers a better woodfuel species prioritization than a single parameter
- Thus; *Albizia grandibracteata* is a more ideal woodfuel species on FVI basis while *Ficus natalensis* is least

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