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# Community-based Forest Management: how to Mitigate Farmer's Infiltration in Protected Forests in Cote d'Ivoire?

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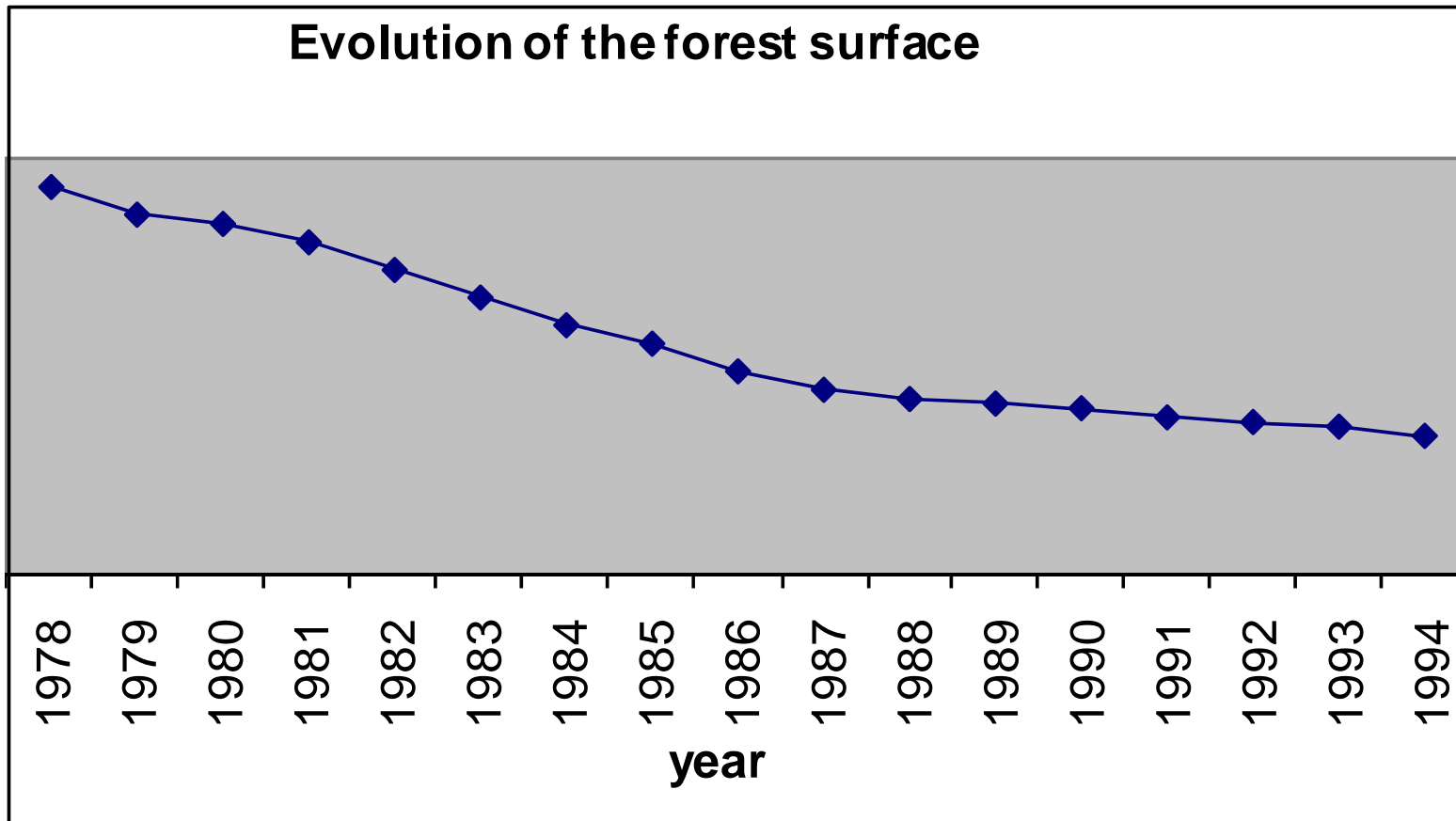
# Content

