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 (Serpentié. 1996)
- Grown **wildly** in 21 countries

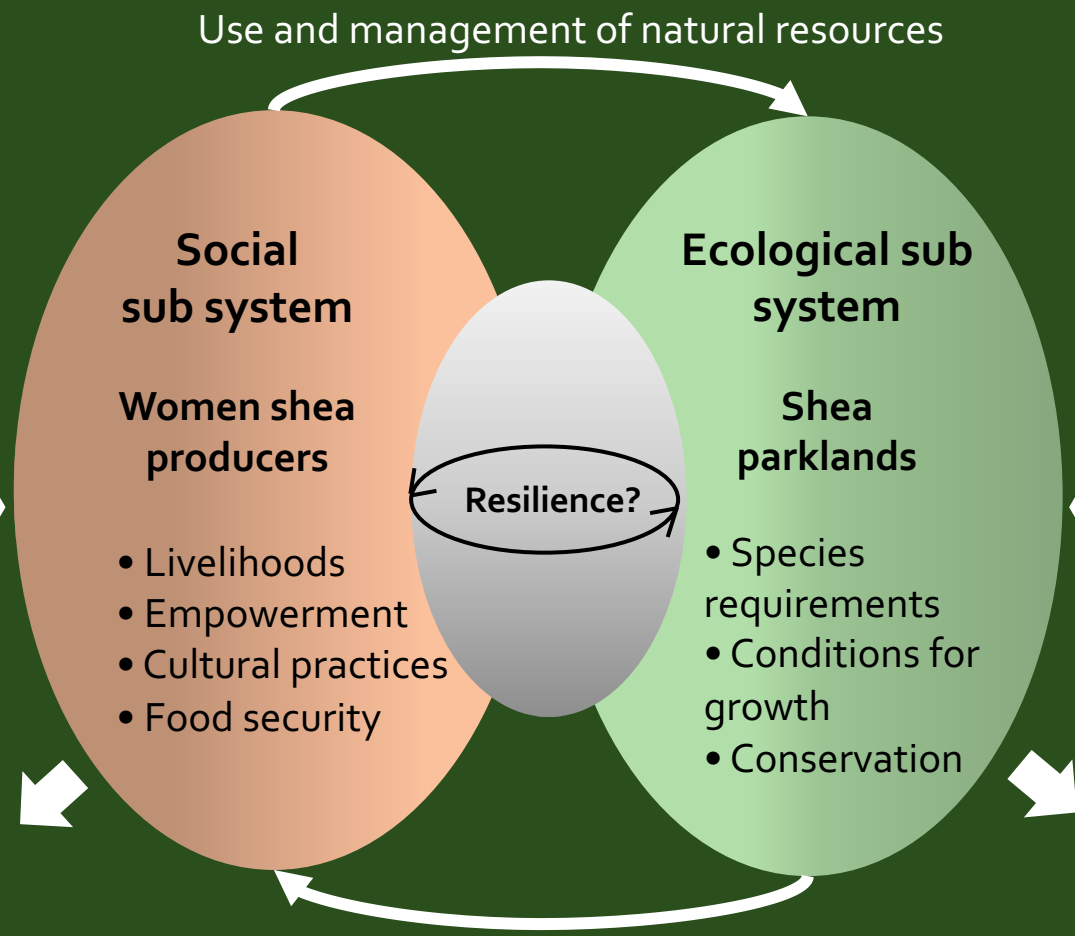
Globalized market

- 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

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

- **Reduced access to shea resources**

→ Long term threat to women shea producers' social & financial independence

- **Impaired regeneration & ageing stands**
- **Declining shea stands density**

→ 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

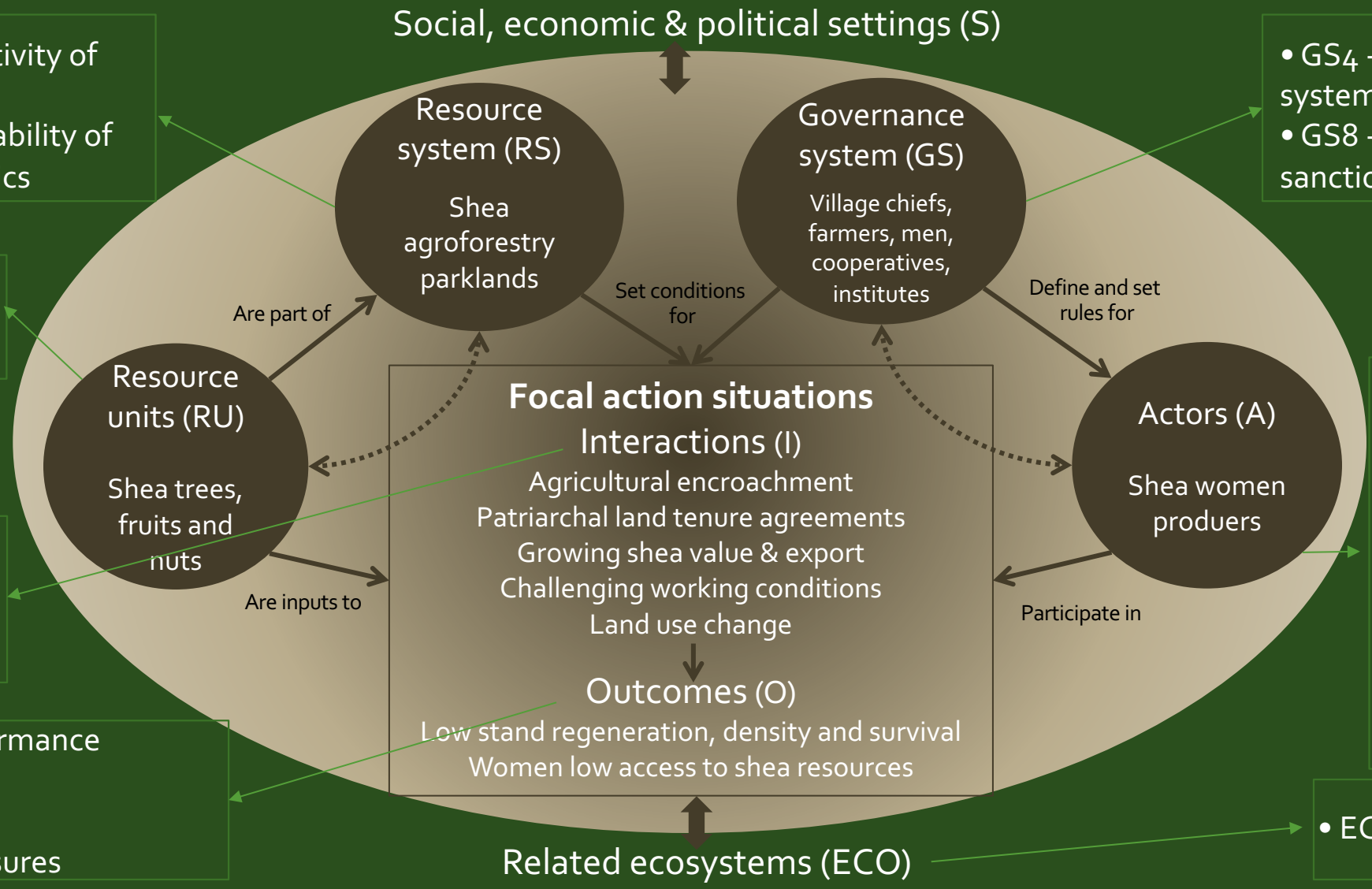
Aim of the study

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**.

