Effect of conservation agriculture (on crop yields and system productivity) in maize-based farming system in the mid-hills of Nepal

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Humanitarian Technology: Science, Systems and Global Impact
Boston, MA, USA
May 14, 2014

Welcome

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Acknowledgement

- Sustainable Agriculture and Natural Resource Management: Feed the Future Food Security Innovation Lab

- USAID

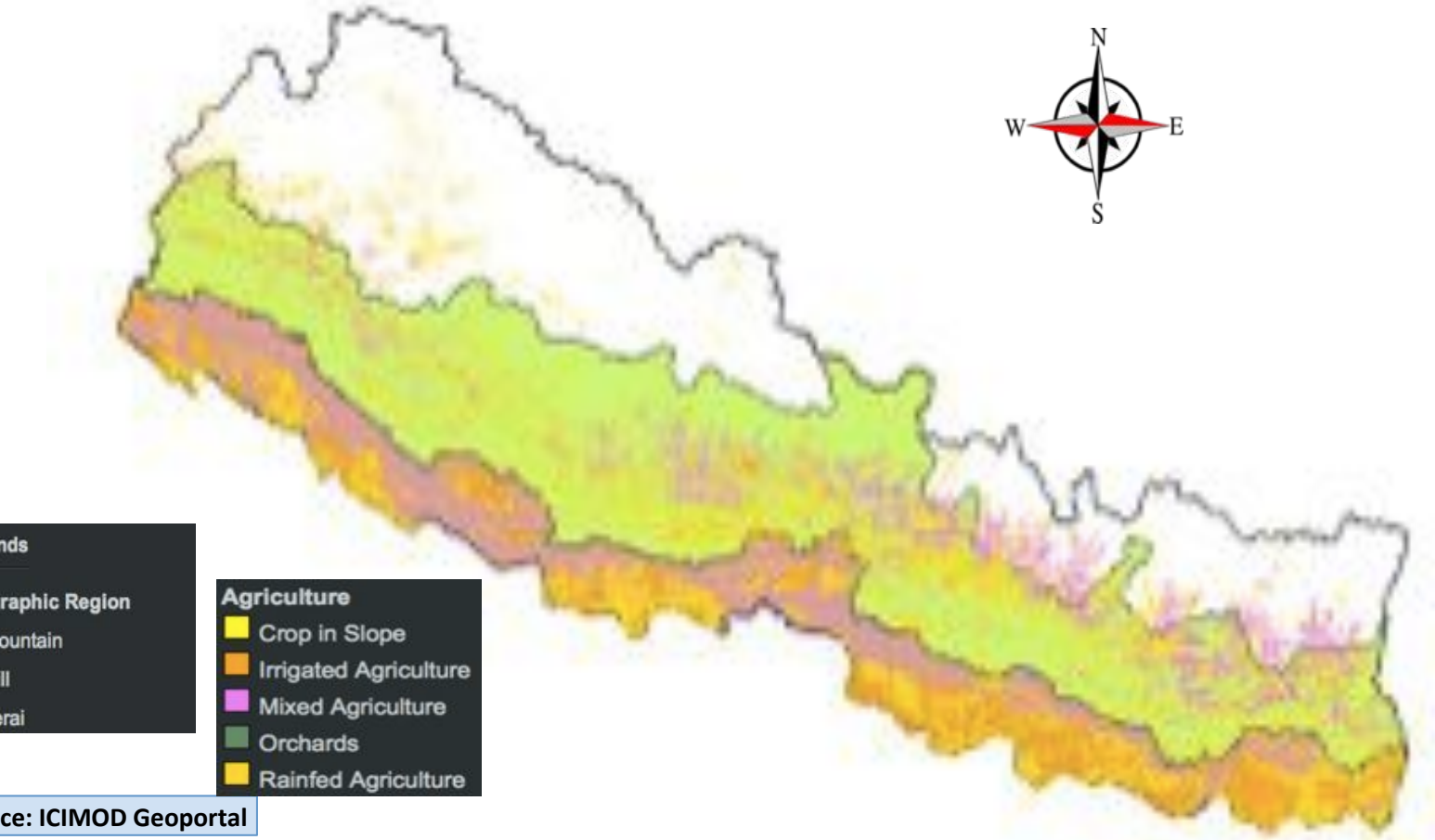
INTRODUCTION

Conservation of agriculture resources (e.g. soil fertility) is essential for sustainable agriculture development

Challenges

- ❓ Conservation sometimes conflicts with short term productivity
- ❓ worldwide, one in eight people are still undernourished; higher among rural farmers
- ❓ if adoption of conservation practices reduce yields, it would be a constraint for food insecure farmers to adopt those practices

Nepal: mid-hill



Source: ICIMOD Geoportal

Poverty-degradation problem in hill region of Nepal

- **Problems of poverty, food insecurity and malnutrition**
  - >49% poor Nepalese live in the hills
  - >95% hill districts are food insecure
  - >55% farmers in hills are under poverty line

- **Challenges for sustainability**
  - Annual soil loss 3-20 t/ha sometimes up to 105 t/ha
  - Decline of soil fertility


