Carbon sequestration potential of Agroforestry in the Sahel
Outline

• Agroforestry for carbon sequestration
• Parkland Agroforestry in the Sahel
• Potential areas for Agroforestry
• Carbon stock in parkland Agroforestry
• Climate change impact on C stocks
Agroforestry for carbon sequestration

Agroforestry – definition

- Integration of trees or shrubs with crop and/or livestock production
- Aims to enhance productivity, profitability, and the provision of ecosystem services
- At the interface of climate change adaptation and mitigation
- Agroforestry can sequester 3 Mg C ha\(^{-1}\) year\(^{-1}\) – most of all changes to cultivated land (IPCC 2001)
Agroforestry for carbon sequestration

Research questions

• How much carbon can be sequestered by parkland Agroforestry in the West African Sahel?

• How will climate change affect C sequestration potential?
Parkland Agroforestry in the Sahel
Parkland Agroforestry in the Sahel
Potential areas for Agroforestry

Datasets

- No data on Agroforestry distribution; limited on land use
- Recent 2-km resolution land use map for West Africa (USGS, Tappan et al. unpublished)
- 18 published articles on parklands (101 locations)
- Climate information (min/max temps, precipitation) from WorldClim database
Potential areas for Agroforestry

Approach

Known parkland locations

Climatic data layers

Ecological niche modeling – Maximum Entropy (MaxEnt)

Requires occurrence input (species, ecosystems)
Characterizes environment based on GIS layers (climate)
Calculates suitability score for all locations within study extent

Phillips et al. 2006. Ecological Modelling 190, 231–259
Potential areas for Agroforestry

**Approach**

1. **Known parkland locations**
2. **Climatic data layers**
3. **Confine to agricultural land**
4. **MaxEnt suitability**
Potential areas for Agroforestry

Approach

Known parkland locations

Future climate data layers

Confine to agricultural land

Future MaxEnt suitability
Potential areas for Agroforestry

MaxEnt: Suitable areas for parkland Agroforestry
Current climatic conditions
Potential areas for Agroforestry

MaxEnt: Suitable areas for Parkland Agroforestry
Current climatic conditions

MaxEnt suitability score

Agricultural area (million ha)
Carbon stock in parkland agroforestry

Information very scarce: only 3 studies

Takimoto et al. 2008. Agriculture, Ecosystems and Environment 125, 159–166
Carbon stock in parkland agroforestry

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Carbon stock in parkland agroforestry

MaxEnt: Suitable areas for Parkland Agroforestry
Current climatic conditions

No agroforestry

Carbon stock (Tg C) [million t C]
Carbon stock in parkland agroforestry

MaxEnt: Suitable areas for Parkland Agroforestry
Current climatic conditions

Max parklands

No agroforestry
Carbon stock in parkland agroforestry

MaxEnt: Suitable areas for Parkland Agroforestry
Current climatic conditions

Max parklands

No agroforestry

Carbon stock (Tg C) [million t C]

- Max parklands
  - 558 Tg C

- No agroforestry
  - 2.05 Pg CO₂
Carbon stock in parkland agroforestry

MaxEnt: Suitable areas for Parkland Agroforestry
Current climatic conditions

Open questions

What is the baseline / how much parkland exists?

How much can be sequestered annually, for how long?

Will climate change affect suitability of the Sahel for parklands?
Climate change impact on C stocks

Agricultural areas suitable for parkland agroforestry

MaxEnt suitability score
- < 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- > 0.9

Agricultural area (million ha)
Climate change impact on C stocks

Agricultural areas suitable for parkland agroforestry

Climate scenario

B2a emissions

A2a emissions

Agricultural area (million ha)

MaxEnt suitability score

- < 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- 0.4 - 0.5
- 0.5 - 0.6
- 0.6 - 0.7
- 0.7 - 0.8
- 0.8 - 0.9
- > 0.9
Climate change impact on C stocks

Agricultural areas suitable for parkland agroforestry

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MaxEnt suitability score:
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Agricultural area (million ha)
Conclusions

• Under current climatic conditions, parkland Agroforestry can raise C stocks by about 0.5-0.6 Pg above the ‘pure agriculture’ baseline

• Future expected climates may not support parklands, not even agriculture

• Agroforestry is also an adaptation tools: controls microclimates, diversifies incomes, enhances soil fertility etc.

Agroforestry is a valuable tool for climate change mitigation and adaptation in the West African Sahel
Thanks for your attention!

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