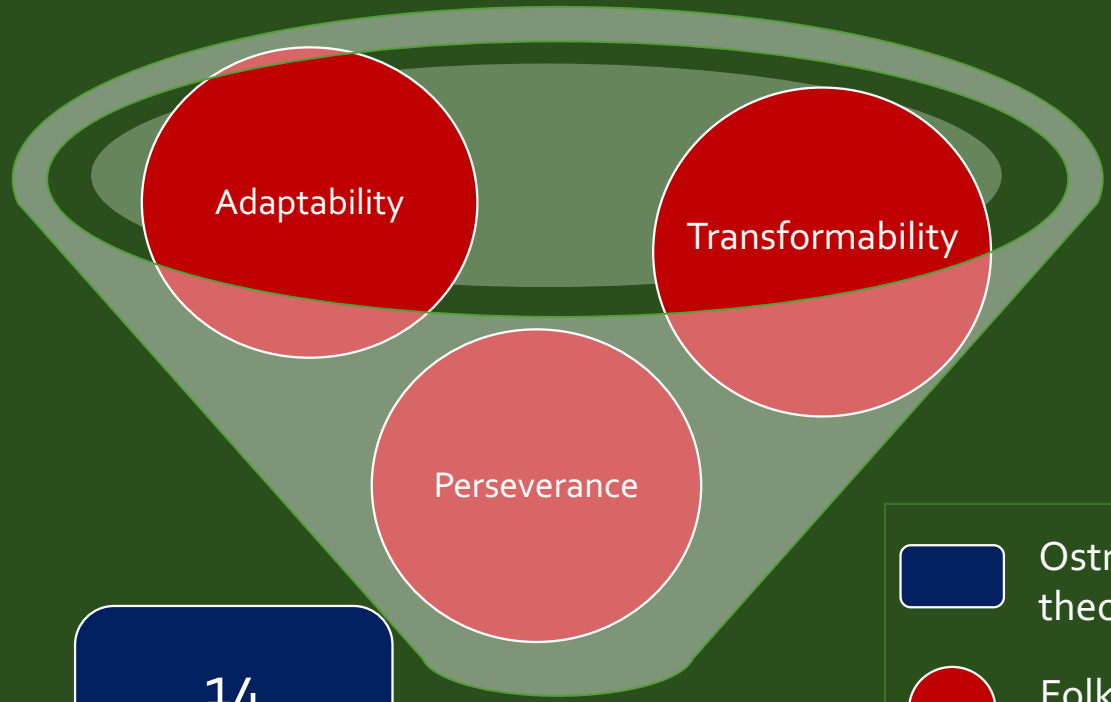
Research questions

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



Shea SES framework multi-level variables of resilience



2nd tier variables

14 themes

3rd tier variables

19 indicators

4th tier variables

115 variables

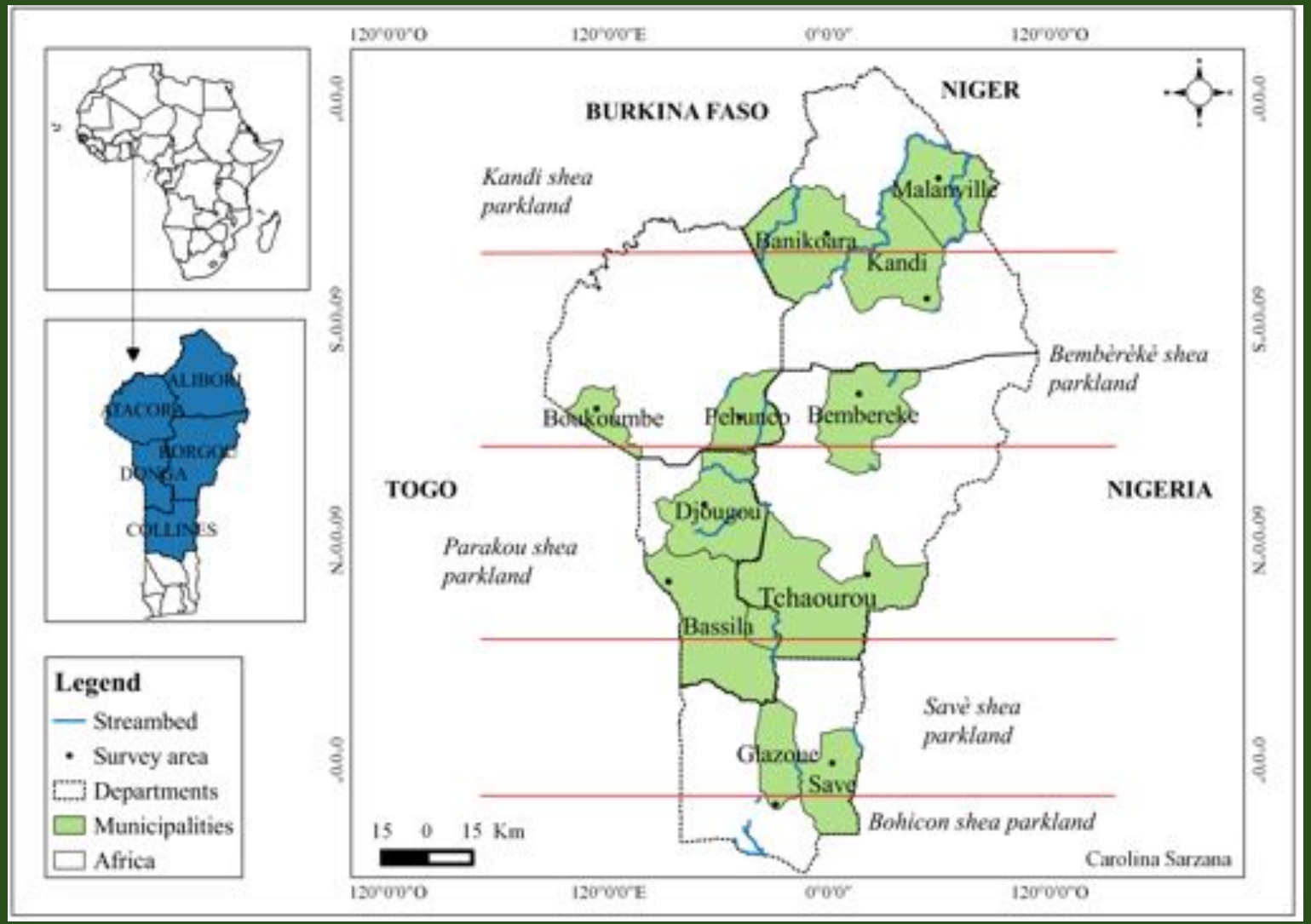
Ostrom's SES theoretical framework

Folke's SES resilience thinking theory

Indicators	Variables
Economic attributes	Access to microfinances, access to cooperative funds, access to remittances, children education, house materials, owned cropland
Social attributes	Bonding social capital, bridging social capital, linking social capital
Working environment and conditions	Arduous collection, arduous transportation, arduous processing, arduous nut stocking, arduous nut drying, distance from fields & fallows, violence, long production process, low quantity of fruits, deforestation and fallow decline, inaccessibility of fallows, absence of market, erratic climate
Competition for resources	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
Technologies available	Availability of transport means, of collection materials, of processing tools, of materials for drying nuts, for stocking nuts
Dependence on shea for subsistence	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
Perception of shea SES vulnerability	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
Entrepreneurship	Sources of income, additional skills
Leadership, independence and property-rights	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

Indicators	Variables
