Financial analysis of fuelwood production from woodlots in the savannah transition zone of Ghana

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- Methods
  - Project area description: context
  - Description of system analyzed
  - Data collection
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High demand for fuelwood in Ghana for heating and cooking

- 50% Fuelwood in the Ghanaian energy mix

IEA, 2014
98% of producers extract wood for fuel from natural sources.
INTRODUCTION

- All year round production
- Uncoordinated inter-sectoral efforts for resource management
- No standard management of fuelwood resources except natural regeneration

- Hardly any effective policy to regulate exploitation, marketing and trade in fuelwood and charcoal
INTRODUCTION

- 70 species reported by producers being extracted for fuel around Ghana
- Most frequently extracted are native hard wood species
  - with high calorific values
    - Anogeissus, Ptericarpus
    - Mangroves, Celtis
    - Albizia, Vitellaria paradoxa
    - Khaya, Etc.

Obiri et al 2014 and 2015
INTRODUCTION

DECLINING STOCKS OF PREFERRED FUELWOOD SPECIES

Commercial producers

- 5-20km to harvest wood for charcoal
ITTO funded a 3 year project (2013-2016)

To contribute to reduction in forest degradation in the forest savanna transition zone of Ghana

Specific Objective

EXPERIMENT woodlots of highly productive species with communities

- sustainable fuelwood production
- contributing to carbon sequestration
Introduction: Project components

- Baseline
- Establishment of woodlots & silviculture
- Biomass production potential
- Energy profile of species in trial plots
- Economics
- Policy
- Etc.
INTRODUCTION: WHY WOODLOT ECONOMICS?

- Technically feasible to produce fuelwood from woodlots

- Little is known of its economics in smallholder systems
OBJECTIVE OF THIS PAPER

EX-ANTE FINANCIAL ANALYSIS OF FUELWOOD PRODUCTION FROM MULTIPUPOSE WOODLOT

1. To demonstrate economic feasibility of fuelwood production from woodlots on smallholder plots
   - For wealth creation
   - Sustain fuelwood dependent livelihoods

2. Information to support policy decisions for promoting sustainable supply of fuelwood
   - 40 year national plantation development strategy
METHODS: Study Area

KINTAMPO FOREST DISTRICT

- One major hub fuelwood for charcoal production and supply in Ghana
Forest – Savannah Transition/ Woodland Vegetation

Local economy is agrarian

All year round fuelwood production for charcoal from natural woodland is a major livelihood activity
METHODS

- WOODLOT ESTABLISHMENT AND ASSESSMENT
PARTICIPATORY PROCESS FOR ESTABLISHING WOODLOTS

Introductory meeting & planning → Seedling production → Land preparation

Seedling production → Monitoring → Pegging & planting

Monitoring → Growth evaluation → Review meeting with farmers

1 year old Acacia woodlot →
METHODS

IDENTIFICATION OF PRIORITY SPECIES FOR WOODLOTS
Preferred native tree species for woodlot establishment

- Annogeisus
- Ptericarpus

% of respondents
ECOLOGICAL STUDIES
INVENTORY OF FUELWOOD SPECIES
Fuelwood Species Abundance
COMAPARISON BETWEEN COMMUNITY LAND AND FOREST RESERVE

Traditional woodfuel species

- Anogeissus leiocarpus
- Combretum glutinosum
- Pterocarpus erinaceus
- Daniellia oliveri
- Acacia Kirkii
- Terminalia mollis
- Combretum fragrans
- Mitragyna inermis

Frequency

Buru
attakura
Priority fuelwood species

GHANA FORESTRY COMMISSION

National Recommended fuelwood species

- National forest plantation development strategy
  - 6 exotic species proposed for woodfuel production

1. Acacia auriculiformis
2. Acacia mangium
3. Senna siamea
4. Millettia thonningii
5. Azadirachta indica
6. Eucalyptus spp.
Priority woodfuel species

1. *Anogeissus leiocarpus* (Kane)
2. *Pterocarpus erinaceus* (Rose wood- Krayie)
3. *Khaya senegalense*
4. *Azadirachta indica* (Neem)
5. *Senna siamea*
6. *Acacia mangium* and *Acacia cracicapra* (Acacia)
7. *Terminalia ivorensis*

Seed collection and processing
Species screening at the germination laboratory and seedling production on-station
METHODS: Woodlot establishment

- Farmer woodlot plot design and tree-food crop-mix

FC = FOOD CROP
50 farm trials planted with 3 native & 3 exotic spp. 2014-2015
2014-2016 WOODLOTS

Neem

Cassia

Acacia

Anogeissus
DATA USED & ANALYSIS

- Woodlot rotation & operations
- INPUT-OUTPUT (COST & REVENUES)
- FIELD OBSERVATIONS