NEPAL
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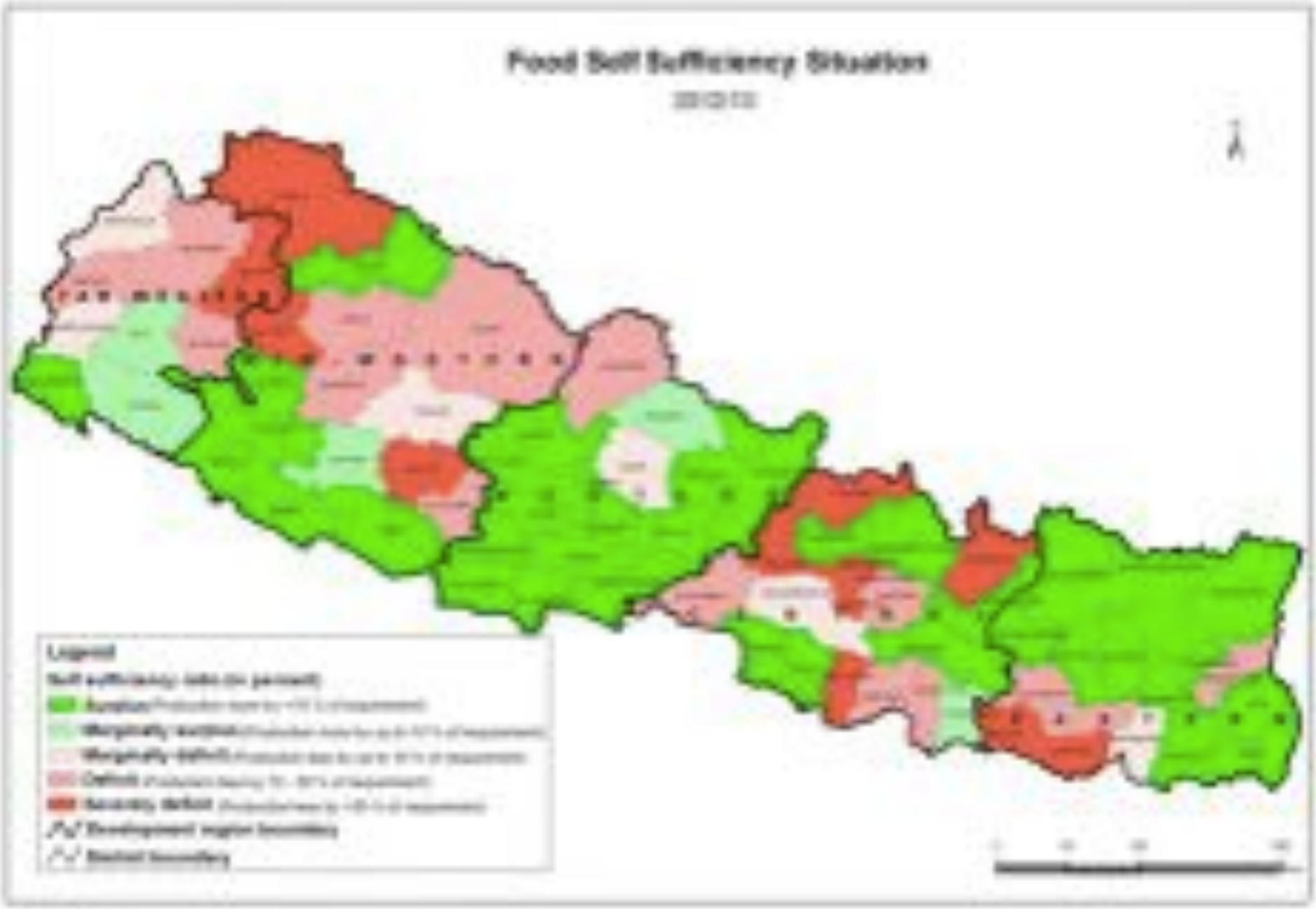
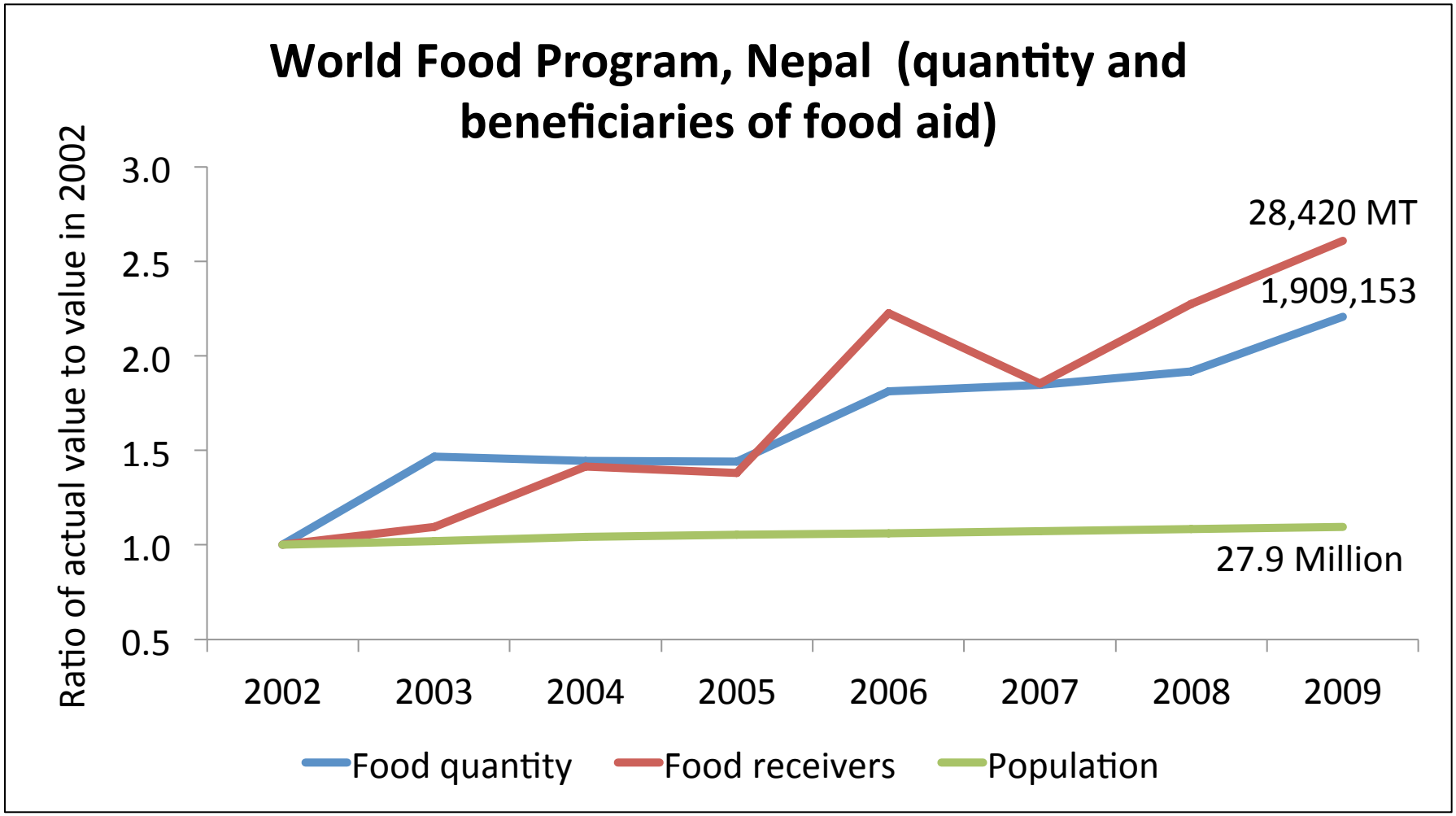


Source: MPF-JICA

Current focus: short-term solution



Source: WFP, 2010. Nepal: An Evaluation of WFP"s Portfolio Vol I Full report

Current focus: short-term solution

- Government of Nepal expense $4.5 Million/year to subsidize food transportation
- World Food Programme (WFP) has allocated $43.0 Million/year (about $17.4 M/year for food purchase)
  - Compare it to the capital expenditure of Ministry of Agriculture = $8.11 M in 2011

What need to be done?

- Support farmers to adopt technologies that can increase yield and improve sustainability

Situation analysis

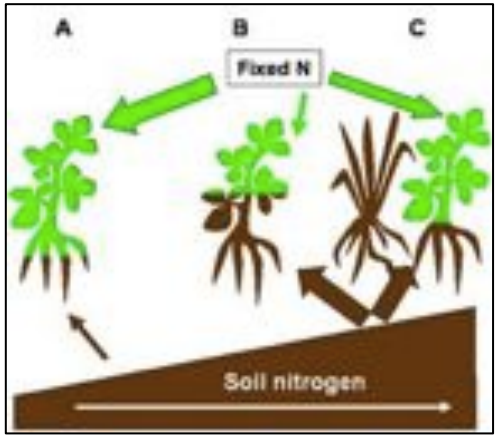
- **Push for Intensification**
  + high food demand (about 2% pop. growth)
  + limited arable land (per capital 0.09 ha)
  + low crop yields (≈ half of world average)
- **High land degradation**
  + intensification
  + sloping land
  + no conservation practices
- **Climate change**
  - ➢increased climatic variations, increased challenges

Conservation agriculture production system (CAPS)

CAPS - conservation while increasing productivity

<u>CAPS is simultaneous implementation of</u>

- <u>reduced tillage</u>
- <u>management of year-round soil cover</u>
- <u>following optimum crop rotation</u>



CAPS is an option for the system!

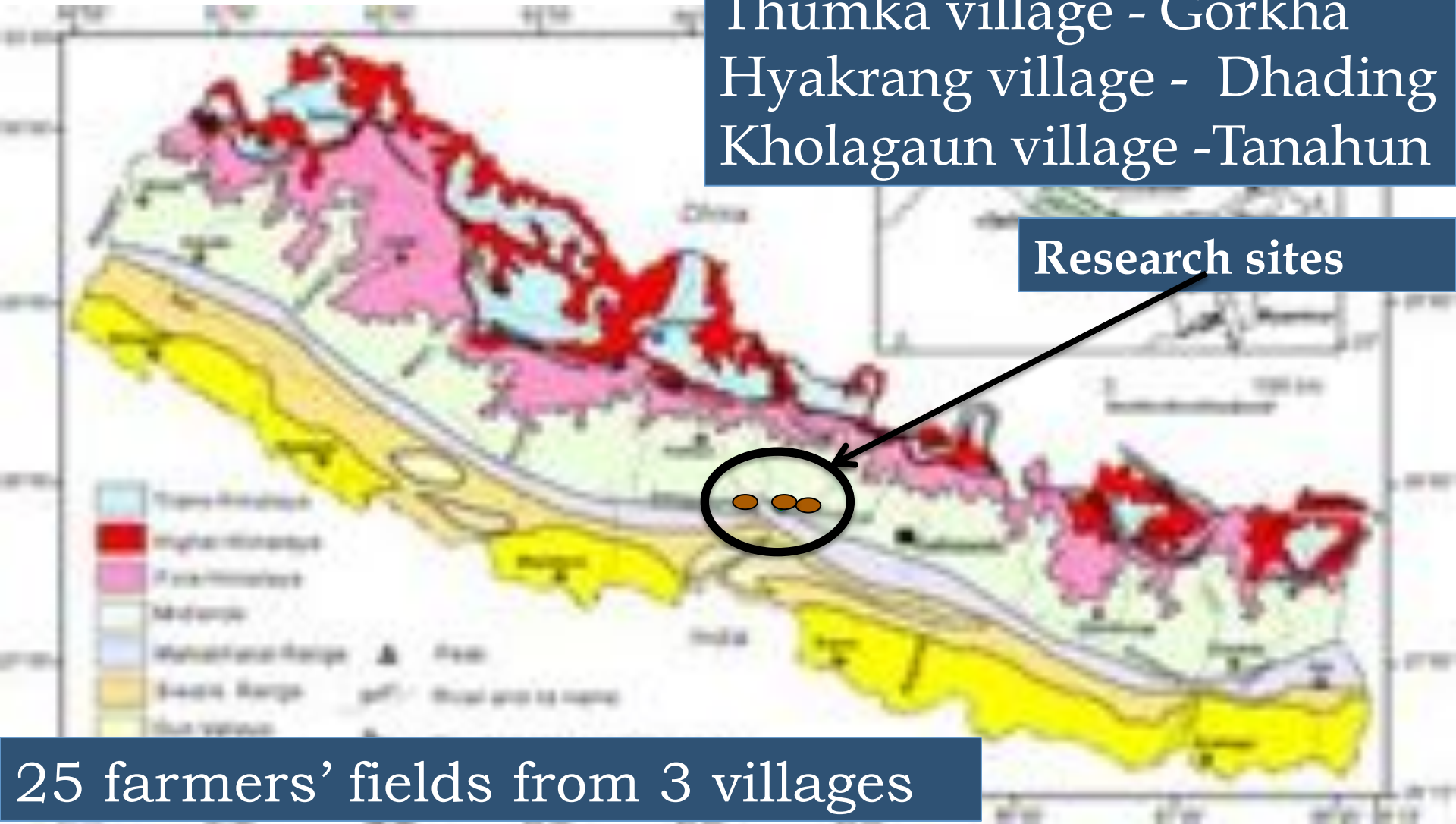
- **Opportunity**
  - ✓ principles separately tested and validated in Nepal
- **Questions**
  - ✘ is it feasible in subsistence (and food insecure) system?
  - ✘ Is it feasible without external inputs?
- **ALSO, it require local customization and evaluation**