Shea conservation & management measures	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
Climate change effects on production	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
Environmental events effects on production	Droughts, floods, strong winds, erosion, pest invasion, fire (natural & anthropogenic), land use change effects on tree production, nut collection, nut stocking, shea butter quality
Shea stocking levels	Shea stand density index in fields, shea stand density index in bush and fallow areas
Shea seedlings recruitment limitation	Shea seedlings recruitment limitation in fields, shea seedlings recruitment limitation in bush and fallow areas
Shea saplings recruitment limitation	Shea saplings recruitment limitation in fields, shea saplings recruitment limitation in bush and fallow areas
Agricultural expansion dynamics	Documented deforestation, documented land pressure, documented bushland retreat, bushlands available, relative stand density index

Study sites


BURKINA FASO
NIGER
TOGO
NIGERIA
Kandi shea parkland
Bembèrèkè shea parkland
Parakou shea parkland
Savè shea parkland
Bohicon shea parkland
Malanville
Banikoara
Kandi
Bembèrèkè
Djougou
Tchaourou
Bassila
Glazoue
Save
Legend
Streambed
Survey area
Departments
Municipalities
Africa
15 0 15 Km
Carolina Sarzana

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 m^2 circular plots for tree counting and DBH measurements
- Four 100 m^2 circular plots for seedlings counting

Nested questionnaires

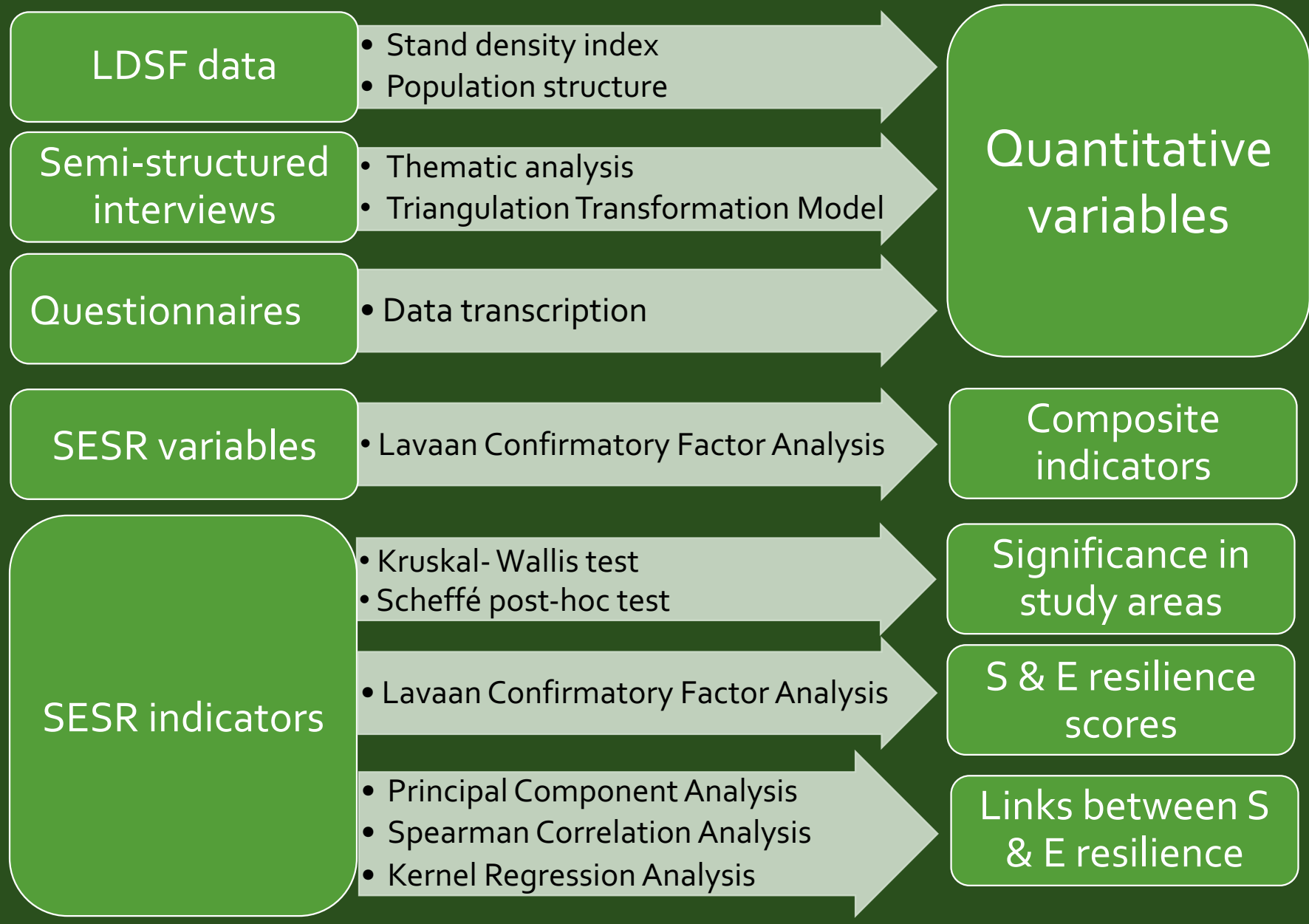
- Simple random sampling
- 15 women shea producers

