Harvesting method optimizing shoot and culm production in *Dendrocalamus hamiltonii*

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Background

Poverty alleviation potential of NTFPs

•NTFPs – great potential for poverty alleviation under optimal conditions

•NTFP development one of the key strategies to alleviate poverty in Bhutan

Problems

•Lack of resource assessment methods

•Lack of sustainable utilization standards/methods

•Etc.

Background

Potential of bamboo *Dendrocalamus hamiltonii*

•One the the priority species of NTFP development in Bhutan

•Used for construction, fencing, baskets, containers, shoots eaten fresh or pickled

Constraints

•Lack of interest in intensive management (irrigation, fertilization)

•Aim to harvest bamboo from wild stands with little input

Solution

•Proper bamboo silviculture

Methods - Species

Dendrocalamus hamiltonii

- Central Himalayas to Northeast India up to 1800 m, also in the sub-tropical & warm-temperate zones of Bhutan
- Sympodial bamboo with pachymorph rhizomes and culms up to 25 m height
- Culms thin walled – suitable for weaving
- Good fodder material
- *D. hamiltonii* var. *edulis* is a variety with especially palatable shoots

Methods - Study area

- Eastern Himalayas, Bhutan
- Southern-central part of the country with warm-temperate climate
- Tshanglajong Community Forest established 2010
- Altitude 870 m
- Precipitation 1800 mm
- Mean annual maximum 26.2 °C
- Mean annual minimum 15.2 °C
- Open forests dominated by *Castanopsis* sp., *Cinnamomum* sp., *Flueggea virosa*, *Mangifera sylvatica*

Methods – action research framework

Objectives

Understand local knowledge on bamboo ecology, harvesting methods, utilization, socio-economics, legal & administrative constraints

Use the information to design viable harvesting methods & experimentally compare them

Methods – social research

- Small group discussion
- Transect walks

Results – Social research

- *D. hamiltonii* is the only one of 6 speices to be used
- No specific harvesting method, more easily accessible culms cut first
- No restrictions on location or time
- Shoots collected in July-August
- Population occasionally involved in bamboo weaving
- Products (shoots, baskets, etc.) sold on farm or in a nearby town at 8 km distance
- Farmers do not want to invest time and resources into bamboo activities, since markets are unreliable and they face labor shortage on farms

Methods – Experimental research: objectives, design

Objectives

Experimentally compare treatments identified through social research in terms of shoot and culm production

Design

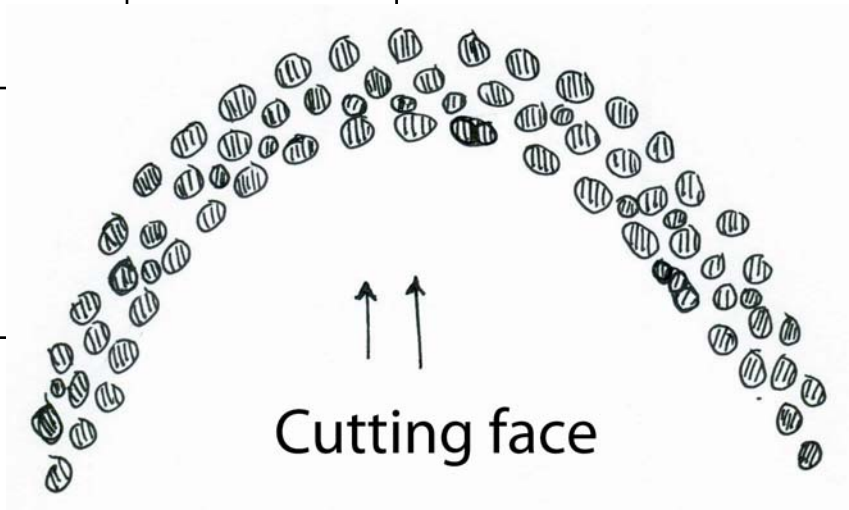
4 treatments with 4 replicates each

Measurements 2009-2011 annually:

