Agroforestry coffee practices in relation to productivity and erosion control in the Pirrís watershed, Costa Rica

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Case study

Agroforestry system (AFS): coffee + shade trees

- *Coffea arabica*
- *Erythrina poepiggiana*
  and/or *Musaceae* spp
- Some full sun plantations

Small-scale farms (2ha on average) in central Costa Rica, but with intensive management and high-value crop
Erosion in the Pirris watershed

• Intense rainy season + steep slopes = high rate of soil erosion

• ICE hydroelectric dam project, highly susceptible to sedimentation
OBJECTIVE
Find out what are the constraints and potential pathways in coffee AFS for decreasing soil erosion at the plot scale

HYPOTHESIS
Different environmental and economic constraints will affect current management practices and the opportunities for putting environmental services in place

CONSTRAINTS
- Cost of labour and chemicals
- Coffee sale price
- Microclimate conditions
- Fungus attacks (*Mycena citricolor*)
Interviews

• 30 farmers of plots of different sizes and slope orientations
• Field visits and demonstrations of agricultural practices

Key management variables selected
• Fertiliser
• Herbicides
• Fungicides
• Shade tree density
Conceptual model

• Based on information from interviews and farmer explanations

• Describes a typical coffee plantation and management for Llano Bonito

• Aims:
  – Represent farmer conception of the AFS
  – Basis for highlighting differences between practices in the typology
Constraints and opportunities – general model

ECONOMIC FACTORS
- Coffee sale
- Products cost
- Labour cost
- Payment for env. services

MANAGEMENT
- Coffee renewal
- Fungicides
- Fertiliser
- Shade trees
- Weed management
- Cut branches

ENVIRONMENTAL FACTORS
- Sunlight
- Slope orientation

COFFEE AGROFORESTRY SYSTEM
- Mycena fungus
- Nitrogen inputs
- Plant growth and potential production
- Water availability
- Mineral availability
- Flowering intensity
- Grain growth
- Water infiltration
- Runoff

PERFORMANCE
- Hydrological system
- Plant & nutrient system
- Erosion
- Yield

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Constraints and opportunities – general model

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**PERFORMANCE**
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Constraints and opportunities – general model

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**PERFORMANCE**
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• Use of Principal Component Analysis (PCA) and Agglomerative Hierarchical Clustering (AHC) (Blazy et al, 2009)
• Min. 5 plots/group

1. Intensive management
2. Sunny plots with lots of trees to protect coffee
3. Low investment in chemicals
4. Plots suffering from fungus attacks
1 Intensive management

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**COFFEE AGROFORESTRY SYSTEM**
- Hydrological system
- Plant & nutrient system
- Yield
2. Plots with high tree density

COFFEE AGROFORESTRY SYSTEM

- Water availability
- Water infiltration
- Runoff
- Erosion
- Yield

ECONOMIC FACTORS
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MANAGEMENT
- Coffee renewal
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- Cut branches
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ENVIRONMENTAL FACTORS
- Sunlight
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Hydrological system
Plant & nutrient system
3. Low investment in chemicals

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**ENVIRONMENTAL FACTORS**
- Sunlight
- Slope orientation
- Mycena fungus

**COFFEE AGROFORESTRY SYSTEM**
- Nitrogen inputs
- Mineral availability
- Plant growth and potential production
- Flowering intensity
- Grain growth

**PERFORMANCE**
- Water infiltration
- Water availability
- Runoff
- Erosion
- Yield
4. Plots with fungal invasion

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ENVIRONMENTAL FACTORS
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Performance

Now what..?

- Combining typology and conceptual model illustrates different constraints and potential pathways for decreasing soil erosion
- Use numerical coffee AFS model (CAF2007) to test these relationships and explore the trade-offs in each scenario
- Economic analysis for each group
- Bring model simulations to the farmers and discuss implementation of the new practices
Thank you!

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Photos from L. Meylan and B. Rapidel