Obiri et al., 2014
SYSTEM ANALYZED: financial analysis

- 20 farmer managed multipurpose woodlot of 6 species mix
- Mahogany in the mix for timber for 25 years
- 5 rotations, each for 5 years over 25 years production period
  - First harvest 5 years after planting trees with food crop integration for first 2 years
  - Subsequent production based on 5 years of coppice growth with food crop integration in first 2 years

<table>
<thead>
<tr>
<th>5 years</th>
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</thead>
<tbody>
<tr>
<td>Food crops 2yrs</td>
<td>Fuel Trees 5yrs</td>
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<td>Food crops 2yrs</td>
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<td>Fuel Trees 5yrs</td>
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</tbody>
</table>

EST. 5 years + timber

20 years coppice
Sequential cropping agroforestry model used in establishment and Management of rotations in woodlots

Source: Elevitch & Wilkinson, 2000

Initial planting of tree seedlings and crops

Years 1–5 Trees grow and begin to shade out crops
Cost and return items estimated for plantation establishment and management

- PRICES AT 2015 MARKET RATE

A. Fixed costs
   - Land

B. Recurrent
   - Tools (cutlass, chisel, spraying machine, etc.)
   - Planting materials i.e. tree seedlings, seeds of food intercrops planted in the first 1-3 years to take advantage of the soil rent on clearing of vegetation for woodlot establishment
   - Herbicides and manual weed control
   - Labour for land preparation, planting, maintenance and harvesting of wood

C. Revenue/returns
   - Total revenue was estimated from quantity of wood harvested per hectare * price per unit
ANALYTICAL PROCEDURE

FINANCIAL COST-BENEFIT ANALYSIS

- Discounted cash flow over 25 years at 25% lending rate for agric & forestry projects (ADB, 2015). Estimated:
  - Net returns
  - Benefit : Cost Ratio
  - Net Present Value

- Sensitivity: What if?
  - Total costs increases up to 50%
  - Wood OUTPUT decreases (pest, disease and fire) by 50%
Discounting cash flows: Estimating present values of future costs & returns

<table>
<thead>
<tr>
<th>Year</th>
<th>Costs (C)</th>
<th>Income/returns / benefits (B)</th>
<th>Net income/returns/Net benefits (N)</th>
<th>Discount factor (DF) = $1/(1+r)^t$</th>
<th>Discounted net benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(C_0)</td>
<td>(B_0)</td>
<td>(B_0 - C_0)</td>
<td>(1/(1+0.1)^0 = 1)</td>
<td>(DF_0 \times N_0)</td>
</tr>
<tr>
<td>1</td>
<td>(C_1)</td>
<td>(B_1)</td>
<td>(B_1 - C_1)</td>
<td>(1/(1+0.1)^1 = 0.91)</td>
<td>(DF_1 \times N_1)</td>
</tr>
<tr>
<td>2</td>
<td>(C_2)</td>
<td>(B_2)</td>
<td>(B_2 - C_2)</td>
<td>(1/(1+0.1)^2 = 0.83)</td>
<td>(DF_2 \times N_2)</td>
</tr>
<tr>
<td>3</td>
<td>(C_3)</td>
<td>(B_3)</td>
<td>(B_3 - C_3)</td>
<td>(1/(1+0.1)^3 = 0.75)</td>
<td>(DF_3 \times N_3)</td>
</tr>
<tr>
<td>4</td>
<td>(C_4)</td>
<td>(B_4)</td>
<td>(B_4 - C_4)</td>
<td>(1/(1+0.1)^4 = 0.68)</td>
<td>(DF_4 \times N_4)</td>
</tr>
<tr>
<td>5</td>
<td>(C_5)</td>
<td>(B_5)</td>
<td>(B_5 - C_5)</td>
<td>(1/(1+0.1)^5 = 0.62)</td>
<td>(DF_5 \times N_5)</td>
</tr>
<tr>
<td>6</td>
<td>(C_6)</td>
<td>(B_6)</td>
<td>(B_6 - C_6)</td>
<td>(1/(1+0.1)^6 = 0.57)</td>
<td>(DF_6 \times N_6)</td>
</tr>
<tr>
<td>7</td>
<td>(C_7)</td>
<td>(B_7)</td>
<td>(B_7 - C_7)</td>
<td>(1/(1+0.1)^7 = 0.51)</td>
<td>(DF_7 \times N_7)</td>
</tr>
<tr>
<td>8</td>
<td>(C_8)</td>
<td>(B_8)</td>
<td>(B_8 - C_8)</td>
<td>(1/(1+0.1)^8 = 0.47)</td>
<td>(DF_8 \times N_8)</td>
</tr>
<tr>
<td>9</td>
<td>(C_9)</td>
<td>(B_9)</td>
<td>(B_9 - C_8)</td>
<td>(1/(1+0.1)^9 = 0.43)</td>
<td>(DF_9 \times N_9)</td>
</tr>
<tr>
<td>10</td>
<td>(C_{10})</td>
<td>(B_{10})</td>
<td>(B_{10} - C_{10})</td>
<td>(1/(1+0.1)^{10} = 0.39)</td>
<td>(DF_{10} \times N_{10})</td>
</tr>
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<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>25</td>
<td>(C_{25})</td>
<td>(B_{25})</td>
<td>(B_{25} - C_{25})</td>
<td>(1/(1+0.1)^{50} = 0.01)</td>
<td>(DF_{25} \times N_{25})</td>
</tr>
</tbody>
</table>
## DATA ANALYSIS - Cost-Benefit Analysis OVER 25 YEARS