- Clump diameter
- Number of shoots recruited
- Number of shoots harvested
- Number of culms recruited
- Number of culms harvested
- Shoot size

Methods – Experimental treatments

Treatment	Shoots cut	Culms > 2 years cut	Remarks
Control			
Selective cut			ns and stumps, from inside out, at base leaving two
Horseshoe cut			ns and stumps, ıpslope, harvesting from inside of arch, harvesting of culms at base leaving two internodes intact
Clearcut	50%	100%	removal of dead culms and stumps harvesting of shoots from inside out, harvesting of culms at base leaving two internodes intact



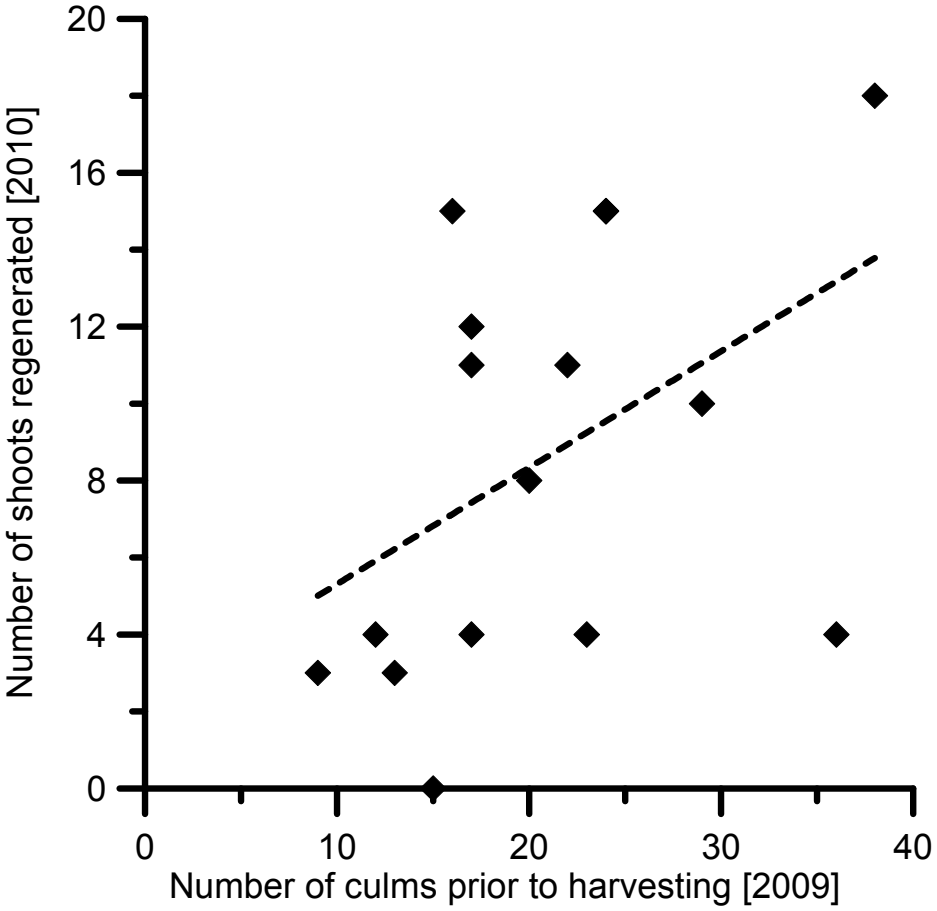
Horseshoe cut – convex arch facing uphill

Methods – Data analyses

- Relationship between variables – Pearson correlation
- Differences in Productivity Index (shoot/culm) – ANOVA
- Edible shoot volume – GLMM: shoots belonging to same clump are correlated, clump number random effect
- Simultaneous differences in numbers of shoots & culms produced and harvested – MANOVA with clump diameter / initial number of culms as proxies for clump size included as covariates

