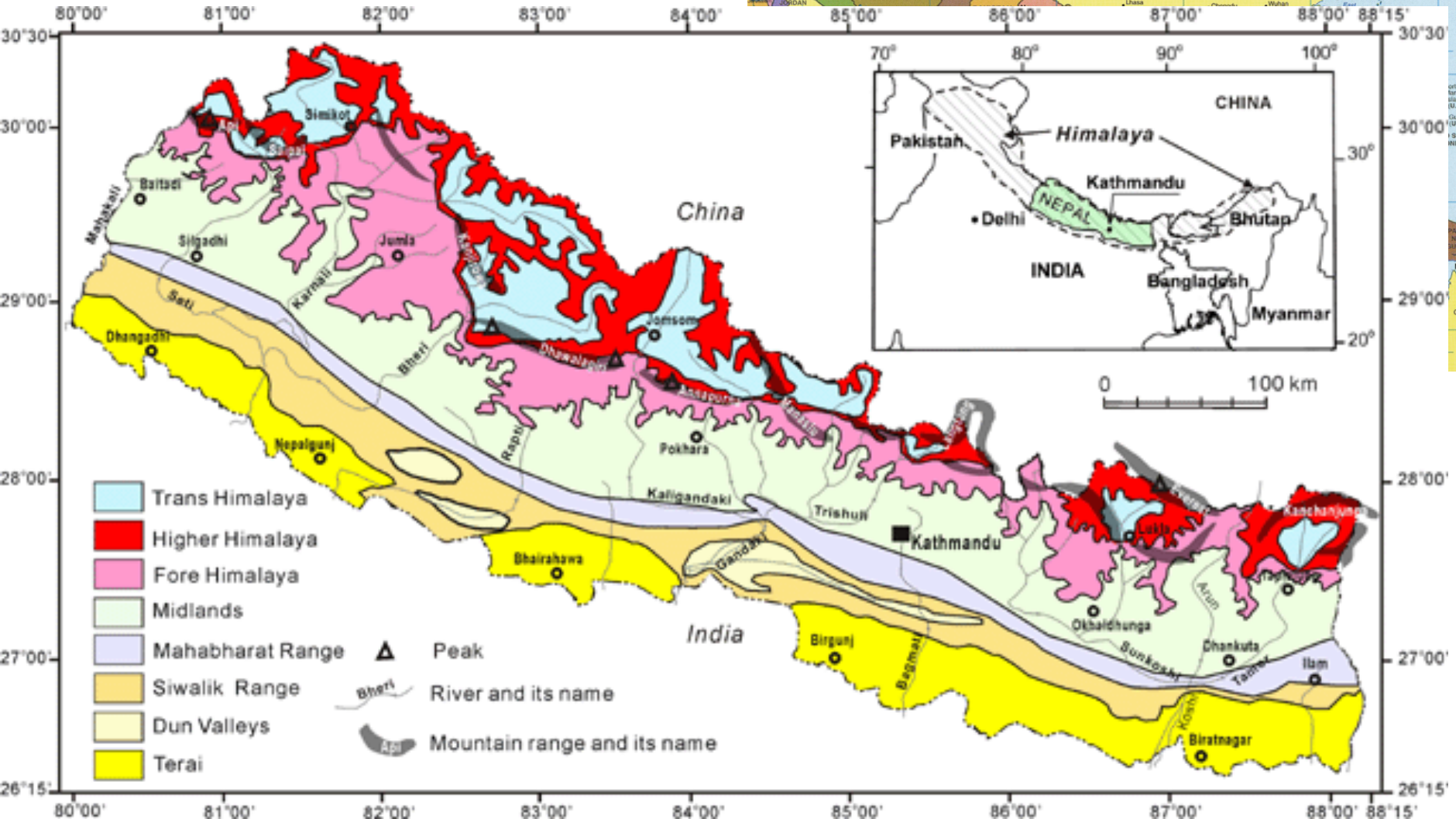




Change in household revenue and aggregate economic benefit by adoption of Conservation Agriculture Production System (CAPS) in the hill-maize system of Nepal