LDSF design

	LDSF	Study
Sub plot	100 m²	100 m²
Plot	1 000 m²	1 000 m²
Plots per cluster	10	4
Plot area per cluster	10 000 m²	4 000 m²
Cluster area*	6,25 km²	2,5 km²
Number of clusters	16	10
Site**	100 km²	25 km²
Illustration of sampling design	 100km² site with 16 sampling clusters	 25 km² site with 10 sampling clusters

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

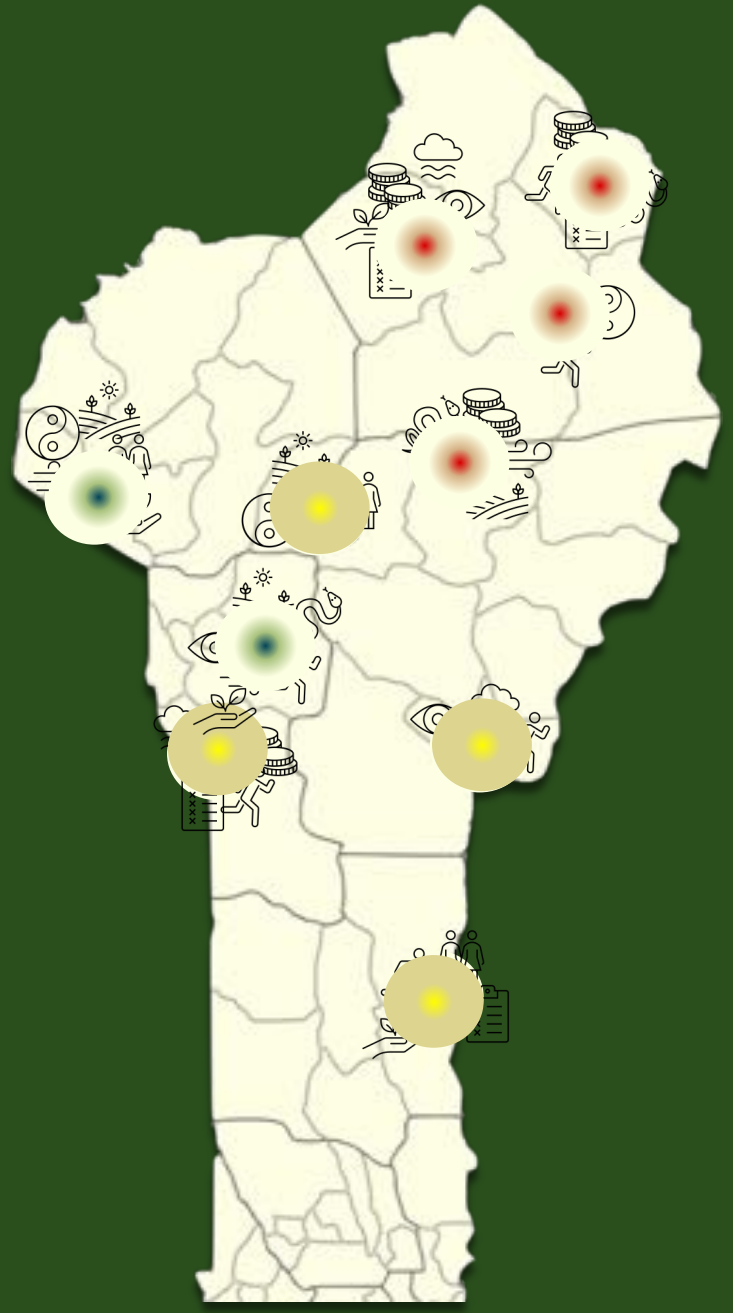
Data analysis
mixed methods



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 natual events effects

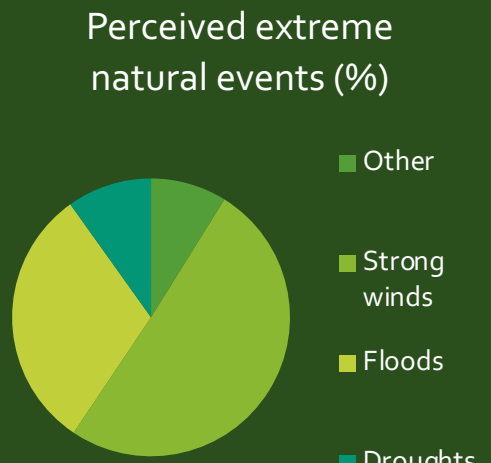
Adaptability

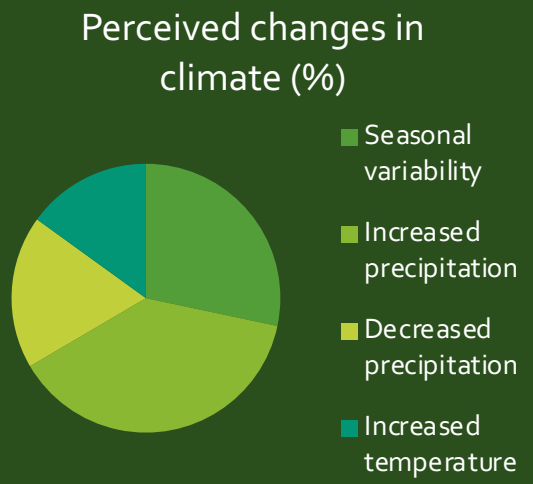
- Shea conservation
- Social attributes
- Perception of vulnerability
- Technologies available