OBJECTIVES

i) to evaluate the crop yields and economic return from adopting CAPS in the initial years of transition

ii) to determine the impact of intercropping of staple and cash crops (millet and legume) for yield and economic returns under different CAPS

Nepal: study sites



25 farmers' fields from 3 villages

METHODOLOGY

❑ On-farm evaluation

1. Selection of CAPS through focus groups

   ✗ Two tillage type: strip tillage (ST) & full tillage (FT)
   ✗ Two crop rotation {summer-post rainy season}

   CAPS1: FT maize-legume
   CAPS2: FT maize-millet+legume
   CAPS3: ST maize-millet+legume

   Legume crop for CAPS:
   2011- cowpea; 2012 & 2013 – black gram

2. Traditional system: FT maize-millet

Farmers at on-farm trials in Hyakrang and Kholagaun VDC, photo – Durga Shrestha, LI-BIRD

RESULTS AND DISCUSSION

On-farm evaluation trial data

1st season performance

- Maize yield
- maize plant density

2nd season performance

- Millet yield
- Legume yields
- CR_{millet}
- Land equivalency ratio

System productivity

Annual Revenue

Maize yield equivalent

Conclusion

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Difference of crop yields by CAPS

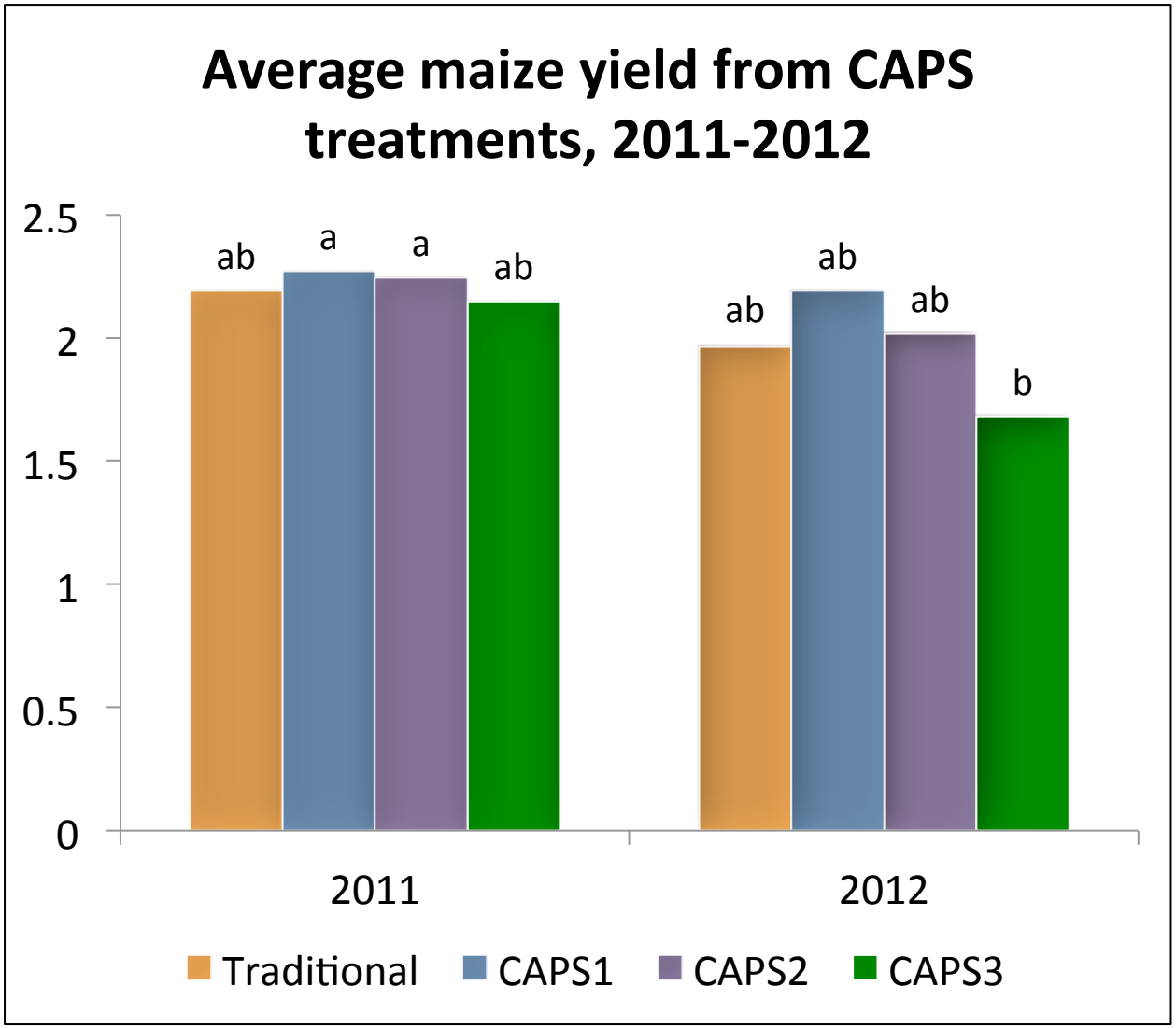
Result of ANOVA

Source of variation	Maize (ton/ha)	Maize plant density (plants/m2)
Year (Y)	***	***
Village (V)	NS	NS
CAPS (T)	NS	NS
Y x T	NS	NS
V x T	NS	NS
Y x V	***	***
Field (village)	**	**

***, **, * indicate the factor were significant at P<0.001,P<0.01, P<0.05; NS indicate factor was not significant at p<0.05