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Nepal: mid-hill



CONTEXT

Agriculture in mid-hills of Nepal



- ❑ maize-based rain-fed cropping system



In National level, maize crop is hill followed by:

- ❑ Millet → 37.9%;
- ❑ Cowpea → 1.3%;
- ❑ Black gram → 2.6%
- ❑ Other legume (soybean, horse gram, green gram, pea, rice bean etc.) → 6.2%





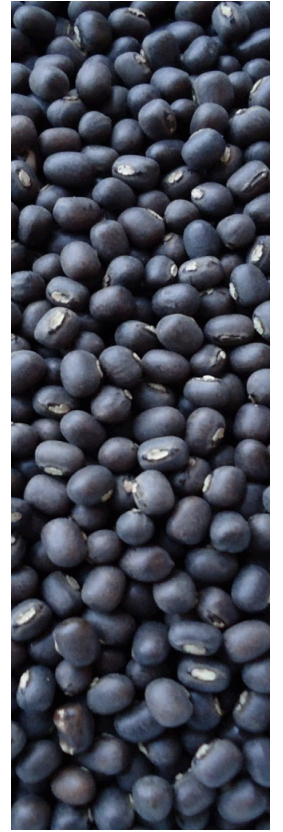
Maize



Cowpea



Millet



Blackgram

Agriculture in mid-hills of Nepal



☐ Cultivation at steep slope

Agriculture in mid-hills of Nepal



☐ Long open fallow after winter ploughing (Khanal, 2004)

CONTEXT: PROBLEM

- ❑ low productivity
- ❑ significant soil degradation (MoEST, 2006; Manandhar et al, 2009)
- ❑ Annual soil loss 3-20 t/ha (Gardner et al. 2000), up to 105 t/ha (Chalise and Khanal, 1997)
- ❑ Downward poverty-degradation spiral (Upadhaya, 2010)

CONTEXT: TECHNOLOGY

- ❑ Conservation agriculture (CA)
 - Minimum soil disturbance
 - Year round soil cover
 - Optimum crop rotation, cropping system

- ❑ CA useful for sustainable agro-ecosystem management (Kassam et al., 2009; Jat et al., 2010)

- ❑ Potential of CA in Nepal for sustainable soil management (Atreya et al., 2006)

RESEARCH PROBLEM

- Socio-economic factors are important determinants of adoption decision for soil and water conservation technologies in Nepal (Tiwari et al, 2008)
- Economic factors and profitability play an important role in decision making about technology adoption (e.g. Cary and Wilkinson, 1997)
- Short term benefits of CA varies (FAO, 2004)

RESEARCH PROBLEM

- **Farm Level**

- How farmers can maximize their benefits adopting *CAPS* in maize-based hill farming system of Nepal ?

- **National level**

- What would be the overall economic impacts of adoption of *CAPS*?

RESEARCH OBJECTIVE

- To identify the revenue maximizing cropping mix for a representative farm under different scenarios of soil conservation
- To estimate the change in total economic surplus by adoption of CAPS in maize-based farming system of Nepal

METHODOLOGY

- **Data and sources:**
 - ❖ Baseline data - define representative household (37 HHs from 3 villages)
 - ❖ Field trial data - difference in yield and cost of production coefficients
 - ❖ Secondary information- Ag Stat Nepal (MoAC, 2011), annual soil loss estimates, elasticity of demand and supply

Coefficients for model

1. Yield coefficients

Production system	M Yield (kg/m ²)	C Yield (kg/m ²)	Mi Yield (kg/m ²)	Bg yield (kg/m ²)
Maize-millet/CT	0.125		0.088	
Maize-black gram/CT	0.125			0.062
Maize-cowpea CT	0.131	0.088		
Maize-cowpea +millet/CT	0.129	0.065	0.043	0.046
Maize-cowpea +millet/ST	0.122	0.060	0.036	0.042