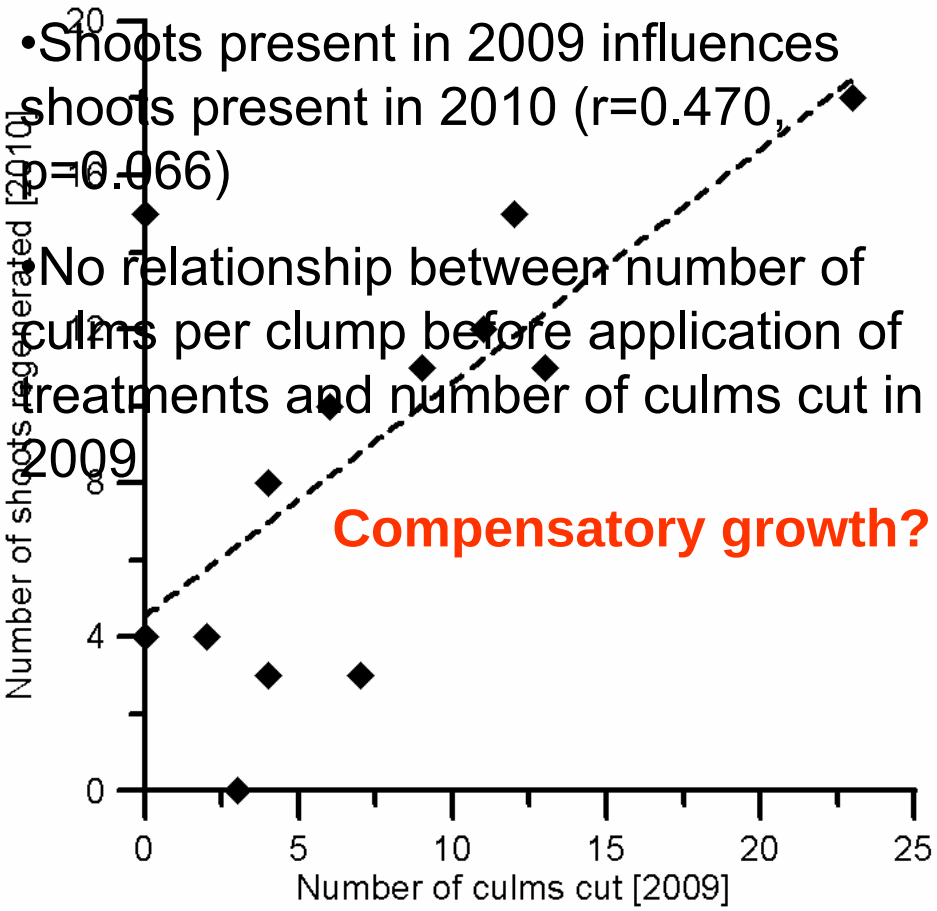
Results – Factors affecting shoot regeneration

Number of culms may influence number of shoots recruited the following year (r=0.447, p=0.083)