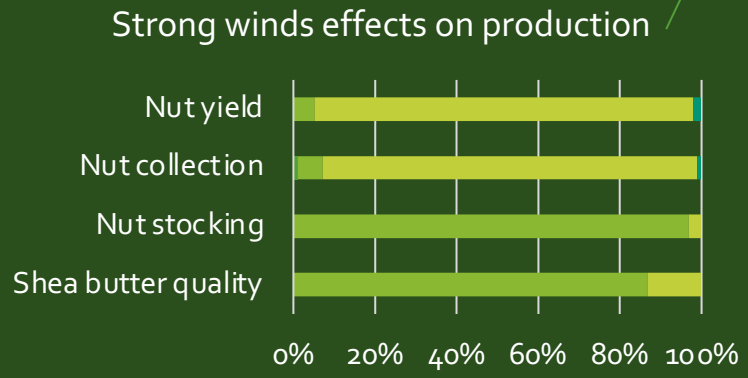
Transformability

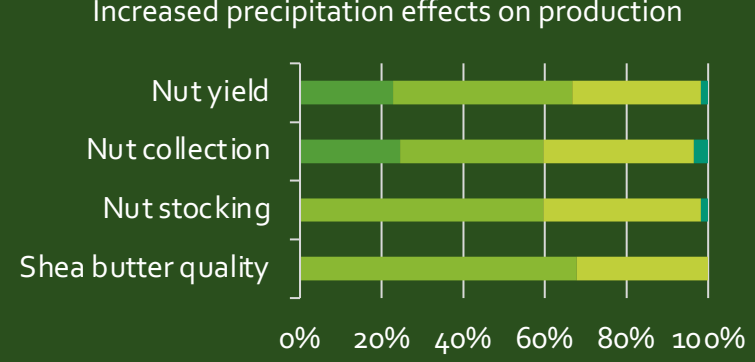
- Dependence on shea
- Entrepreneurship
- Economic attributes

