Social – ecological resilience of the shea butter value chain upstream end

The case of Beninese shea parklands

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Outline

Introduction
Aim and research questions
Theoretical framework
Methodology
Results
Discussion
Conclusion
Background information

**SHEA NUTS**

**Tree species**
- Endemic African tree adapted to Sudano-Sahelian climate and seasonality
- Fallow areas are crucial for regeneration (Serpentè. 1996)
- Grown **wildly** in 21 countries

**Globalized market**
- Seven fold increase in **export value** since 2000 (Rousseau et al. 2017)
  - Cocoa Butter Equivalent industry (90%)
  - Cosmetic industry (10%)

**Livelihood provision**
- Nutritional health, **subsistence** & wellbeing for a rural community of 80 million people (Seghieri. 2019)
  - Domestic consumption
  - Skin based medicine
  - Income stability
- Income for 16 million **women** (Seghieri. 2019)
The Shea social – ecological system (SES)

**External drivers**
- Poverty
- Land use change
- Growing shea value & export
- Patriarchal land tenure norms

**Pressures**
- Competition for resources
- Challenging work conditions
- Lack of field ownership
- Decreasing availability of public areas for nut collection

**Women shea producers**
- Livelihoods
- Empowerment
- Cultural practices
- Food security

**Shea parklands**
- Species requirements
- Conditions for growth
- Conservation

**Use and management of natural resources**

**External drivers**
- Climate change
- Demographic pressure
- Land use change
- Valuable shea tree wood

**Pressures**
- Decreasing fallow areas
- Agricultural encroachment
- Climate change effects
- Weak conservation practices

**Delivery of ecosystem goods and services**

**Introduction**

**Research aim**

**Theoretical framework**

**Methodology**

**Results & discussion**

**Conclusion**

- Reduced access to shea resources → Long term threat to women shea producers’ social & financial independence
- Impaired regeneration & ageing stands → Long term threat to shea parklands survival
The case of Beninese shea parklands

- Rural dependence on shea for income, nutrition & cultural practices: 36-46% northern household earnings (Aleza et al. 2018)

- Shea stands degradation: ageing stands and declining density
  - Land use change & agricultural encroachment
  - Nomadic cattle herds
  - Illegal logging
  - Fires

- Women endure production pressures
  - Scarcity of shea resources
  - Competition for resources
  - Dismissal of shea manufacturing practices
  - Challenging work conditions
Aim of the study

The aim of this research is to frame, map and analyze how the resilience of Beninese shea SES is stressed and appraise links between social and ecological resilience.
Research questions

1. How is the resilience of shea SESs limited across Beninese agroforestry parklands and what characterizes hotspots of vulnerability?

2. How does shea parklands ecological resilience relate to the resilience of women’s livelihoods, and what conclusions can be drawn by such links?
Theoretical framework: Ostrom’s SES framework

- **Social, economic & political settings (S)**
  - Resource system (RS)
    - Shea agroforestry parklands
  - Governance system (GS)
    - Village chiefs, farmers, men, cooperatives, institutes

- **Resource units (RU)**
  - Shea trees, fruits and nuts
  - Growth or replacement rate
  - Productivity of system
  - Predictability of system dynamics

- **Actors (A)**
  - Shea women producers
  - Socioeconomic attributes
  - Leadership/entrepreneurship
  - Knowledge of SES
  - Importance of resource (dependence)
  - Technologies available

- **Focal action situations**
  - Interactions (I)
    - Agricultural encroachment
    - Patriarchal land tenure agreements
    - Growing Shea value & export
    - Challenging working conditions
    - Land use change

- **Outcomes (O)**
  - Low stand regeneration, density and survival
  - Women low access to Shea resources