- Context of the study
- Research question
- Objective
- Methodology and materials
- Results
- Policy implications

## **Context of the study(1) (Deforestation process)**

- Cote d'Ivoire had the highest rate of deforestation in Sub saharan Africa (5.2%)(N'guettia, 1999)
- From 16 million hectares in 1960, the forest area is less than 3 million hectares today representing less than the recommended rate of forest cover of 20% (Direction of environment, 2000)

## Context of the study(2)





## ...Context of the study(3) (Impacts of deforestation process)

Deforestation has direct impacts on climate, land stability and land productivity

As consequences:

- Land saturation since from 3.5% in 1960, we passed to 11% in 1975, 23% in 1989 (National Environnemental plan, 1996) and 23.5 % in 1997 (World Resources, 2000-2001)
- Peasants' infiltrations in protected forests with a rate of 26% (Sodefor, 1998) and more than 30% (Aifort, 2008) (NB: more than 25% of the cocoa and coffee produced in CI come from these protected forests (Aifort, 2008))

# Context of the study(3)

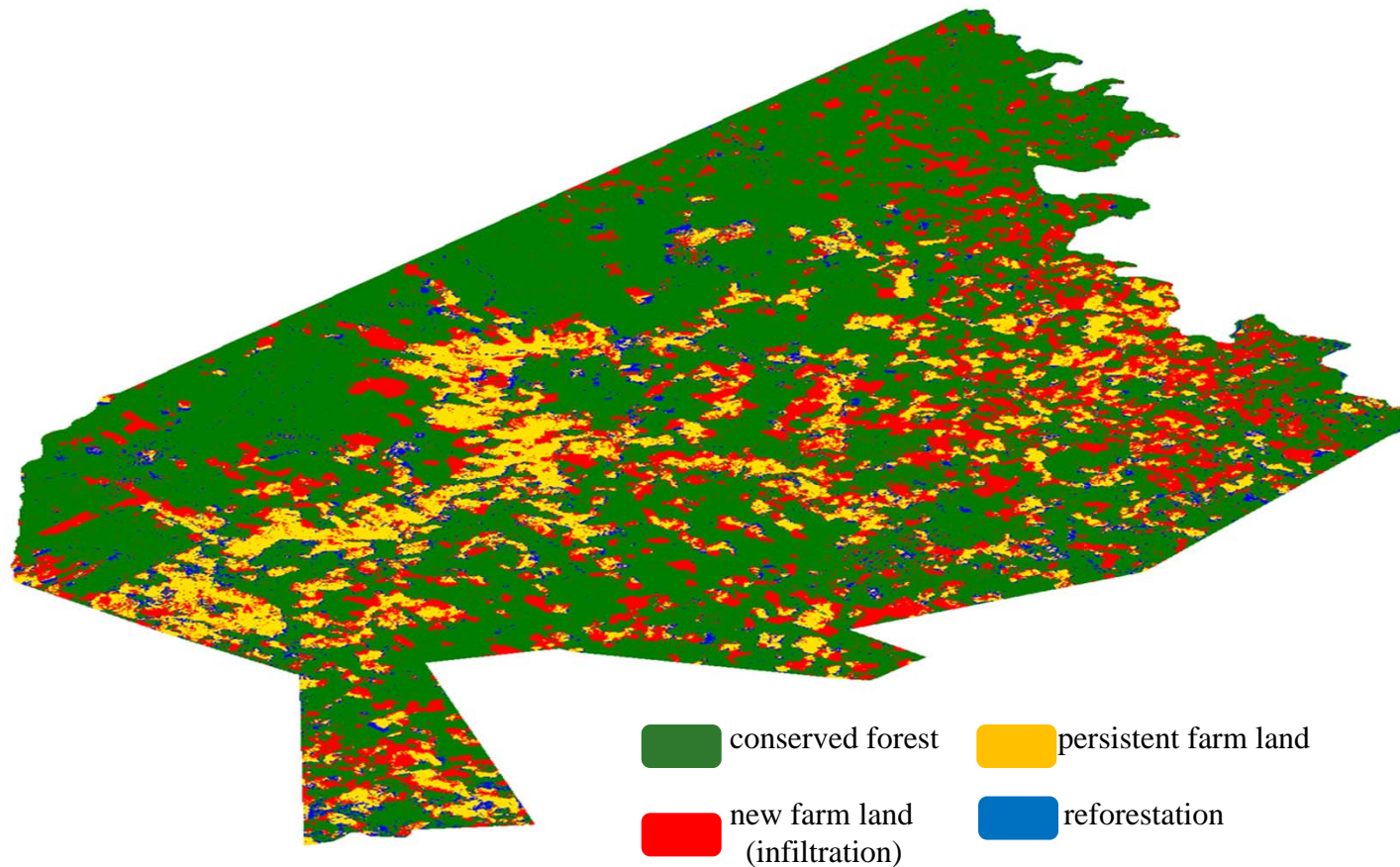
## (Farming system)