LP model summery

Objective: Maximize total revenue

Constrains

Total Area constrain (4673 m² per season)

Available labor hours (monthly)

Available cash flow (Outflow in month $i \leq$ inflow in month $i-1$)

Minimum consumption requirements of crops

Scenarios

1. Current Practice
2. NO soil conservation scenario
3. Soil conservation scenario (soil loss constrained to $< 1 \text{ t ha}^{-1}\text{year}^{-1}$)

Representative household

Area constrain

Available land of maize-based hill system (per season)	4673 m ²
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Minimum consumption need constrain

Millet	30 Kg
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Maximum capital (money) requirement constrain

Cash outflow in month $i <$ cash inflow in $i-1$ month	\$ 400
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Labor constrain

Monthly labor person, hours (4 x 7 x 26)	728 person hours
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RESULTS AND DISCUSSION

Scenario – Current Practice

- Revenue = 1160 USD from of the area
- Soil loss = about $3.9 \text{ ton-ha}^{-1}\text{yr}^{-1}$

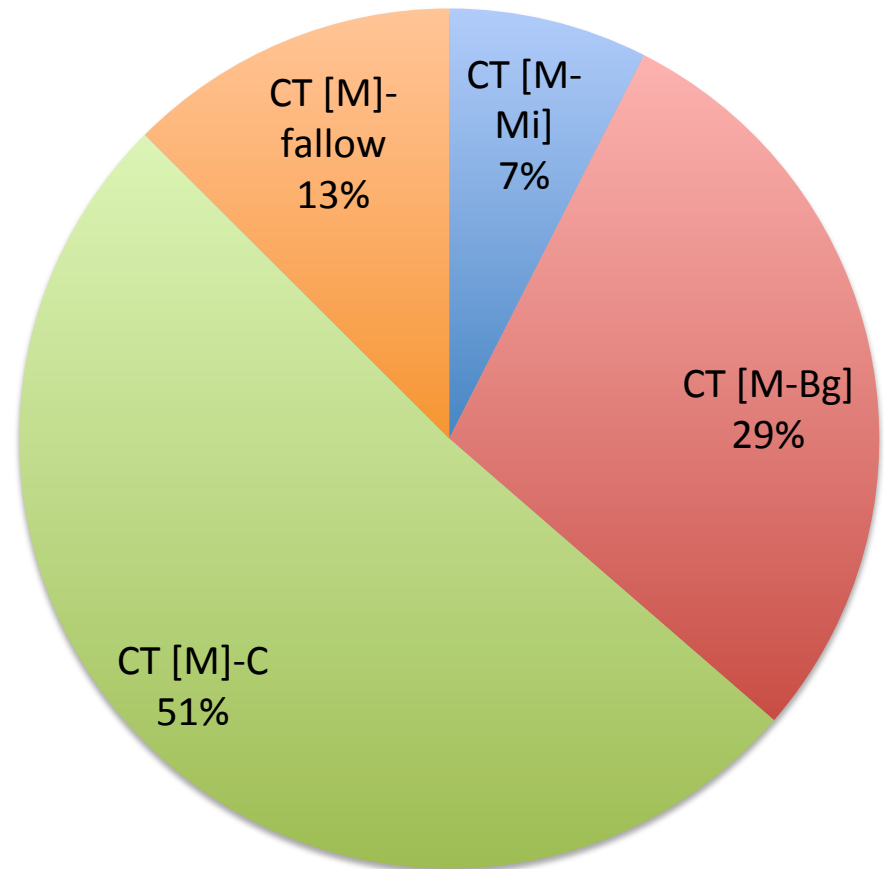


Fig: Allocation of total land

No soil conservation scenario

- Total revenue = 1209 USD (+ 4.5% to traditional)
- Soil loss = 3.3 ton-ha⁻¹yr⁻¹ (-15% to traditional)