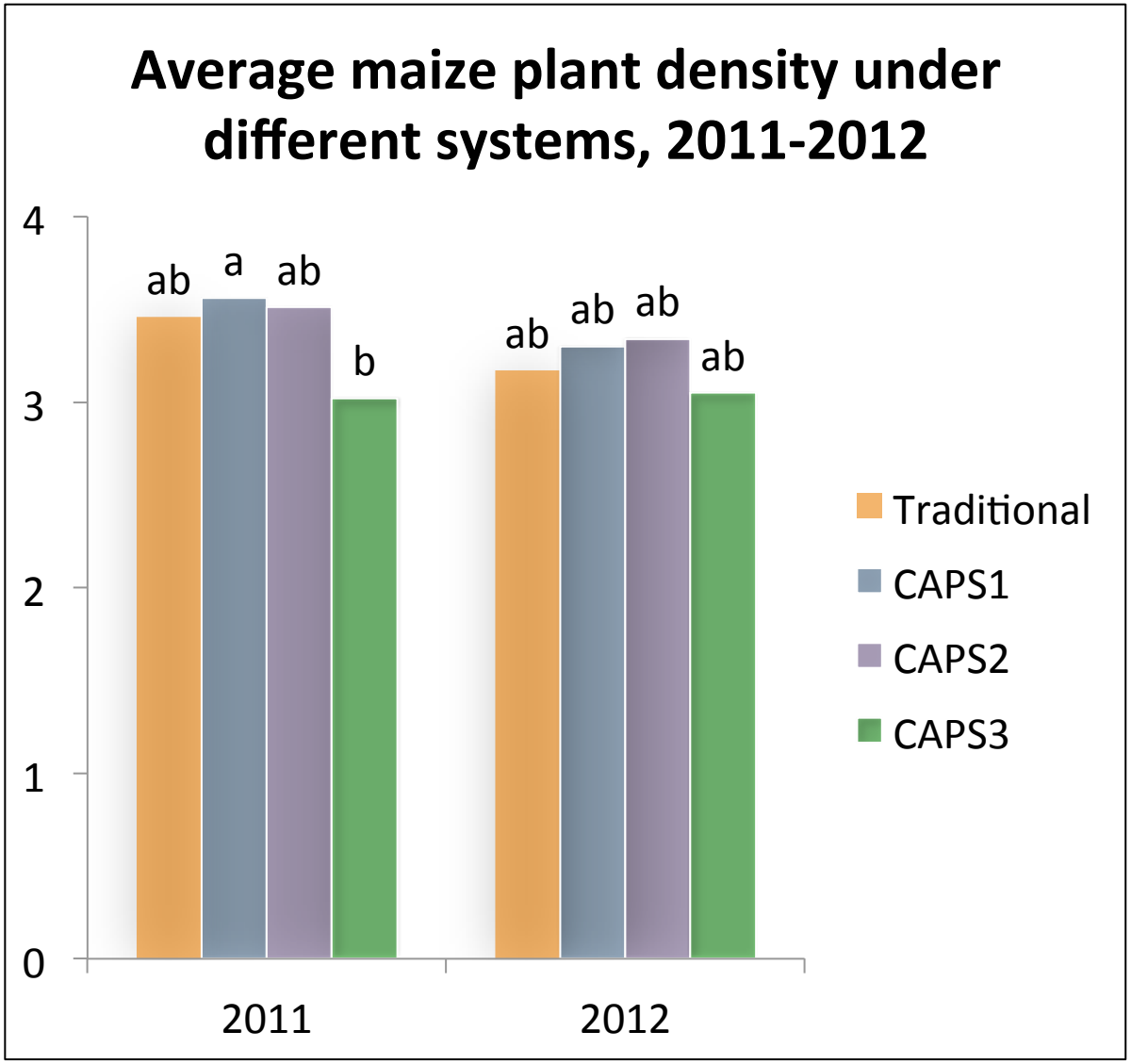
Comparable maize yield in all systems

- Lower yield in 2012 because of weather
- Maize yield was not different among all CAPS and traditional system for both years



Maize plant density reflects the yield pattern

- Arithmetically, CAPS3 had 11% lower plant density (and 11% lower yield)
- Difference in plant density among CAPS was not significant



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Difference of crop yields by CAPS

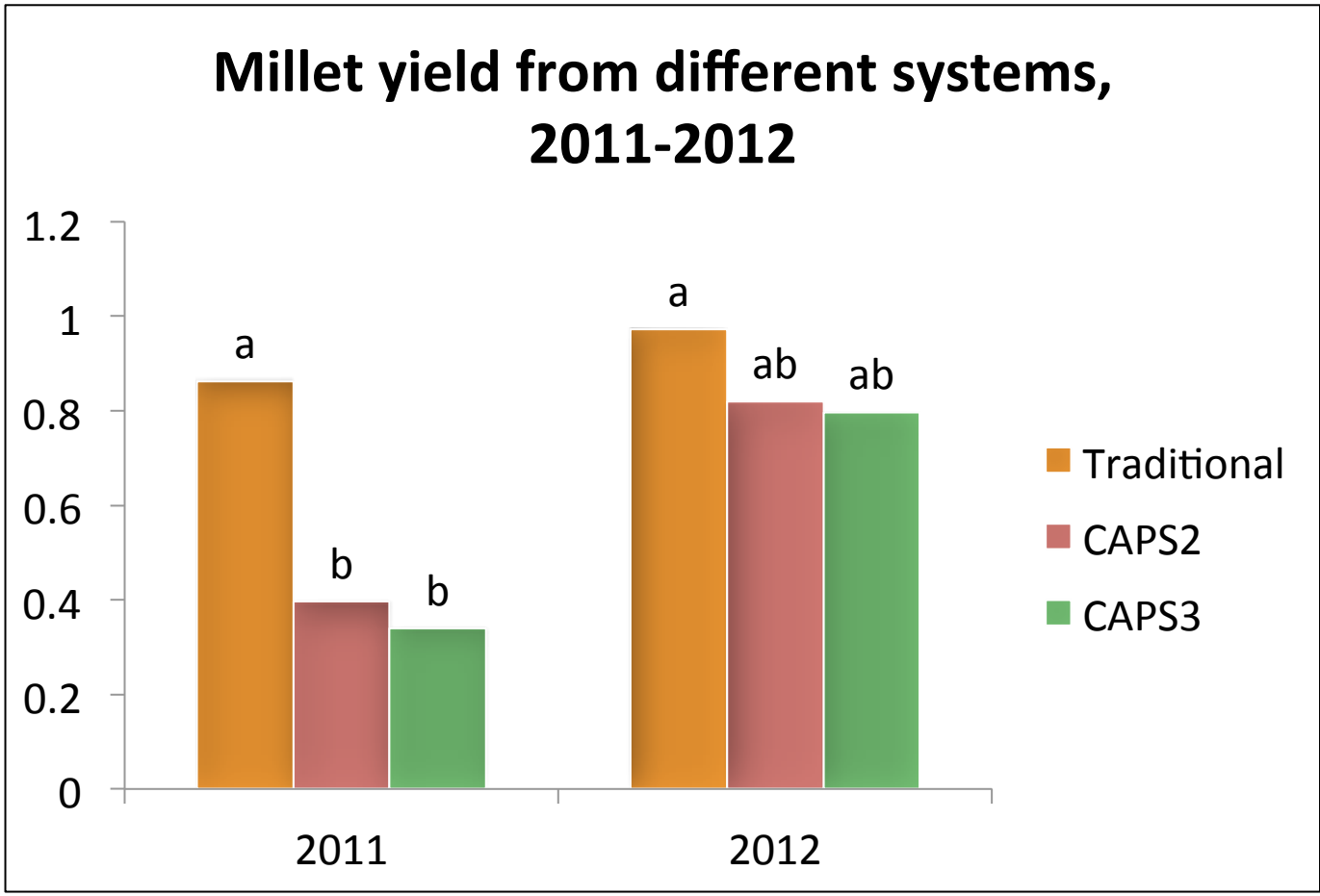
Result of ANOVA

Source of variation	Millet (ton/ha)	Black gram (ton/ha)	Cowpea (ton/ha)
Year (Y)	***	-	-
Village (V)	**	NS	NS
CAPS (T)	***	***	**
Y x T	NS	NS	-
V x T	NS	NS	NS
Y x V	***	*	-
Field (village)	**	*	**

***, **, * indicate the factor were significant at P<0.001,P<0.01, P<0.05; NS indicate factor was not significant at p<0.05