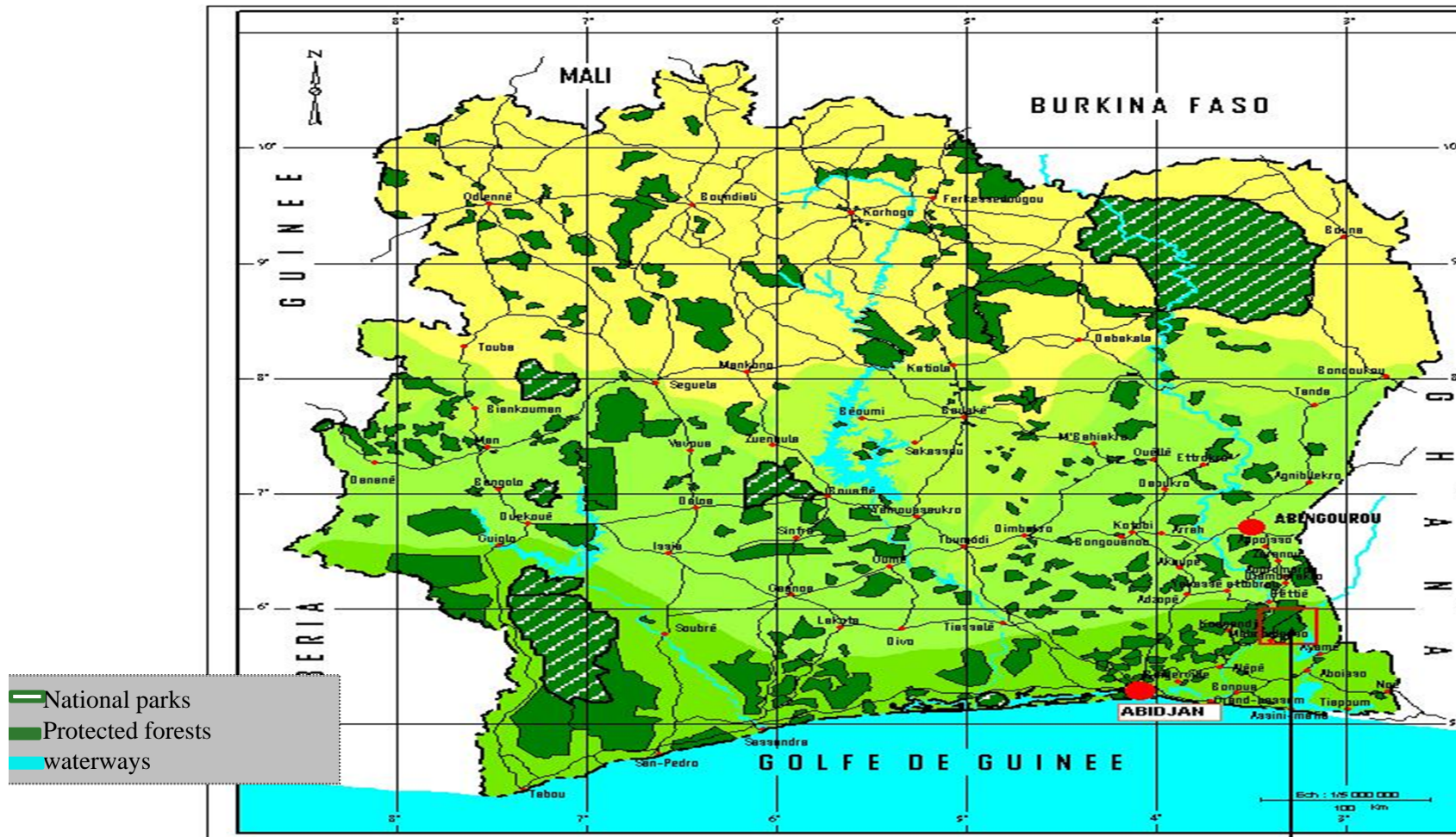


## ...Protected forest of TAMIN





## Protected Forests Distribution across the Country





## ...Context of the study (4)

(How did authorities address this challenge?)

- **Joint Management Policy (JMP)** [in line with the forest management plan 1988-2015, SODEFOR implemented JMP in 1992]

- International pressure with the Sustainable management concept (forest resource scarcity)
- Decentralized policy adoption around the world (multiple interests divergences of actors)
- Poverty reduction strategies implementation (rural populations impoverishment)
- Lack of material, human and financial resources (failure of top-down approach)

## ...(How does JMP work?)

- The main tool of the Joint-Management Policy (for the rehabilitation of protected forests by associating the local populations to the forest management) is called **“Peasant-Forests Commission (PFC)”** which is a forum of discussion and decision-making
- This commission has two components (local and national )
- At local level, it brings together riparian peasants and local authorities (prefect, officials,...)
- At national level, it is composed with ministries, institutions, private sector and peasants (who are under-represented 1/6)
- But, the infiltrations continue





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## ...(potential Gaps in JMP)

- Economic aspects have not been taken into account since only the institutional aspects are addressed through PFC
- According to the literature, the economic aspects matter (fernandez-puente, 1996; Nguingiri, 1999; Gueneau *et al.*, 2004; ferraro *et al.*, 2003; Nicholls, 2004)