Results – Factors affecting shoot regeneration

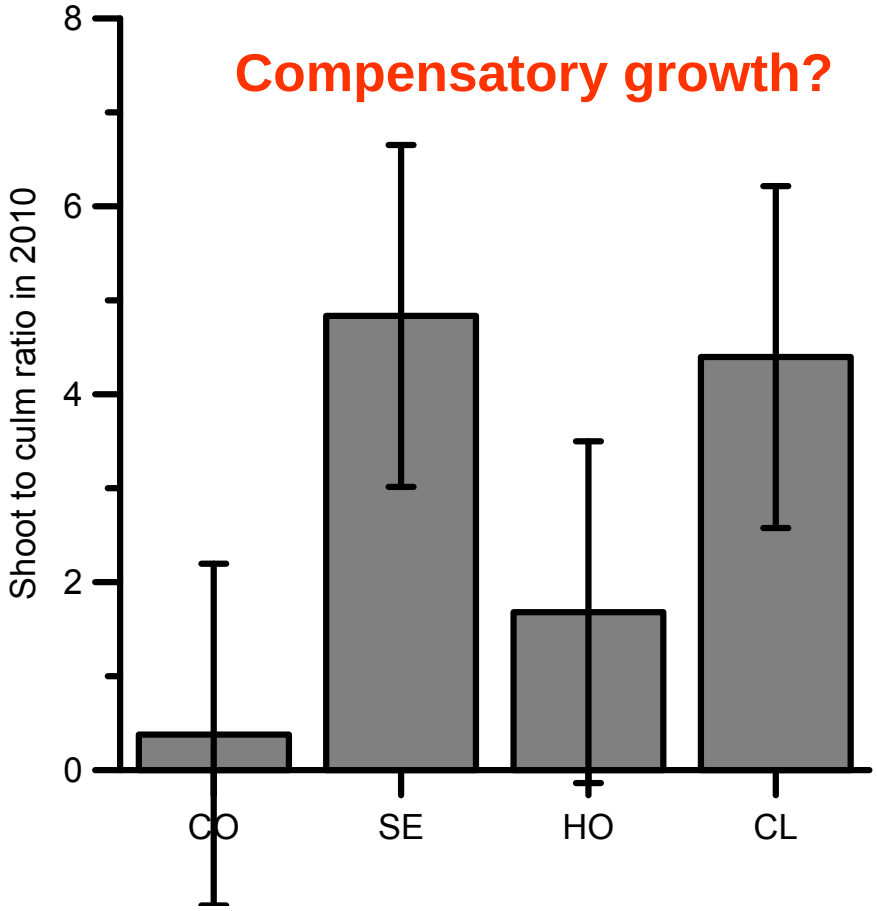
- Number of culms harvested strongly influences number of shoots recruited the following year (r=0.703, p≤0.01)
- Shoots present in 2009 influences shoots present in 2010 (r=0.470, p=0.066)
- No relationship between number of culms per clump before application of treatments and number of culms cut in 2009



Compensatory growth?