Perceptions of climate change effects on shea production





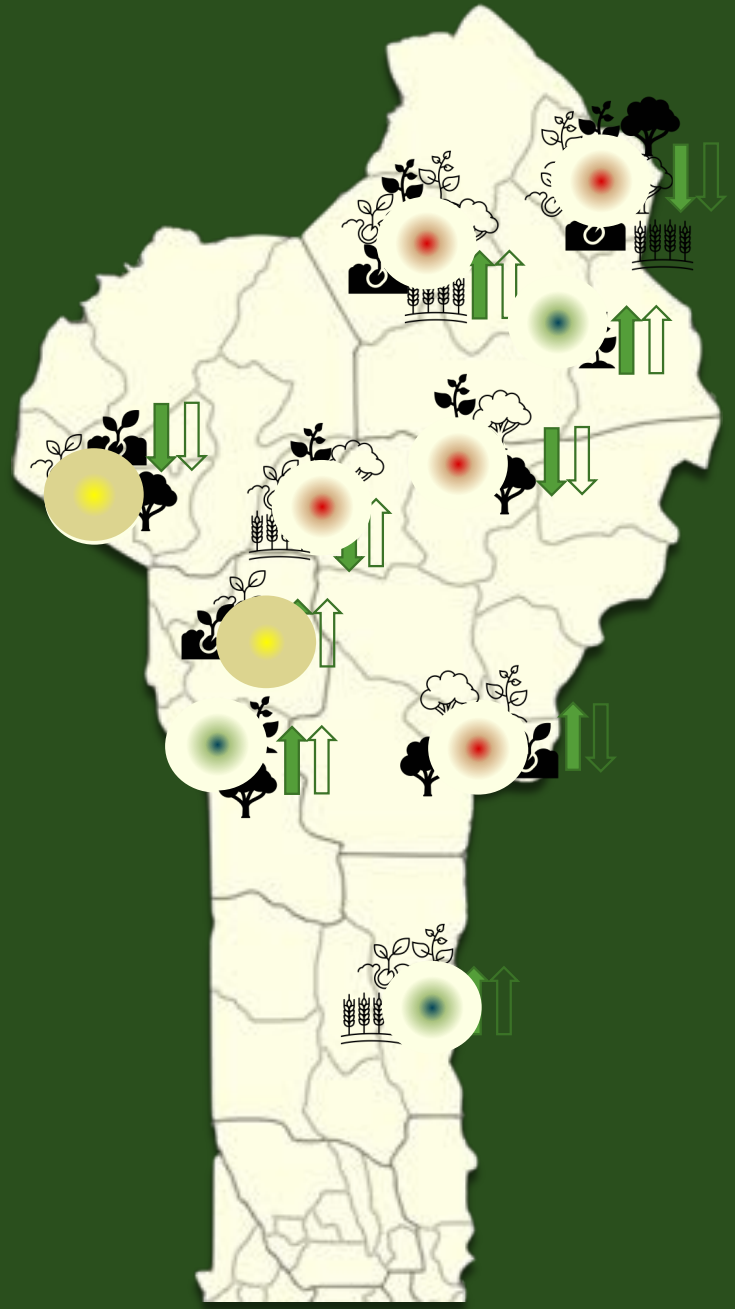




Results

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

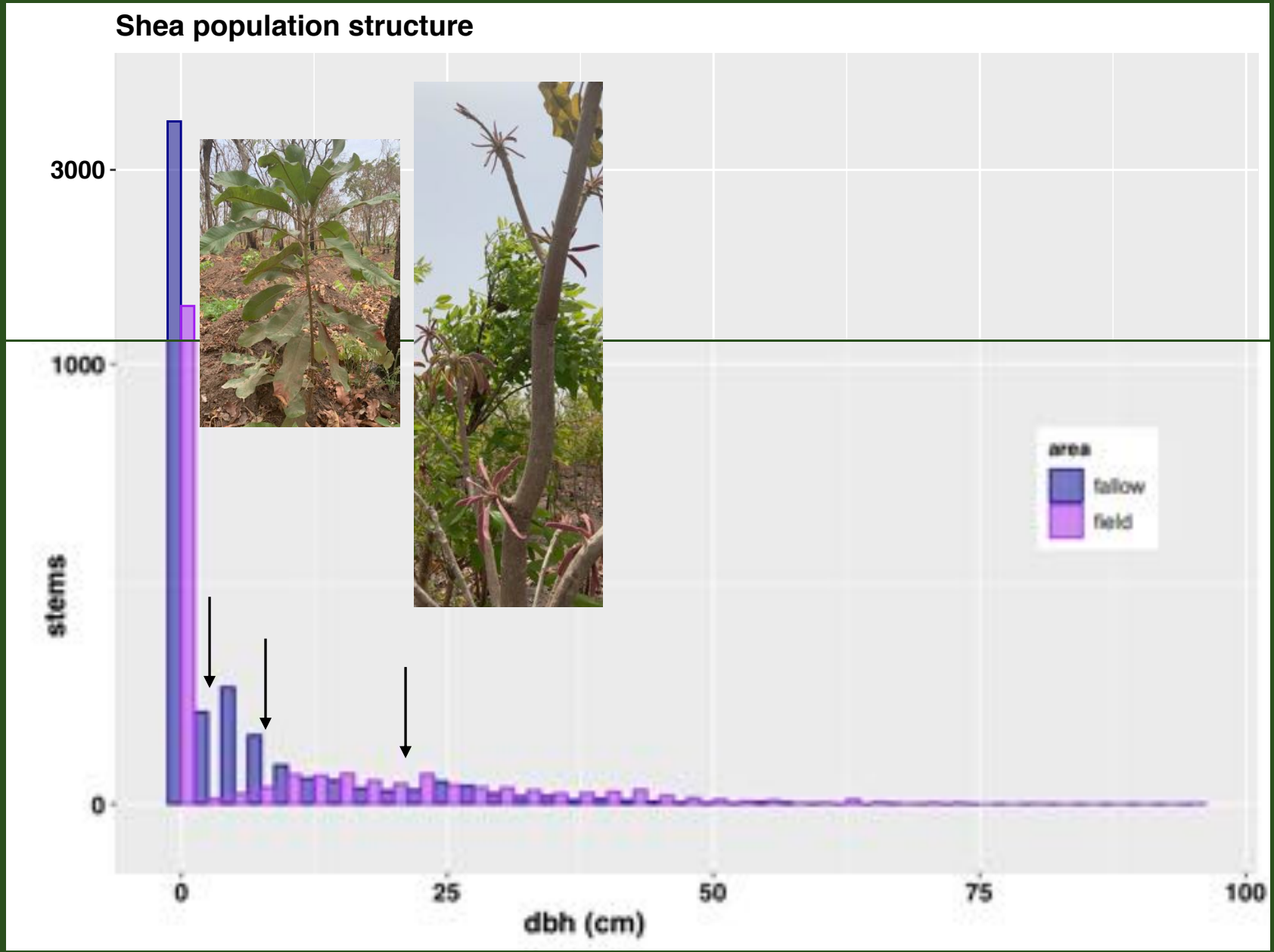


- Saplings recruitment limitation in fallows
- Saplings recruitment limitation in fields
- Seedlings recruitment limitation in fallows
- Seedlings recruitment limitation in fields
- Stocking fallows
- Stocking fields
- Agricultural expansion dynamics