- Moreover, there are some apprehensions about the lack of procedure for allocating benefits at the time when participatory forest programmes were first established (Saxena, 1988; Campbell, 1992).



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## Research Question

- What are the factors that explain the persistence of peasants' encroachments on protected forests?
- What are the economics incentives of the joint management policy?
- In other words, what are the economic factors that drive the optimal level of forest conservation in CI?





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# Objective of the study

## *Main objective*

- Mitigate the peasants' encroachments on protected forests

## *Specific objectives*

- Evaluate the Joint-Management Policy
- Determine the economic incentives (factors) for a sustainable joint forest management policy



## Method of Analysis

- Formalize a bioeconomic model of the joint-management strategy involving SODEFOR and local community in form of optimization programs
- Use optimal control techniques in continuous time to solve those optimization problems
- Compare the market based solutions to the social planner's solutions to derive some policy measures



## ...model formalization

- We formulate a bio-economic model with two agents (local community and SODEFOR) and two activities (agriculture and forest conservation) in the form of dynamic optimization in continuous time.
- SODEFOR has a fixed amount of forest (protected forest) for protection and reforestation.
- The local community lives adjacent to the protected forest and has user right over the remaining land for agricultural purpose.
- These two agents act in a defined area but the conflict arises when farmers infiltrate the protected forest to search for fertile land for agriculture.