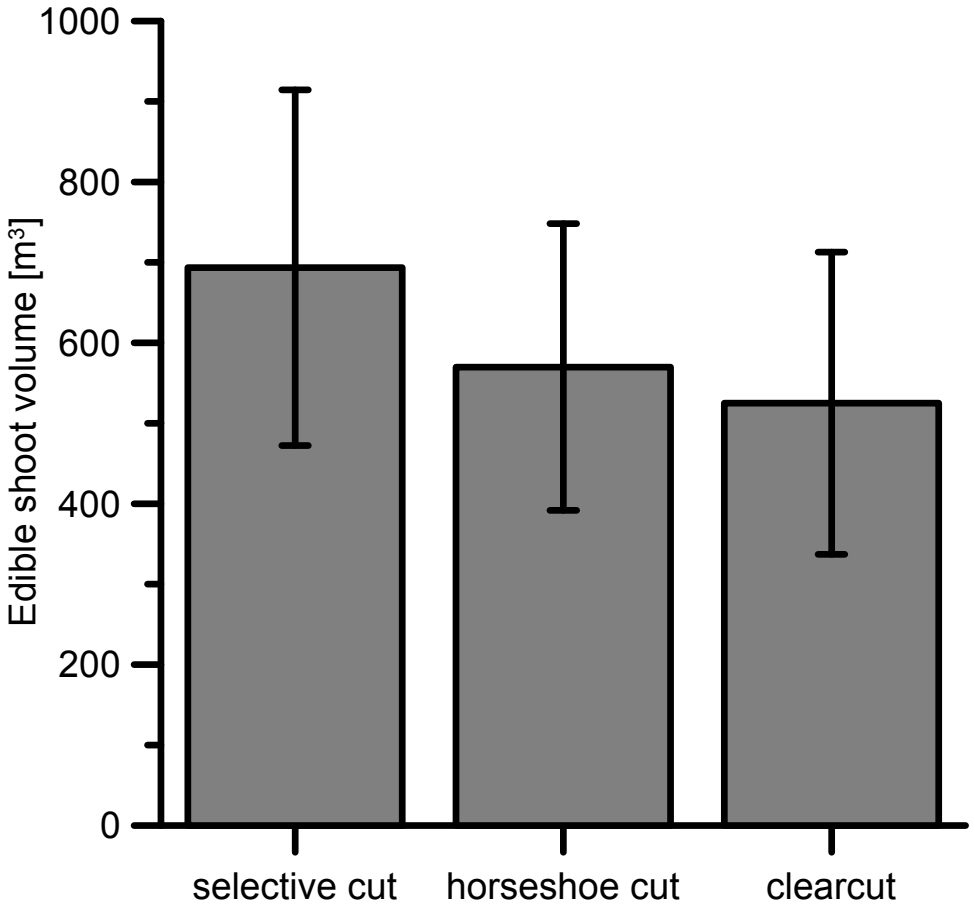
Results – Productivity

Shoot/culm ratio not different between treatments, but tends to be higher with harvesting as compared to control