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

- Field areas
- Bush and fallow areas

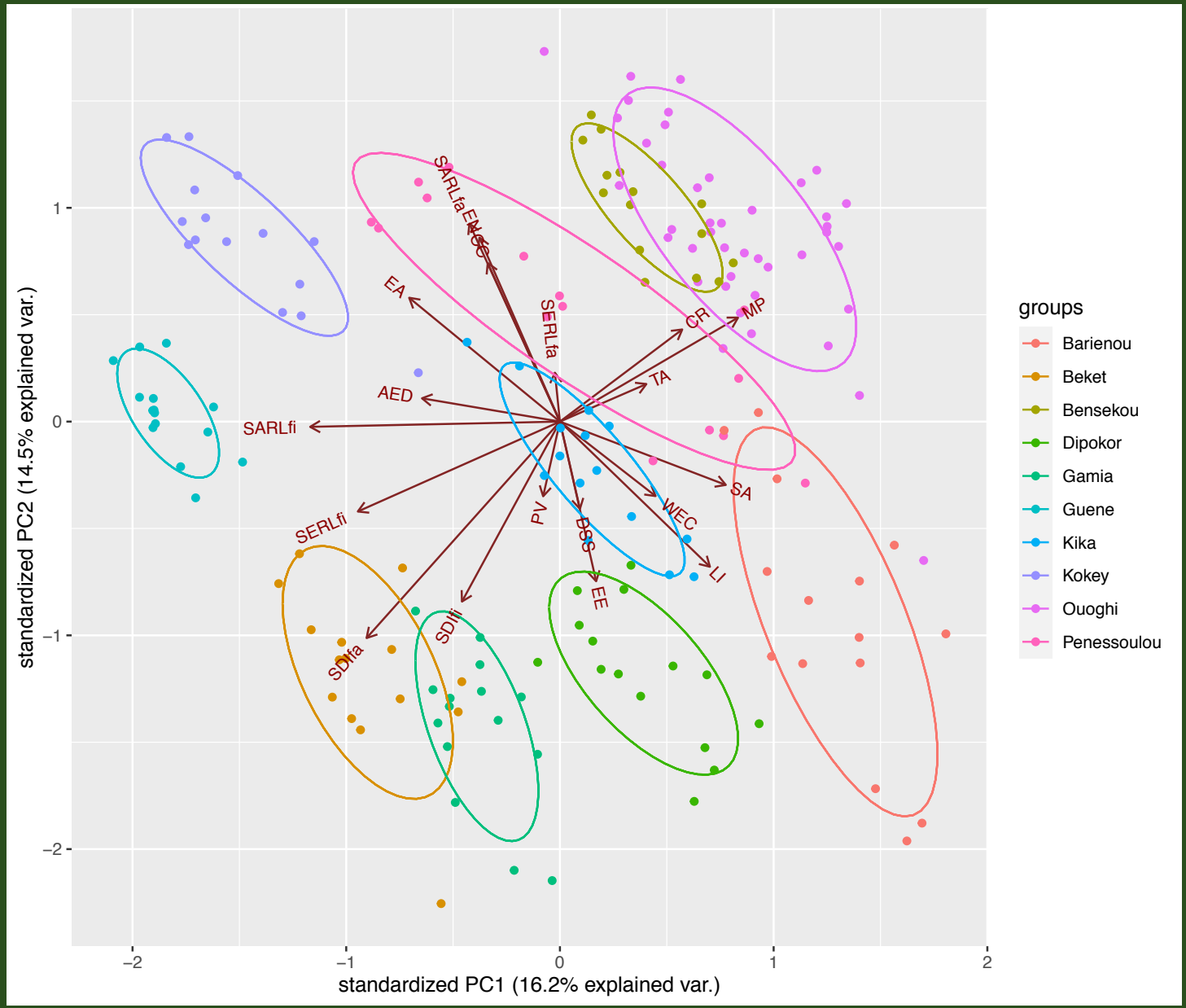
Recruitment limitation



Results

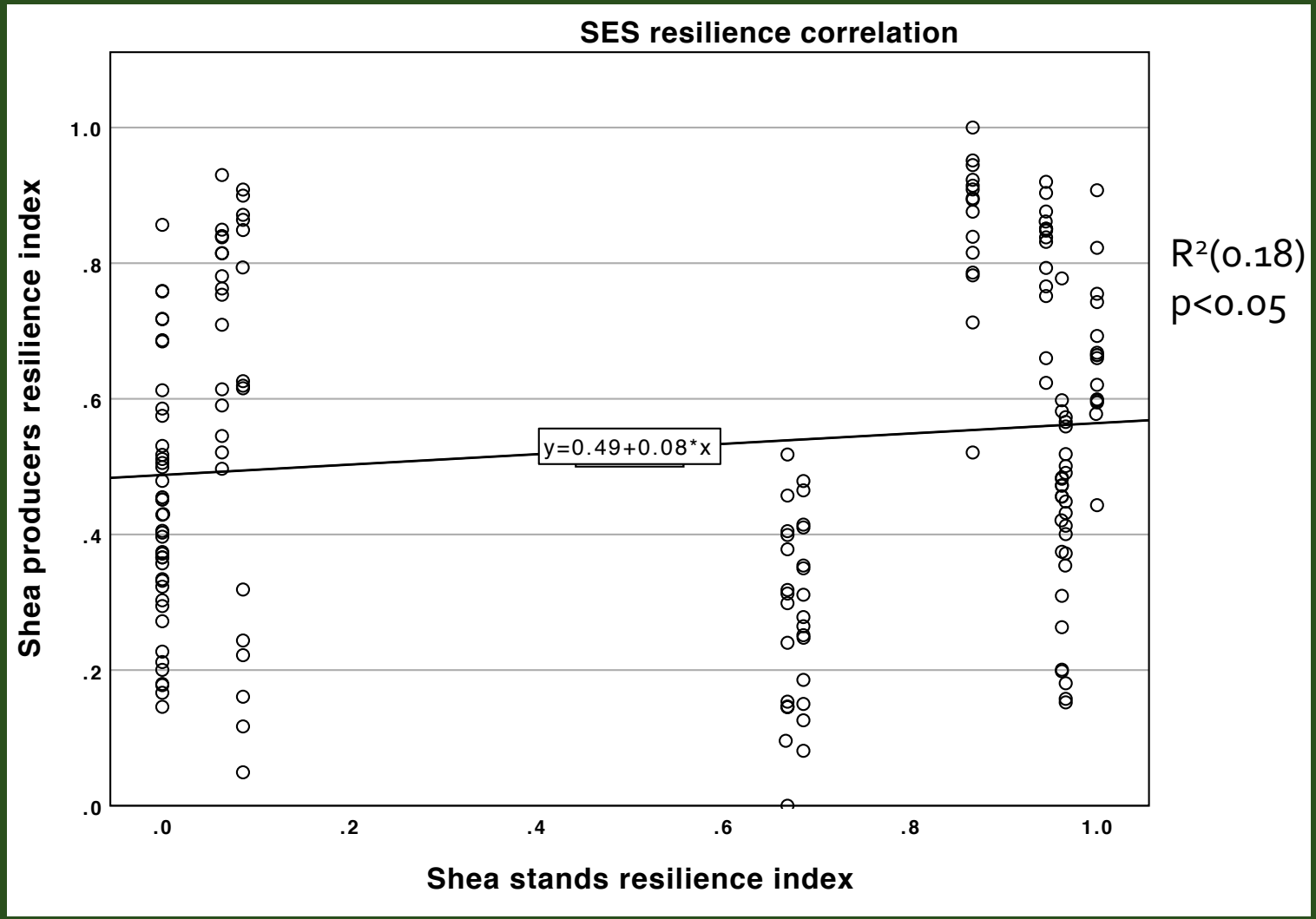
What characterizes hotspots of vulnerability?