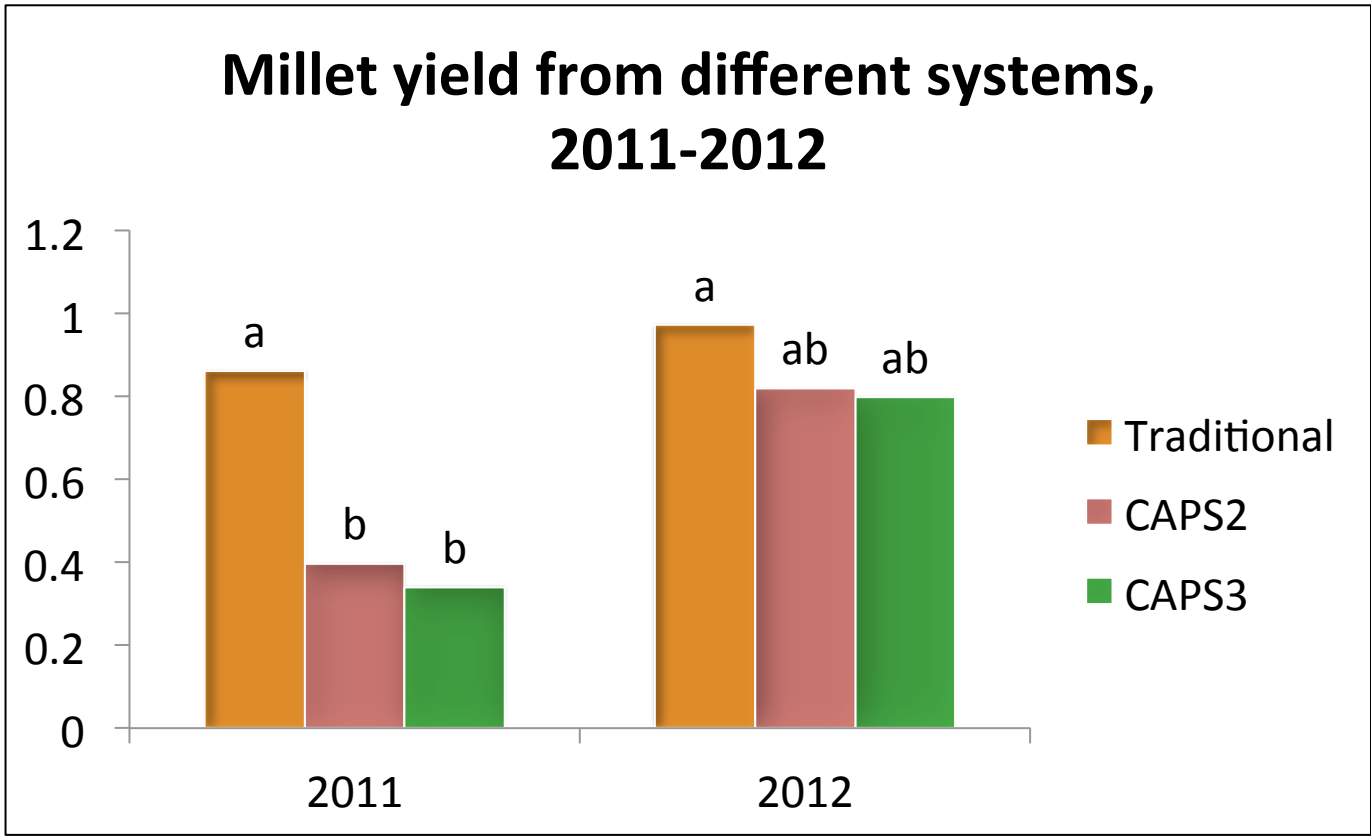
Lower millet production from CA systems in 2011

- Millet Yield in traditional system was higher than CAPS2 & CAPS3 in 2011 under millet+cowpea
- Lower yield due to intercropping



Similar millet production from CAPS systems in 2012

- Millet yield from all system was comparable in 2012 under millet+black gram
- Since millet is primary crop, intercrop with BG is preferred