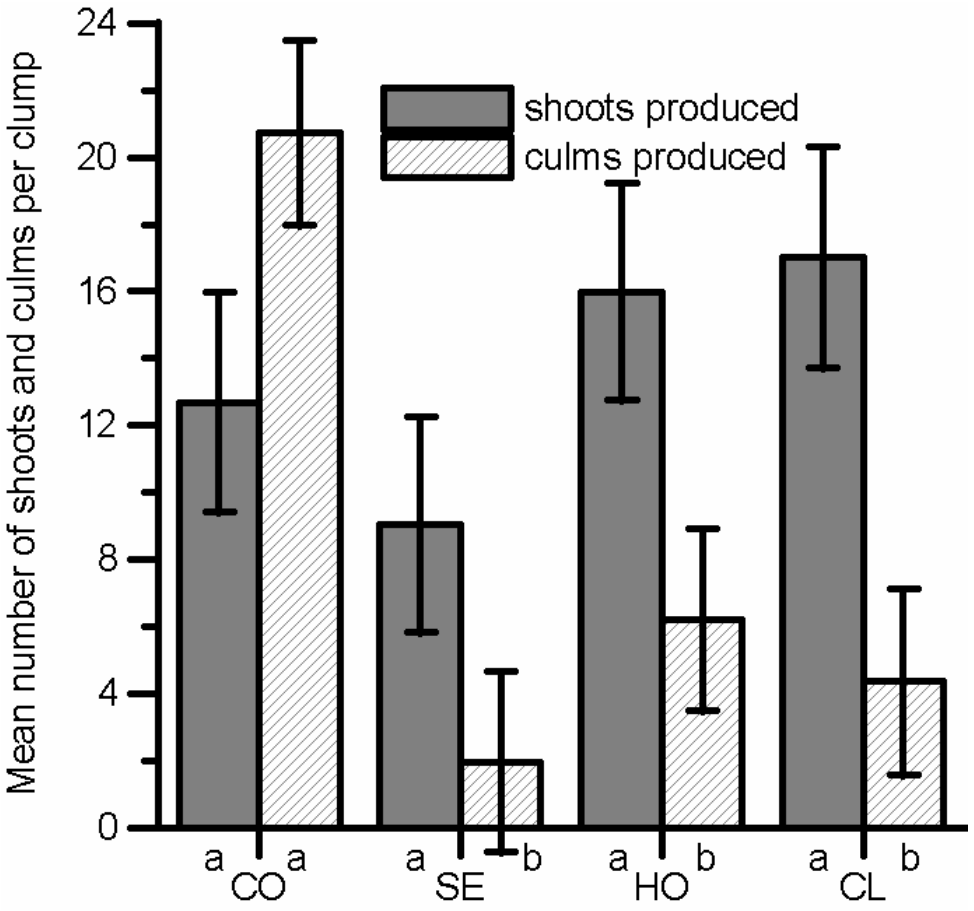
Results – Edible shoot volume

Edible shoot volume not different between treatments



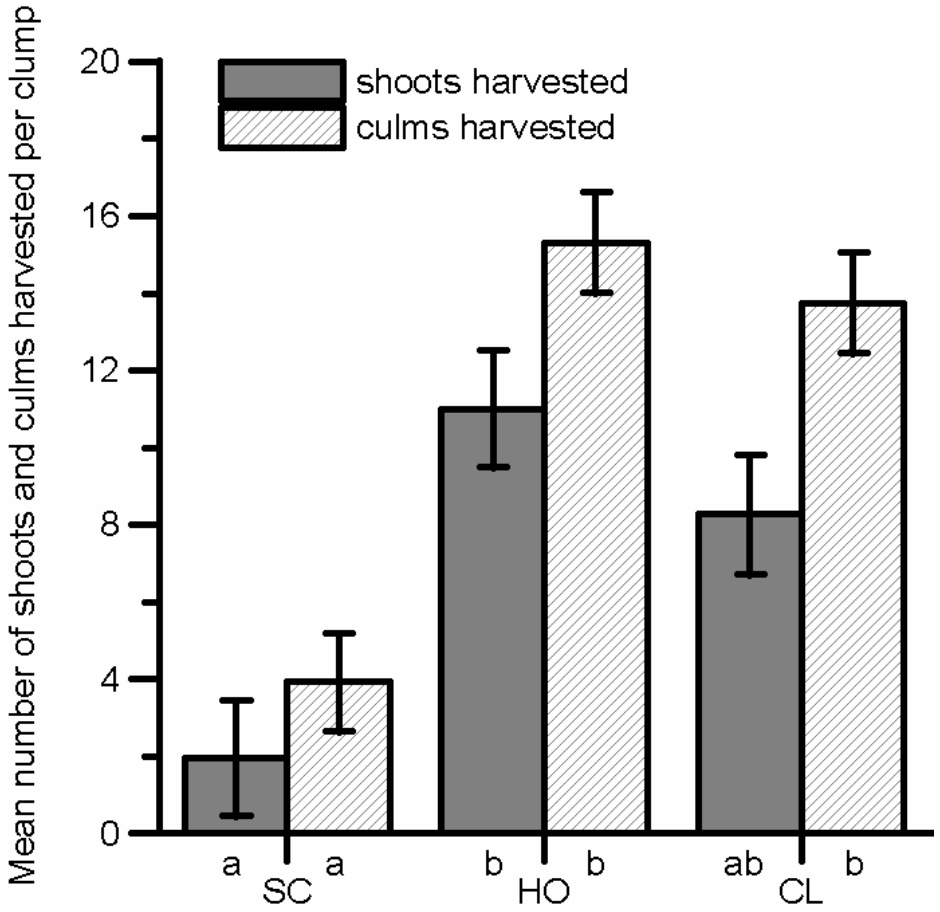
Results – Recruitment of shoots and culms

- Significant differences between treatments in recruitment of shoots and culms (MANCOVA, $\lambda=0.138$; $p\leq0.01$)
- Number of culms before treatments significant covariate ($\lambda=0.231$, $p\leq0.001$)
- Shoots recruited did not differ between treatments in univariate context (orthogonal contrasts, $p>0.05$)
- Culms recruited was significantly higher in control treatment as compared to others (orthogonal contrasts, $p\leq0.01$)



Results – Harvesting of shoots and culms

- Significant differences between treatments in number of shoots and culms harvested (MANCOVA, λ=0.128; p≤0.01)
- Number of culms before treatments significant covariate (λ=0.173, p≤0.001)
- Shoots harvested in horseshoe cut was significantly higher than in selective cut (orthogonal contrasts, p≤0.05)
- Culms harvested was significantly higher in horseshoe cut as compared to others (orthogonal contrasts, p≤0.001)



Conclusions

- Selective cutting dangerous to implement (culms in congested clumps under tension)
- Horseshoe cut initially more labor intensive than SC and requires more skills in spatially arranging clump
- After initially greater labor investment HO is easier to administer, as shoots and culms easily accessible from clump edge
- Need to assess optimal age-class distribution of culms and optimal frequency of harvest


Thank you for your attention!