## ...(local community's program)

He maximizes the flux of net revenue deriving from forest preservation and agricultural activities by taking into account the dynamic of the resources

$$\begin{aligned}
 \underset{(q_{2t}, \theta)}{\text{Max}} \pi^d &= \int_0^{\infty} [\alpha R(q_{1t}) + \beta R(x_{1t}) + R(q_{2t}) - C(\theta)] e^{-\delta t} dt \quad (1) \\
 s/c & \\
 \dot{x}_{1t} &= g_1(x_{1t}) - q_{1t} - I(x_{1t}, \theta) \quad (2) \\
 \dot{x}_{2t} &= g_2(x_{2t}) - q_{2t} \quad (3)
 \end{aligned}$$

→ the revenue from logging activities  
 → the revenue from by-products activity  
 → the revenue from agriculture  
 → the cost of anti-infiltration effort  
 → the infiltration function  
 → the natural growth rate of protected forest  
 → Rate of timber extraction (standing volume)  
 → Surface under farming  
 → The natural growth rate of unprotected forest



## ...(SODEFOR's program)

He maximizes the present value of the income deriving from its main and secondary activities by taking into account the dynamic of the resource especially the infiltration function

$$\text{Max}_{(q_{1t})} \pi^{SOD} = \int_0^{\infty} [(1-\alpha)R(q_{1t}) + (1-\beta)R(x_{1t})] e^{-\delta t} dt$$

$s/c$

$$\dot{x}_{1t} = g_1(x_{1t}) - q_{1t} - I(x_{1t}, \theta)$$

• A share of a remaining revenue from logging

• A share of remaining revenue from by-products exploitation



## ...(Social planner's program)

he maximizes the present value of the forest and agricultural profits while taking into account the public good effect of forest

$$\begin{aligned} \underset{(q_{1t}, q_{2t}, \theta)}{\text{Max}} \pi^{\text{Social}} &= \int_0^{\infty} [\alpha R(q_{1t}) + \beta R(x_{1t}) + R(q_{2t}) + B(x_{1t}) - C(\theta) + \\ &\quad (1 - \alpha)R(q_{1t}) + (1 - \beta)R(x_{1t})] e^{-\delta t} dt \quad (5) \end{aligned}$$

Public good effect of the forest (biodiversity, existence and option values)

*s / c*

$$\dot{x}_{1t} = g_1(x_{1t}) - q_{1t} - I(x_{1t}, \theta) \quad (2)$$

$$\dot{x}_{2t} = g_2(x_{2t}) - q_{2t} \quad (3)$$

# Results (1)

## ...Local community optimal effort level

$$\frac{C'(\theta^*)}{-I'_\theta(x_{1t}, \theta^*)} = \frac{\beta R'_{x_{1t}}(x_{1t})}{(\delta - (g'_{1,x_{1t}}(x_{1t}) - I'_{x_{1t}}(x_{1t}, \theta^*)))}$$

$$\frac{C'(\theta^*)}{-I'_\theta(x_{1t}, \theta^*)} = \frac{\beta(1-\alpha)R'_{q_{1t}}(q_{1t})}{(1-\beta)}$$

- Local community will apply anti infiltration effort up to a level at which the marginal cost of such effort is equal to its marginal benefit.
- the level of anti-infiltration effort and the share of revenue deriving from the by-products accruing to the local community are positively related
- This share is the level of incentive provided to the local community to exert anti-infiltration effort for forest preservation



## Results (2)

### ...SODEFOR's equilibrium

$$\frac{(1-\beta)R'_{x_{1t}}(x_{1t})}{(1-\alpha)R'_{q_{1t}}(q_{1t})} = \delta - (g'_{x_{1t}}(x_{1t}) - I'_{x_{1t}}(x_{1t}, \theta))$$

$$R'_{q_{1t}}(q_{1t}) \geq R'_{x_{1t}}(x_{1t})$$

$$\beta \geq \alpha \quad \left. \vphantom{\beta \geq \alpha} \right\} \begin{array}{l} \alpha \rightarrow 0 \\ \beta \rightarrow 1 \end{array}$$