- **Related ecosystems (ECO)**
  - Climate patterns

**Direct link**

**Feedback**

**Introduction**

**Research aim**

**Theoretical framework**

**Methodology**

**Results & discussion**

**Conclusion**
Shea SES framework multi-level variables of resilience

Introduction

Research aim

Theoretical framework

Methodology

Results & discussion

Conclusion

Ostrom’s SES theoretical framework

Folke’s SES resilience thinking theory

2nd tier variables

14 themes

3rd tier variables

19 indicators

4th tier variables

115 variables

Perseverance

Adaptability

Transformability

2nd tier variables

3rd tier variables

4th tier variables
<table>
<thead>
<tr>
<th>Indicators</th>
<th>Variables</th>
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<th>Variables</th>
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</thead>
<tbody>
<tr>
<td>Economic attributes</td>
<td>Access to microfinances, access to cooperative funds, access to remittances, children education, house materials, owned cropland</td>
<td>Shea conservation &amp; management measures</td>
<td>Perceived lack of informal ban on logging, sanctions for logging, reporting loggers to village chief, individual tree protection, foresters supervision, initiatives for awareness raising, protected areas, planting activities documented sanctions for tree cutting, foresters supervision, activities to enhance regeneration, domestication of shea</td>
</tr>
<tr>
<td>Social attributes</td>
<td>Bonding social capital, bridging social capital, linking social capital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Working environment and conditions</td>
<td>Arduous collection, arduous transportation, arduous processing, arduous nut stocking, arduous nut drying, distance from fields &amp; fallows, violence, long production process, low quantity of fruits, deforestation and fallow decline, inaccessibility of fallows, absence of market, erratic climate</td>
<td>Climate change effects on production</td>
<td>Higher temperatures, increased rainfall, decreased rainfall, erratic rainfall patterns, longer dry season, seasonal variability, stronger winds effects on tree production, nut collection, nut stocking, shea butter quality</td>
</tr>
<tr>
<td>Competition for resources</td>
<td>Reliance on fallows for nut collection, felt competition, men implication, documented evolution of shea producers increase, documented evolution of value, trade and sale of shea</td>
<td>Environmental events effects on production</td>
<td>Droughts, floods, strong winds, erosion, pest invasion, fire (natural &amp; anthropogenic), land use change effects on tree production, nut collection, nut stocking, shea butter quality</td>
</tr>
<tr>
<td>Technologies available</td>
<td>Availability of transport means, of collection materials, of processing tools, of materials for drying nuts, for stocking nuts</td>
<td>Shea stocking levels</td>
<td>Shea stand density index in fields, Shea stand density index in bush and fallow areas</td>
</tr>
<tr>
<td>Dependence on shea for subsistence</td>
<td>Use of shea income, percentage of shea income in total income, capacity to feed family when shea production is reduced, shea based dishes, extent of shea traditional use</td>
<td>Shea seedlings recruitment limitation</td>
<td>Shea seedlings recruitment limitation in fields, Shea seedlings recruitment limitation in bush and fallow areas</td>
</tr>
<tr>
<td>Perception of shea SES vulnerability</td>
<td>Awareness of shea vulnerability, perception of shea regeneration evolution, perception of shea population dynamics, perception of shea fruit production evolution, documented shea stands decline, documented shea stands degradation</td>
<td>Shea saplings recruitment limitation</td>
<td>Shea saplings recruitment limitation in fields, Shea saplings recruitment limitation in bush and fallow areas</td>
</tr>
<tr>
<td>Entrepreneurship</td>
<td>Sources of income, additional skills</td>
<td>Agricultural expansion dynamics</td>
<td>Documented deforestation, documented land pressure, documented bushland retreat, bushlands available, relative stand density index</td>
</tr>
<tr>
<td>Leadership, independence and property-rights</td>
<td>Restricted access to fields by husband, management of own shea income, management of seedling conservation in fields, management of tree felling in fields, management of tree plantation in fields, restricted access to fallow areas by village chief management of seedling conservation in fallows, management of tree felling in fallows, management of tree plantation in fallows, local land tenure rights for women</td>
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</tbody>
</table>
Data collection

- Shea producers sample size: 177
- Clusters sample size: 84
- Key informants sample size: 10

Semi-structured interviews
- Criterion sampling
- 1 village chief

Land Degradation Surveillance Framework (LDSF)
- Criterion sampling
- 5 field area clusters
- 5 bush and fallow area clusters

Cluster plots design:
- Four 1000 m² circular plots for tree counting and DBH measurements
- Four 100 m² circular plots for seedlings counting

Nested questionnaires
- Simple random sampling
- 15 women shea producers
### LDSF design

<table>
<thead>
<tr>
<th></th>
<th>LDSF</th>
<th>Study</th>
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<tr>
<td>Sub plot</td>
<td>100 m²</td>
<td>100 m²</td>
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<tr>
<td>Plot</td>
<td>1 000 m²</td>
<td>1 000 m²</td>
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<tr>
<td>Plots per cluster</td>
<td>10</td>
<td>4</td>
</tr>
<tr>
<td>Plot area per cluster</td>
<td>10 000 m²</td>
<td>4 000 m²</td>
</tr>
<tr>
<td>Cluster area*</td>
<td>6.25 km²</td>
<td>2.5 km²</td>
</tr>
<tr>
<td>Number of clusters</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>Site**</td>
<td>100 km²</td>
<td>25 km²</td>
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</tbody>
</table>

* Each cluster in the study corresponds to a crop field or a fallow area.
** The site in the study corresponds to the visited village.