<table>
<thead>
<tr>
<th>Profitability indicator</th>
<th>Formula</th>
<th>Decision criteria</th>
</tr>
</thead>
</table>
| B/C Ratio               | \[
\frac{\sum B_t}{(1+r)^t} \div \frac{\sum C_t}{(1+r)^t}
\] | BCR ≥ 1.0 |
| NPV                     | \[
\sum_{t=0}^{t=n} \frac{(B_t-C_t)}{(1+r)^t}
\] | NPV ≥ 0 |

B=benefit, C=cost, t=time in years or rotation/production period, r=discount rate, n=rotation length in years
RESULTS
# RESULTS AND DISCUSSION

<table>
<thead>
<tr>
<th>COST &amp; OUTPUT PARAMETERS</th>
<th>Cash flow (GH₵)/ha (over 25 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue</strong></td>
<td></td>
</tr>
<tr>
<td>Food crops (Maize, cassava, pepper &amp; yam)</td>
<td>67,400</td>
</tr>
<tr>
<td><strong>Fuelwood</strong></td>
<td>20,400</td>
</tr>
<tr>
<td>Mahogany Timber</td>
<td>74,000</td>
</tr>
<tr>
<td><strong>Total revenue</strong></td>
<td>161,800</td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
</tr>
<tr>
<td>Land</td>
<td>1,500</td>
</tr>
<tr>
<td>Tools/Equipment</td>
<td>1,740</td>
</tr>
<tr>
<td>Food crop seeds, tree seedlings and fertilizers</td>
<td>1,940</td>
</tr>
<tr>
<td>Labour (land preparation, planting, weeding, creation of fire belt, harvesting and processing food crops)</td>
<td>15,610</td>
</tr>
<tr>
<td>Labour for production (harvesting wood, collection, packing near site, cutting into pieces and stacking)</td>
<td>4,960</td>
</tr>
<tr>
<td>Marketing costs (assumed wood will be purchased on farm and food crops at farm gate)</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total Costs</strong></td>
<td>25,750</td>
</tr>
<tr>
<td><strong>Net income</strong></td>
<td>136,040</td>
</tr>
</tbody>
</table>

Labour = GHC20,750  
1USD = GHC4
## PROFITABILITY OF WOODLOT: discounted cash flow over 25 years

<table>
<thead>
<tr>
<th>Profitability indicators</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>25% DR</td>
</tr>
<tr>
<td>Benefit/Cost Ratio (BCR)</td>
<td>2.87</td>
</tr>
<tr>
<td>Net Present Value (NPV) GHC</td>
<td>13,000.00</td>
</tr>
</tbody>
</table>
# Sensitivity of Profitability

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Benefit/cost ratio</th>
<th>Net Present Value (NPV) (GHC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base scenario @ 25%</td>
<td>2.87</td>
<td>13,000.00</td>
</tr>
<tr>
<td>Increase total cost at 50%</td>
<td>1.93</td>
<td>9,547.00</td>
</tr>
<tr>
<td>Decrease in wood yield by 50%</td>
<td>1.81</td>
<td>8,371.00</td>
</tr>
</tbody>
</table>
CONCLUSIONS & LESSONS

- Ex-ante financial analysis indicates that:
  - It is economically feasible to integrate (multipurpose) fuelwood woodlots into farming systems
  - Profitable at 25% market discount rate
  - Profitable with upward changes in cost and decreased wood yield up to 50%

- Shorter rotations of 5 years for fuelwood production from fast growing tree species
  - Increases the frequency of food crop integration
  - Enhances income from the woodlot production system
  - Residual fertilizer from food crop enhances tree growth
CONCLUSIONS & LESSONS

- Diversifying woodlot with timber enhances overall income
  - **Short term (food crops)**
  - **Medium term (fuelwood)**
  - **Long term (timber)**

- Threats to profitability although not very sensitive to changes
  - Problems with establishment and maintenance that needs to be minimized

Weed management  Abandoned farms  Cattle browsing  Termites  Fire
NEXT STEPS

- Economics of alternative traditional land use to compare results with woodlots
- Species specific economics
- Labour (returns to labour)
ACKNOWLEDGEMENT

- ITTO-funds
- Colleague scientists
- Technicians
- Farmers of Kintampo North