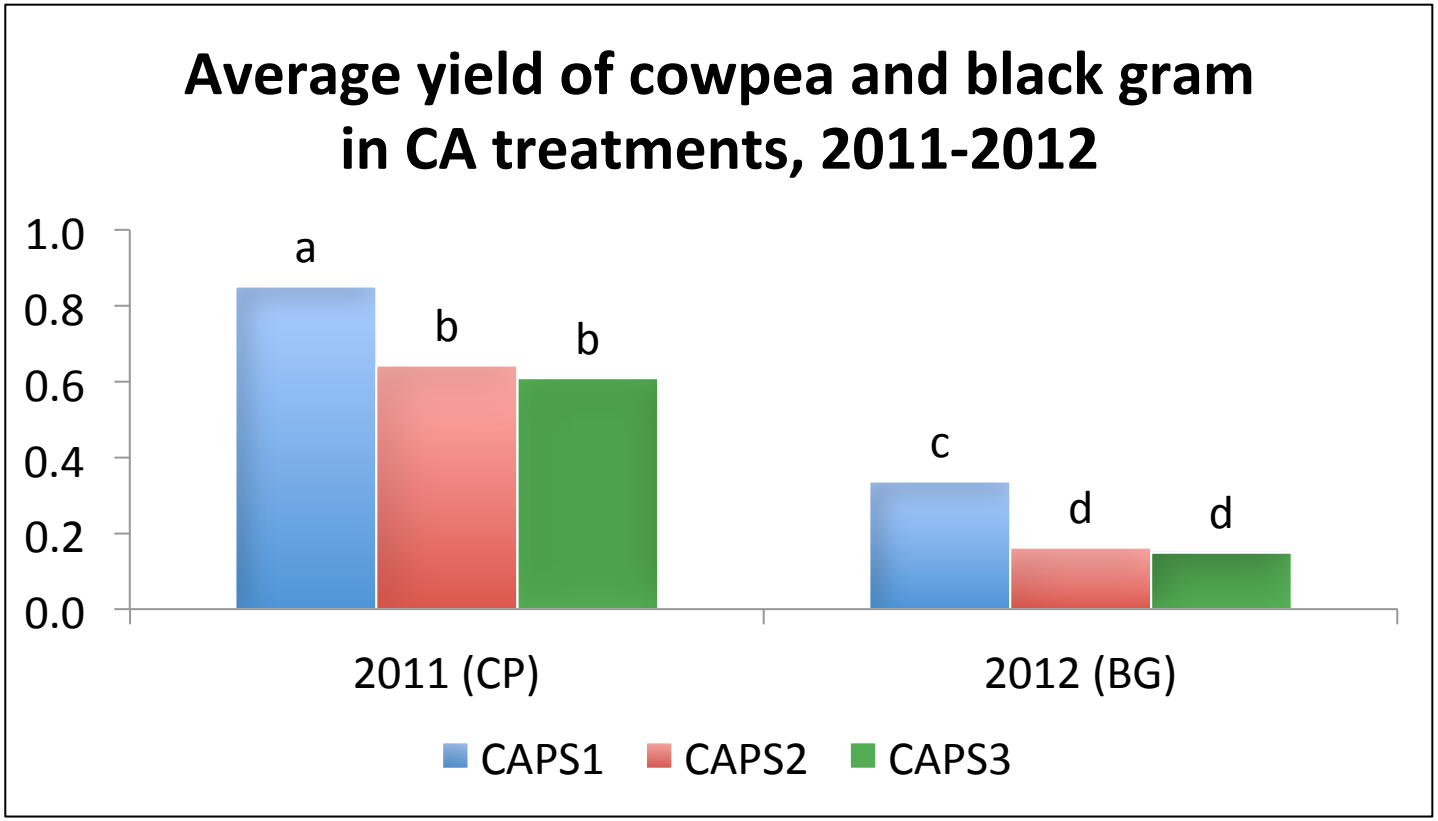


Higher legume production in CAPS

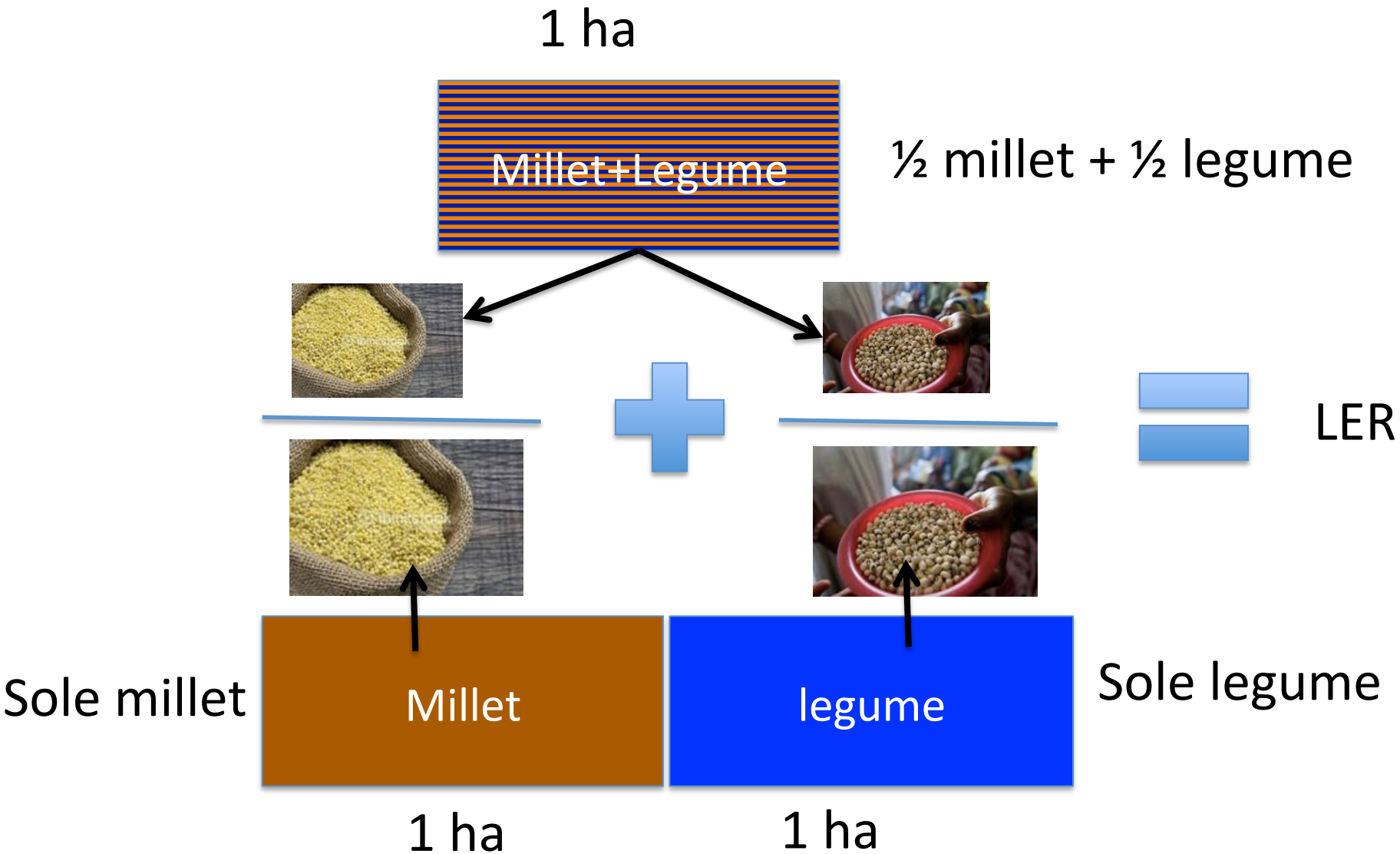
Black gram and cowpea yields in -

- CAPS1 was higher than CAPS2 and CAPS3 b/c of sole cropping Vs intercropping

- CAPS2 and CAPS3 were not different

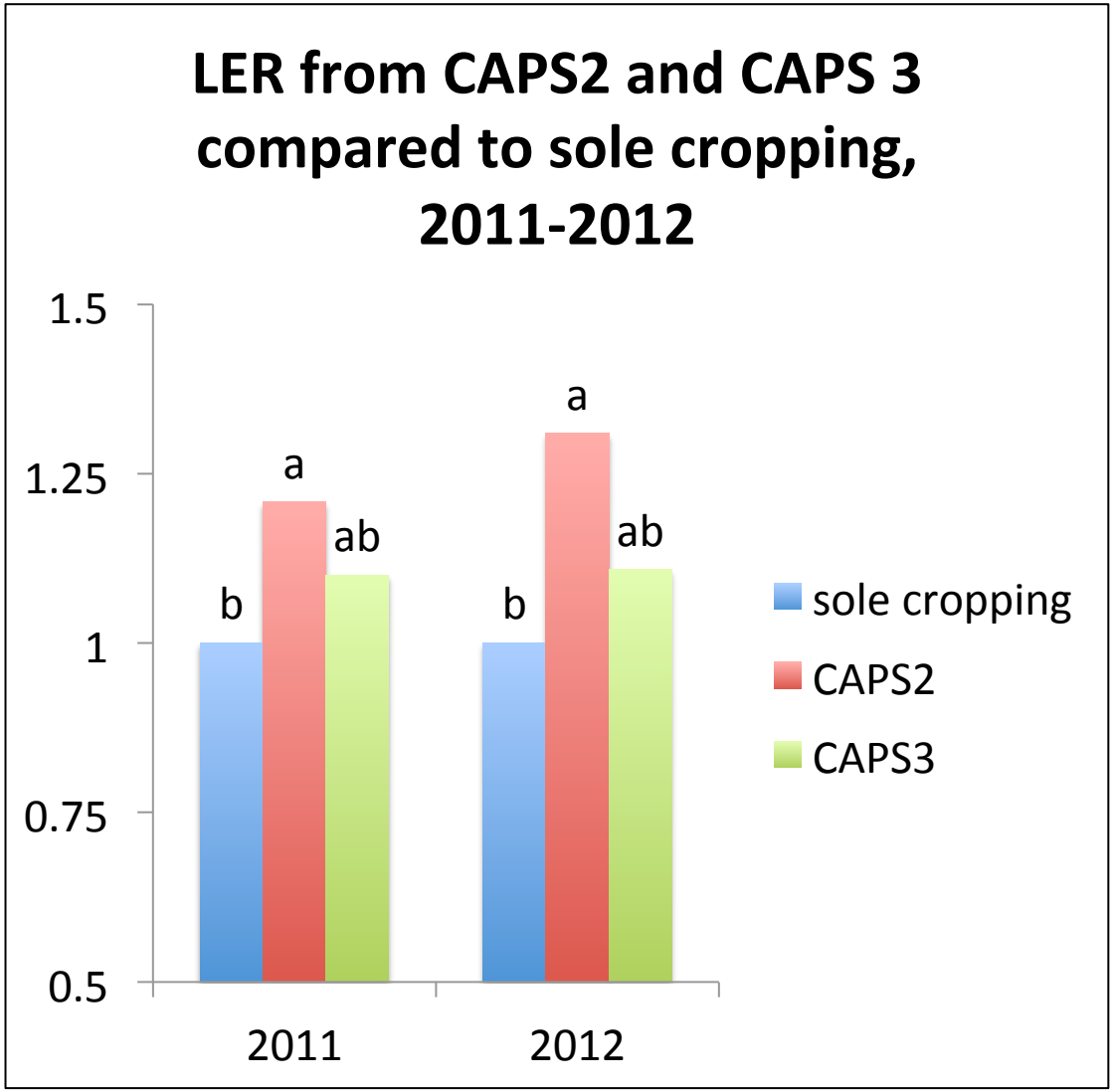


Land equivalency ratio (LER)



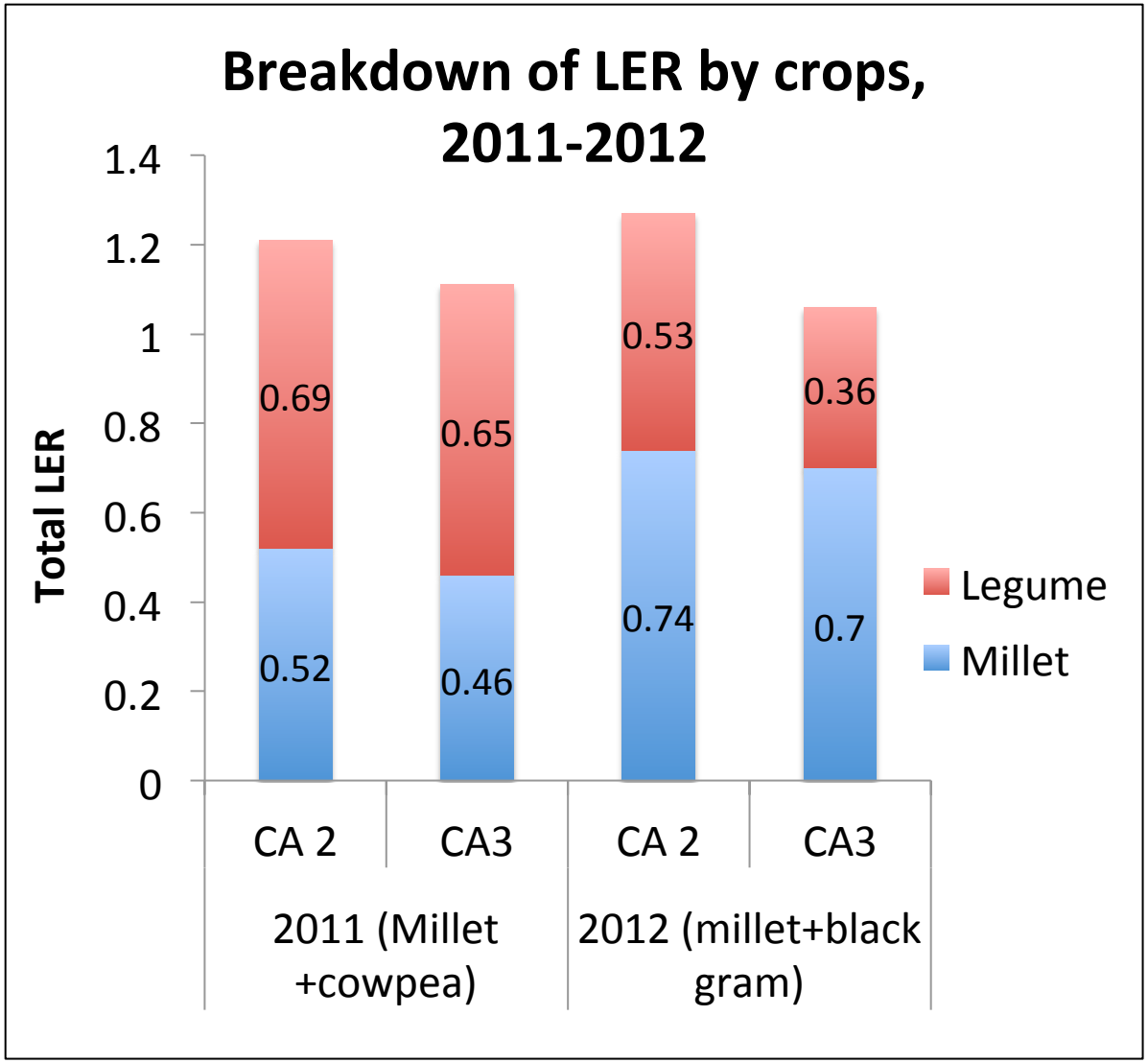
Land equivalency ratio (LER)