**Illustration of sampling design**

- 100 km² site with 16 sampling clusters
- 25 km² site with 10 sampling clusters

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**Introduction**

**Research aim**

**Theoretical framework**

**Methodology**

**Results & discussion**

**Conclusion**
Data analysis
mixed methods

LDSF data
- Stand density index
- Population structure

Semi-structured interviews
- Thematic analysis
- Triangulation Transformation Model

Questionnaires
- Data transcription

SESR variables
- Lavaan Confirmatory Factor Analysis

SESR indicators
- Kruskal-Wallis test
- Scheffé post-hoc test
- Lavaan Confirmatory Factor Analysis
- Principal Component Analysis
- Spearman Correlation Analysis
- Kernel Regression Analysis

Quantitative variables

Composite indicators

Significance in study areas

S & E resilience scores

Links between S & E resilience

Introduction

Research aim

Theoretical framework

Methodology

Results & discussion

Conclusion
Results

In what ways is the resilience of Beninese shea producing communities affected?

- Kruskal Wallis & post-hoc Scheffé
- Confirmatory factor analysis

Perseverance
- Challenging work conditions
- Competition for shea
- Property rights
- Climate change effects
- Extreme natural events effects

Adaptability
- Shea conservation
- Social attributes
- Perception of vulnerability
- Technologies available

Transformability
- Dependence on shea
- Entrepreneurship
- Economic attributes
Perceptions of climate change effects on shea production

Introduction

Research aim

Theoretical framework

Methodology

Results & discussion

Conclusion
Results

What is the current ecological state of shea parklands and how has it evolved in recent years?

- Kruskal Wallis & post-hoc Scheffé
- Confirmatory factor analysis

Higher/lower shea density levels compared to data collected 15 years ago (Gnanglè. 2005)
Recruitment limitation

Shea population structure

- dbh (cm)
- stems
- area
- fallow
- field

Introduction
Research aim
Theoretical framework
Methodology
Results & discussion
Conclusion
Results

What characterizes hotspots of vulnerability?

Principal component analysis
Social and ecological resilience indexes association

Introduction

Research aim

Theoretical framework

Methodology

Results & discussion

Conclusion

Shea stands resilience index

0: more resilient
1: less resilient

Weak correlation at total sample size

Spearman correlation analysis

\[ y = 0.49 + 0.08x \]

SES resilience correlation

R\(^2\) (0.18)

p<0.05
Kernel non-parametric multiple local regression

Dependent variable: social resilience index

Independent variables:
• Saplings and seedlings recruitment limitation in fallows (SARLfa, SERLfa)
• Saplings recruitment limitation in fields (SARLfi, SERLfi)
• Stocking in fields and fallows (SDIfi, SDIfa)

- : more resilient
+ : less resilient

Model 1
F-statistic $p < 0.001$
$R^2 = 57\%$
Only seedlings recruitment limitation in fields (SERLfi) is significantly associated

Model 2
F-statistic $p < 0.000$
$R^2 = 57\%$
$RSE = 16\%$

- At low SERLfi levels, as regeneration decreases shea-based livelihoods resilience increases
- At moderate SERLfi levels, as regeneration decreases, livelihoods resilience decreases
- At high SERLfi levels, as regeneration decreases livelihoods resilience increases
- At very high SERLfi levels, as regeneration decreases livelihoods resilience decreases
Correlations of relevant indicators

- Seedlings recruitment limitation in fields significant correlations
- Agricultural expansion dynamics significant correlations

Spearman correlation analysis

- $R^2(-0.26)$, $p<0.01$
- $R^2(-0.19)$, $p<0.05$
- $R^2(0.64)$, $p<0.01$

Agricultural expansion dynamics

- Economic pressures are linked with agricultural encroachment
- Increased women land access is linked with agricultural expansion dynamics increase
- Shea ecological degradation is linked with agricultural expansion dynamics

Introduction

Research aim

Theoretical framework

Methodology

Results & discussion

Conclusion
Conclusions

Introduction
Research aim
Theoretical framework
Methodology
Results & discussion
Conclusion
Conclusions

- Vulnerability of Beninese shea SES
  - Northern regions, the most dependent on shea for subsistence
  - Low transformability seems to be the most significant factor reducing shea-based livelihoods resilience
  - Seedlings and saplings recruitment limitation, especially in field areas pressure shea stands resilience
- No significant correlation between shea stands decline and shea producers’ resilience
- A link between shea-based livelihoods resilience and shea recruitment limitation in fields exists
  - Agricultural encroachment as driver
- Future trends
  - Increased inequalities in access to shea, especially for women
  - Drifting away from shea resources: transformability


Acknowledgments for the field work team participants