Principal component analysis



Spearman correlation analysis

Social and ecological resilience indexes association



R^2(0.18)
$p<0.05$

0: more resilient
1: less resilient

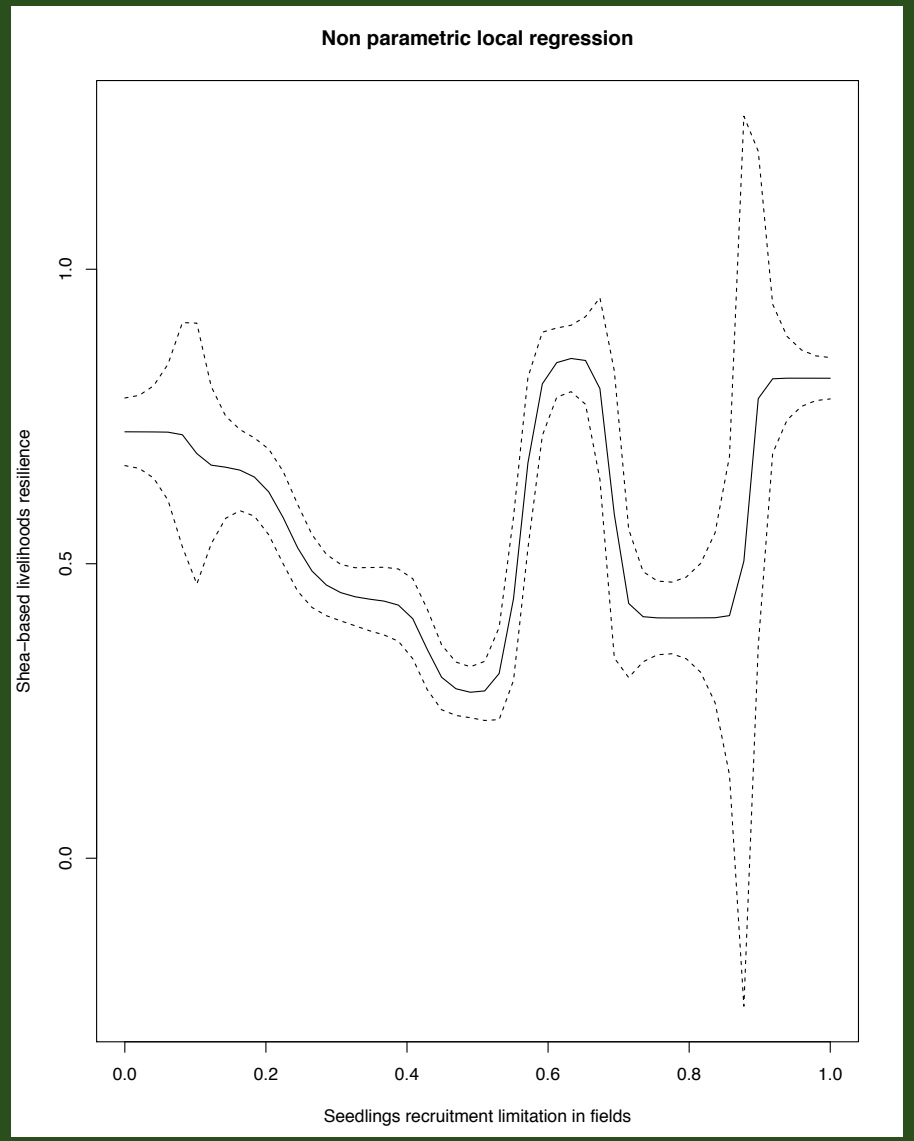
Weak correlation at total sample size

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, SERLfa)
- 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%

```
Kernel Regression Significance Test
Type I Test with IID Bootstrap (399 replications, Pivot = TRUE, joint = FALSE)
Explanatory variables tested for significance:
SERLfi (1)

                SERLfi
Bandwidth(s): 0.03648042

Individual Significance Tests
P Value:
SERLfi < 2.22e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

- 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

Spearman correlation analysis

Correlations of relevant indicators

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

Seedlings recruitment limitation in fields

R^2(-0.28), p<0.01

R^2(-0.19), p<0.05

R^2(0.64), p<0.01

- Agricultural encroachement
- Adaptation measures in place
- Livelihoods transformation
- Dismissal of traditional practices

Agricultural expansion dynamics

R^2(0.25), p<0.01

R^2(-0.26), p<0.01

R^2(0.54), p<0.01

R^2(0.31), p<0.01

R^2(0.64), p<0.01

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

Field areas
Bush and fallow areas

Saplings recruitment limitation in fallows

Saplings recruitment limitation in fields

Seedlings recruitment limitation in fields

Agricultural expansion dynamics

Shea conservation

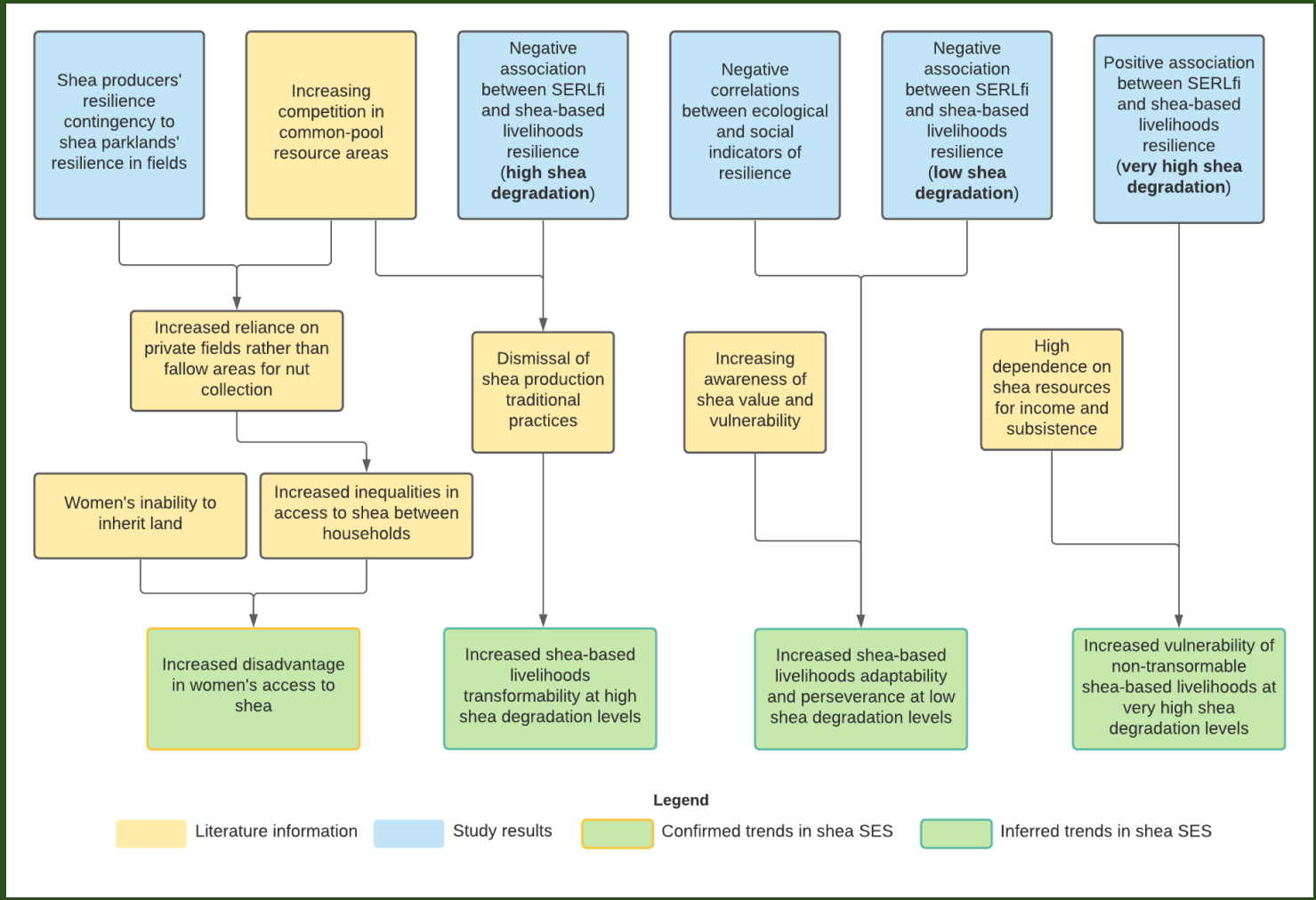
Property rights

Technologies available

Economic attributes

Conclusions

Trends



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

References

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- Seghieri, J. (2019). Shea tree (Vitellaria paradoxa Gaertn. f.): from local constraints to multi-scale improvement of economic, agronomic and environmental performance in an endemic Sudanian multipurpose agroforestry species. Agroforestry Systems, 1-18.

Acknowledgments for the field work team participants