- Sodefor should exploit timber and by-products up to the point where the ratio of the marginal profit associated with the two activities is equal to the difference between the rate of time preference and the rate of regeneration net of infiltration
- In the context of environmental resource management the lower the time preference the greater the conservation



## Results (3)

### ...Social planner's solution

$$\frac{C'(\theta^{*S})}{-I'_{\theta}(x_{1t}, \theta^{*S})} = \frac{R'_{x1t}(x_{1t}) + B'_{x1t}(x_{1t})}{(\delta - (g'_{1,x1t}(x_{1t}) - I'_{x1t}(x_{1t}, \theta)))}$$

$$\frac{C'(\theta^{*S})}{-I'_{\theta}(x_{1t}, \theta^{*S})} = \frac{(1 - \alpha)R'_{q1t}}{(1 - \beta)} (1 + B'_{x1t}(x_{1t}))$$

- The socially optimal effort level is higher than the private effort level.
- Compared to market based solution, we note that beta should tend to 1 and there is an additional term which calls for an external funding due to the public good effect of forest

# How can LC supply socially optimal effort level?

## Local community effort level

$$\frac{C'(\theta^*)}{-I'_\theta(x_{1t}, \theta^*)} = \frac{\beta R'_{x_{1t}}(x_{1t})}{(\delta - (g'_{1,x_{1t}}(x_{1t}) - I'_{x_{1t}}(x_{1t}, \theta^*)))}$$

## Social effort level

$$\frac{C'(\theta^{*S})}{-I'_\theta(x_{1t}, \theta^{*S})} = \frac{\mathbf{1} R'_{x_{1t}}(x_{1t}) + B'_{x_{1t}}(x_{1t})}{(\delta - (g'_{1,x_{1t}}(x_{1t}) - I'_{x_{1t}}(x_{1t}, \theta)))}$$



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## ...local community incentives for forest conservation without international support

$\beta$ tends to $\alpha$ tends to	0	1
0	<b>S1.</b> No incentives (effort level=zero)	<b>S2.</b> Incentives (effort<social effort level) (with welfare improvement)
1	<b>S3.</b> No incentives (effort level=zero) (but with welfare improvement)	<b>S4.</b> Incentives (effort<effort(S2)<social level) (with more welfare improvement)

- S1 is the worst and current situation where there is no incentives and no welfare improvement
- S2 provides more incentives to LC to apply more effort in forest conservation
- In S3 no incentives is provided but there is welfare improvement of LC. It describes the case of ongoing JFM projects by NGOs
- S4 provides less incentives compared to S2 but improves the welfare of the LC. It describes community forestry initiatives

## ...local community incentives for forest conservation with international support

$\beta$ tends to \ $\alpha$ tends to	0	1
0	<b>S1.</b> No incentives (effort level=zero)	<b>S*2.</b> Incentives (Highest effort level=social level) (with welfare improvement)
1	<b>S3.</b> No incentives (effort level=zero) (with welfare improvement)	<b>S*4.</b> Incentives (higher effort level<effort(S*2) (with more welfare improvement)

- With external financial support, the level of effort is more higher compared to the previous case
- S\*2 provides the highest effort level carried out by the LC

## Policy Recommendations

- Forest resources sharing by entrusting the local community with forest by-products (60% of timber exploitation)
- Increase forest by-products profitability
- Need for external funding (through REDD, PES...)
- Forest management plan should be jointly designed
- Reinforcement of institutional component of JMP



# Outputs

- Working paper
- Two policy briefs
- Publishable paper



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kwaye ho ban







# The end



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