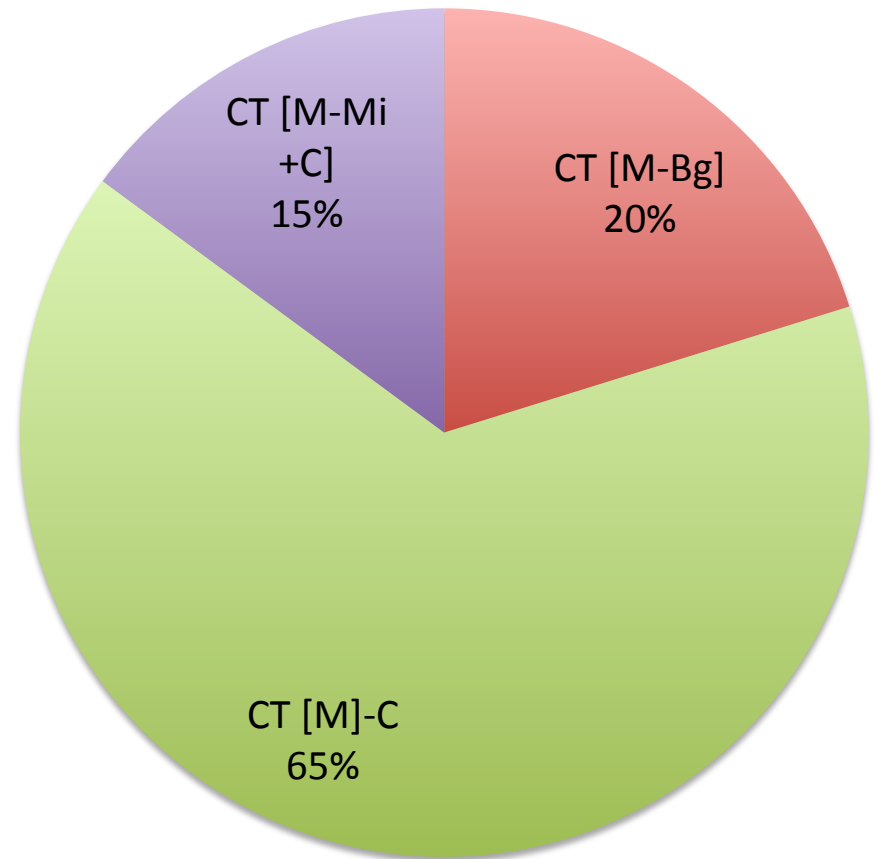


Fig: Allocation of total land

Soil conservation scenario

- Soil loss < 1-ton ha⁻¹ year⁻¹ (fixed)
- Total revenue = \$1099 (-5% of current)
- Attributed to lower yield of strip tillage plots