- CAPS2 was higher than traditional system hence intercropping beneficial under FT
- CAPS3 was comparable with traditional system and CAPS2
- ST nullified the advantage of intercropping



Land equivalency ratio (LER)

- the gain from intercropping was by cowpea (58%) in 2011, while it was by millet (59%) in 2012
- Millet fetch lower price, hence revenue was lower in 2012

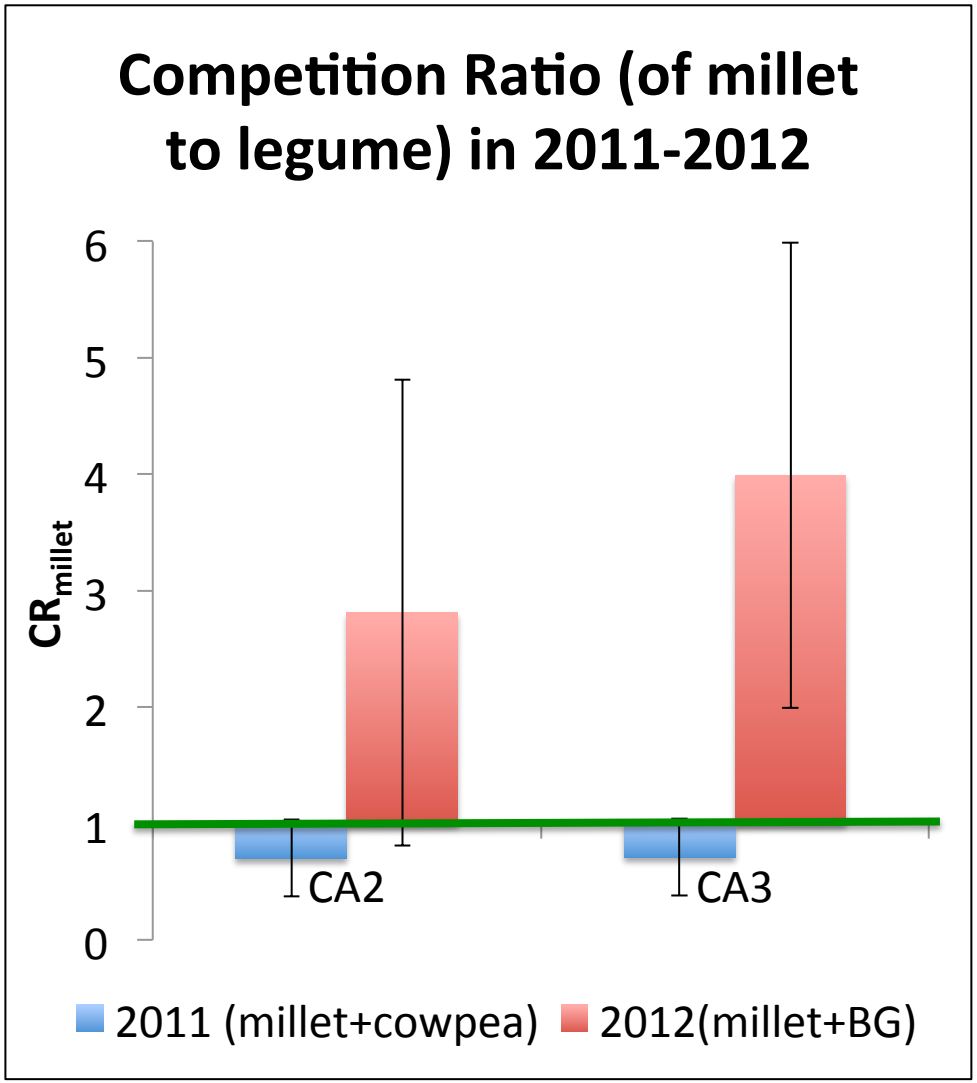


Competition ratio

- Millet was primary crop, hence CR_{millet} was important
- CR can be compared to 1, CR>1 shows competitiveness of the crop over other crop in intercropping

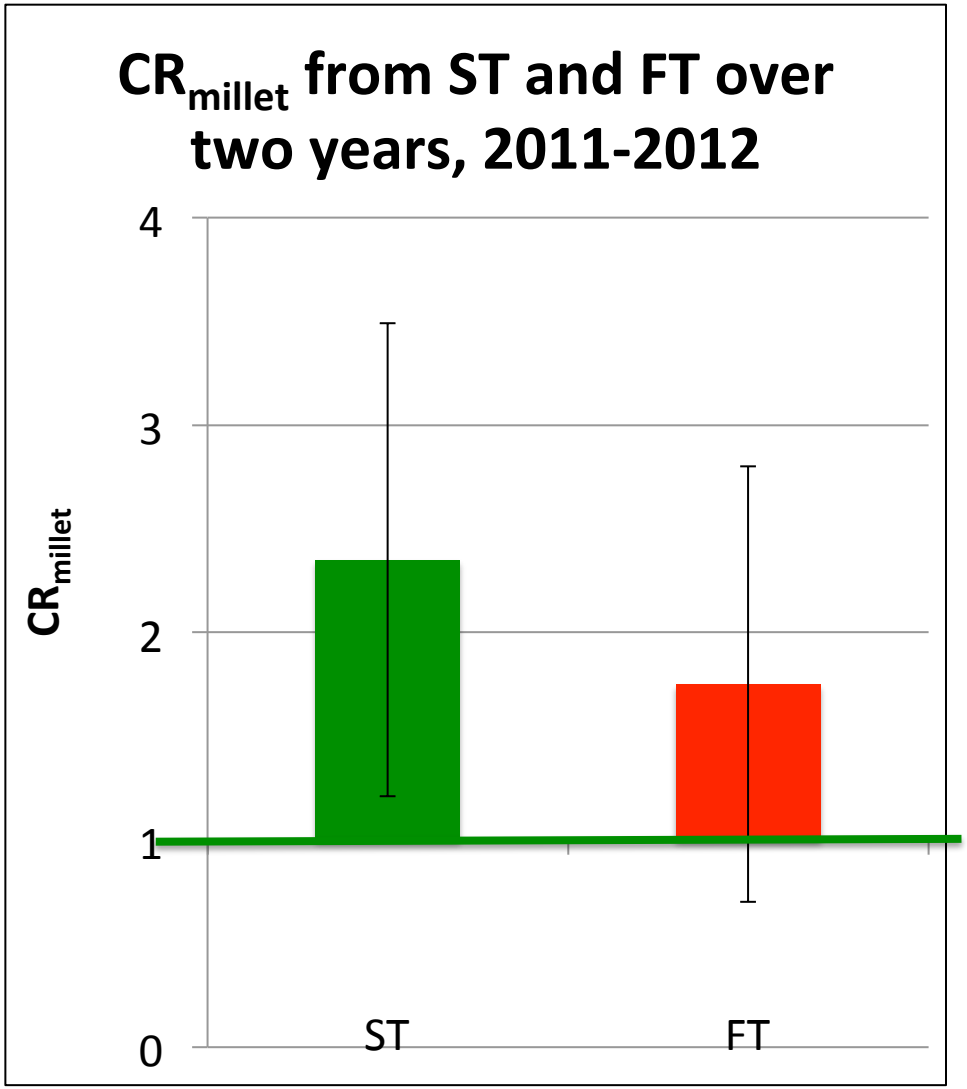
Competition ratio

- Cr_{millet} was lower than 1 for both CAPS2 and CAPS3 under millet +cowpea system
- CR_{millet} was higher than 1 for CAPS3 under millet+black gram system
- Millet performed better with black gram



Competition ratio

- CR of millet was significantly higher than 1 in ST but not in FT
- Millet had higher competitiveness under ST