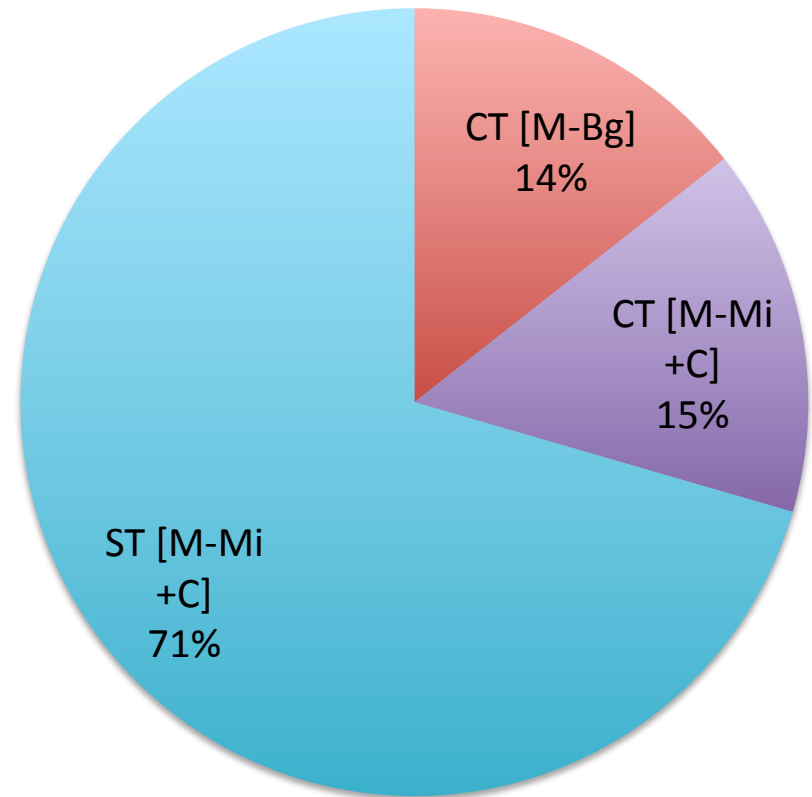


Fig: Allocation of total land

Optimum allocation of land

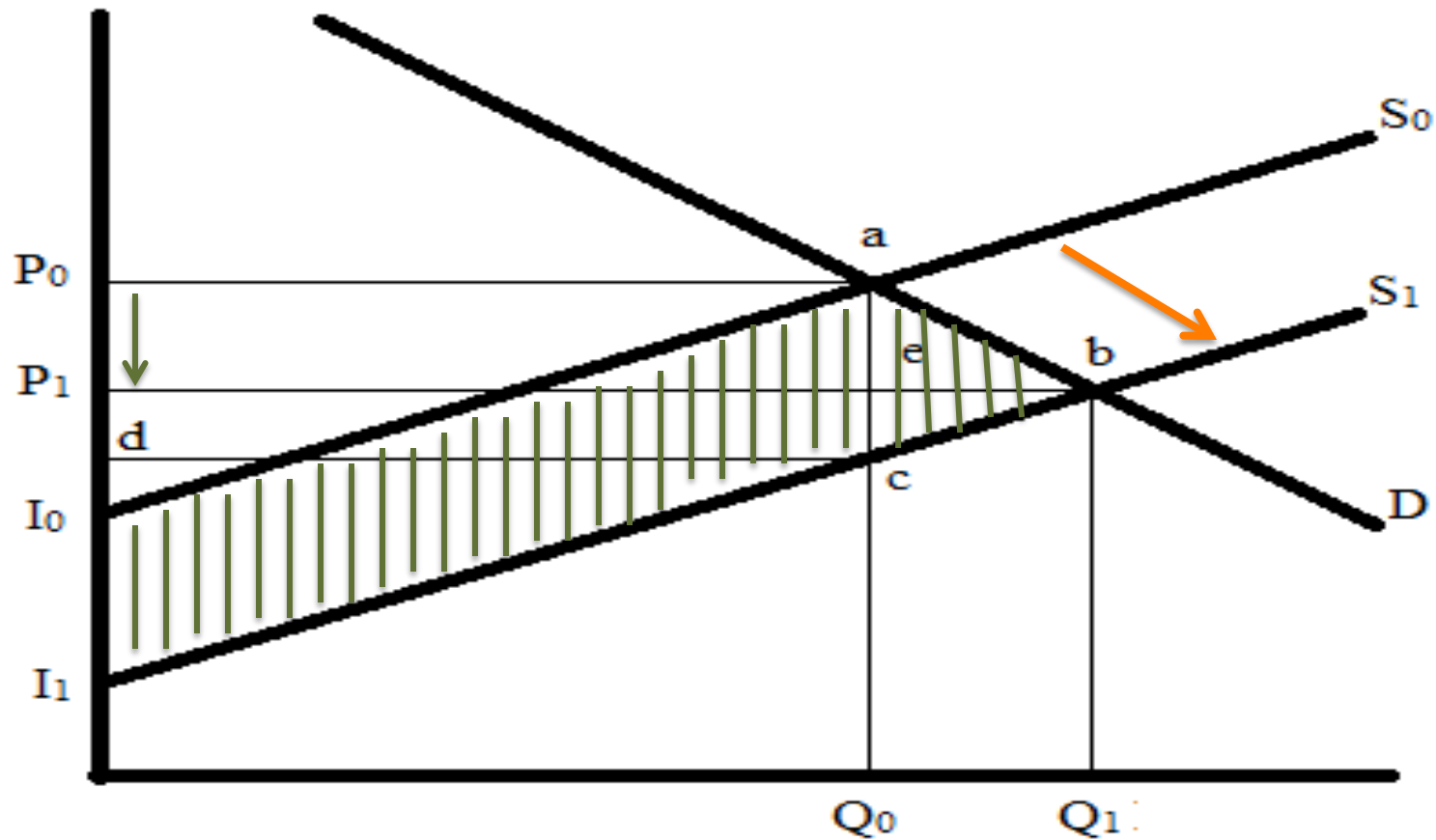
Practices	Current practice	'No-soil conservation' scenario	Soil conservation scenario
		(Soil loss unconstrained)	(Soil loss $\leq 1 \text{ t ha}^{-1} \text{ yr}^{-1}$)
	Area allocated (m ²)	Area allocated (m ²)	Area allocated (m ²)
CT [M-Mi]	341.4 (8%)	-	-
CT [M-Bg]	1318.2 (28%)	943.9 (20%)	672.9 (14%)
CT [M]-C	2332.2 (51%)	3032.7 (65%)	
CT [M-Mi+C]		696.2 (15%)	705.3 (15%)
ST [M-Mi+C]		-	3294.4 (71%)
CT [M]-fallow	571.2 (12%)		
Total revenue (USD)	1160 (100%)	1209 (104.5%)	1099 (95.1%)

Comparison of the scenario

- About 4.5% increase in revenue and about 15% decrease in current level of soil loss can be achieved by adopting legume-millet intercropping
- Sustainability in soil loss can be achieved only through adoption of conservation tillage
- To conserve the soil to sustainable level, farmers need to surrender about 5% of current revenue in initial years

Change in total economic surplus

Closed economy model for total change in economic surplus



Formula used: Alston et al. 1995 also used by Nguema, 2012

Parameters and assumptions for estimating change in total economic surplus

Parameter	Maize	Millet	Cowpea	Black gram
Production (tons)	2,067,722	302,691	5,660	22,530
Baseline area (ha)	623182	206340	8,000	16557
Price per ton (US \$)	376.5	317.6	855.3	1208.2
Percent yield gain	<u>0.0004</u>	<u>-0.0606</u>	<u>0.0522</u>	<u>0.0306</u>
Percent cost increase per ha.	<u>-0.0767</u>	<u>0.1078</u>	<u>0.0194</u>	<u>0.0194</u>
Years to first adoption			1	
Years of benefits			12	
Probability of success (%)			100	
Elasticity of supply	0.390	0.910	0.219	0.088
Elasticity of demand	-0.91	-0.77	-0.92	-0.92
Discount rate (%)				3

Data Sources: MoAC, 2011; Reed et. al, 2012; Prasad et al, 2011;

Total change in economic surplus under different rates of adoption

Maximum adoption rate (%)	Change in economic surplus (NPV million \$) (12 years)
1	375.32
2	610.93
3	706.70
4	663.11
5	479.73

CONCLUSION

- Adoption of a millet and legume intercropping system can increase revenues and reduce soil loss (up to 15%), simultaneously
- Farmers need to surrender some revenue in the initial years to conserve soil
- Total change in economic surplus taking medium term (12 years) planning horizon is positive
- Financial support in initial years essential for adoption of the CA by subsistence farmers

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