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2nd season performance

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Legume yields

CR_{millet}

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System productivity

Annual Revenue

Maize yield equivalent

Conclusion

System productivity significantly different by CAPS

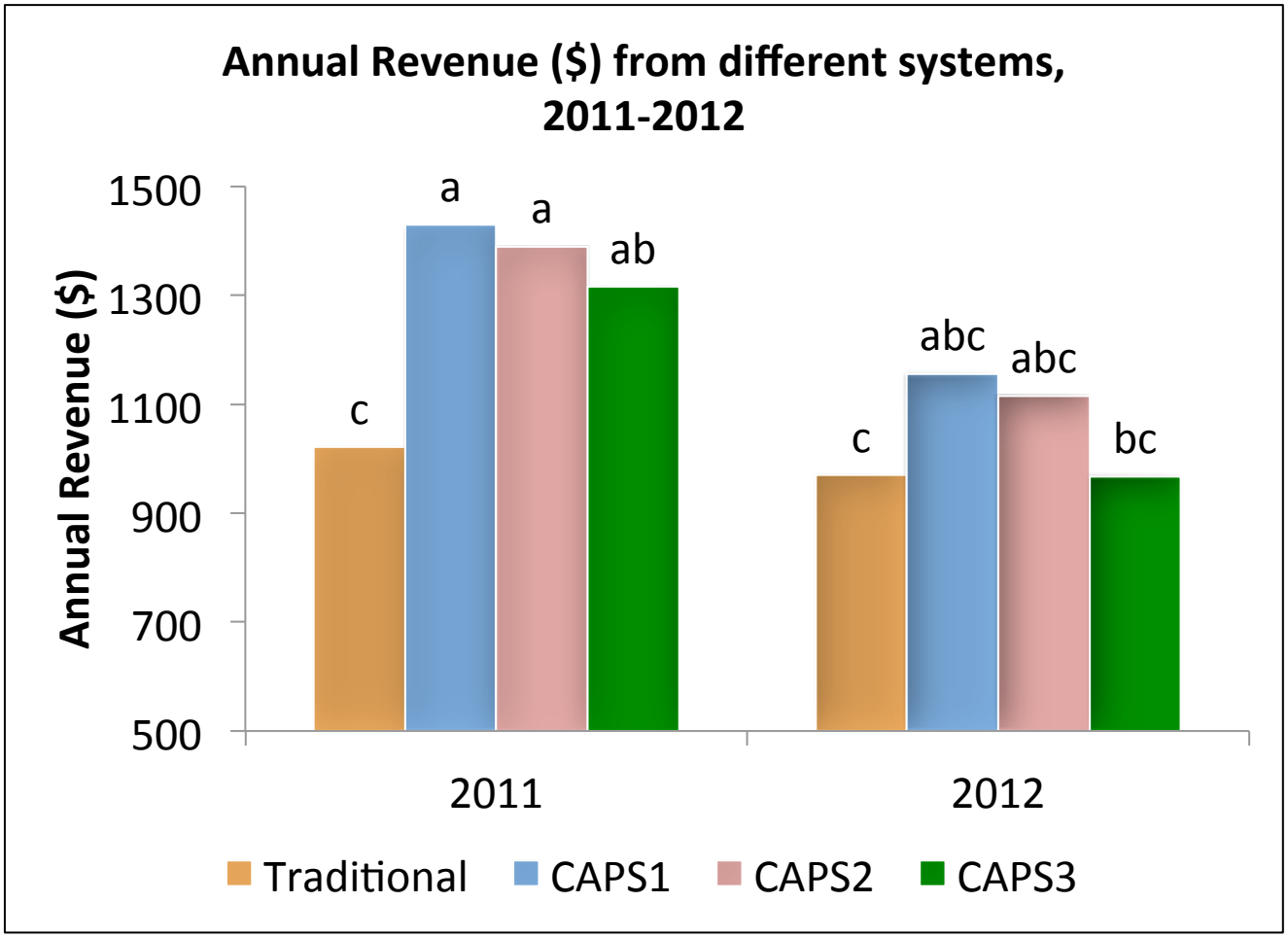
Result of ANOVA

Source of variation	MYE (maize ton/ha)	Annual Revenue ($)
Year (Y)[c]	***	***
Village (V)	NS	NS
CAPS (T)	***	***
Y x T	NS	NS
V x T	NS	NS
Y x V	***	***
Field (village)	**	**

***, **, * indicate the factor were significant at P<0.001,P<0.01, P<0.05; NS indicate factor was not significant at p<0.05

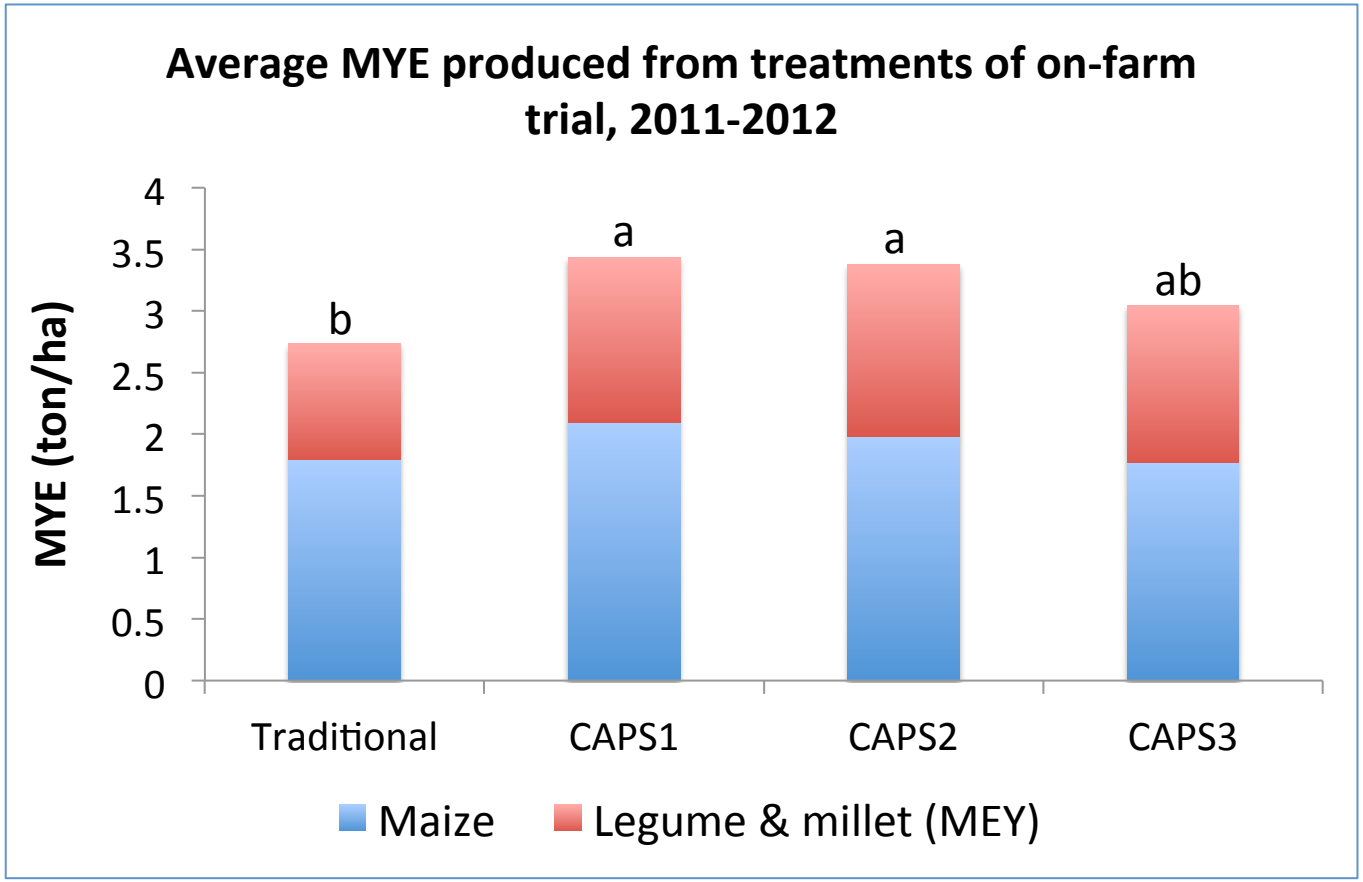
Most CAPS increased annual revenue

- CAPS1 & CAPS2 was higher than traditional system
- CAPS3 was higher than traditional system in 2011, but comparable in 2012



Maize Yield Equivalent (MYE)

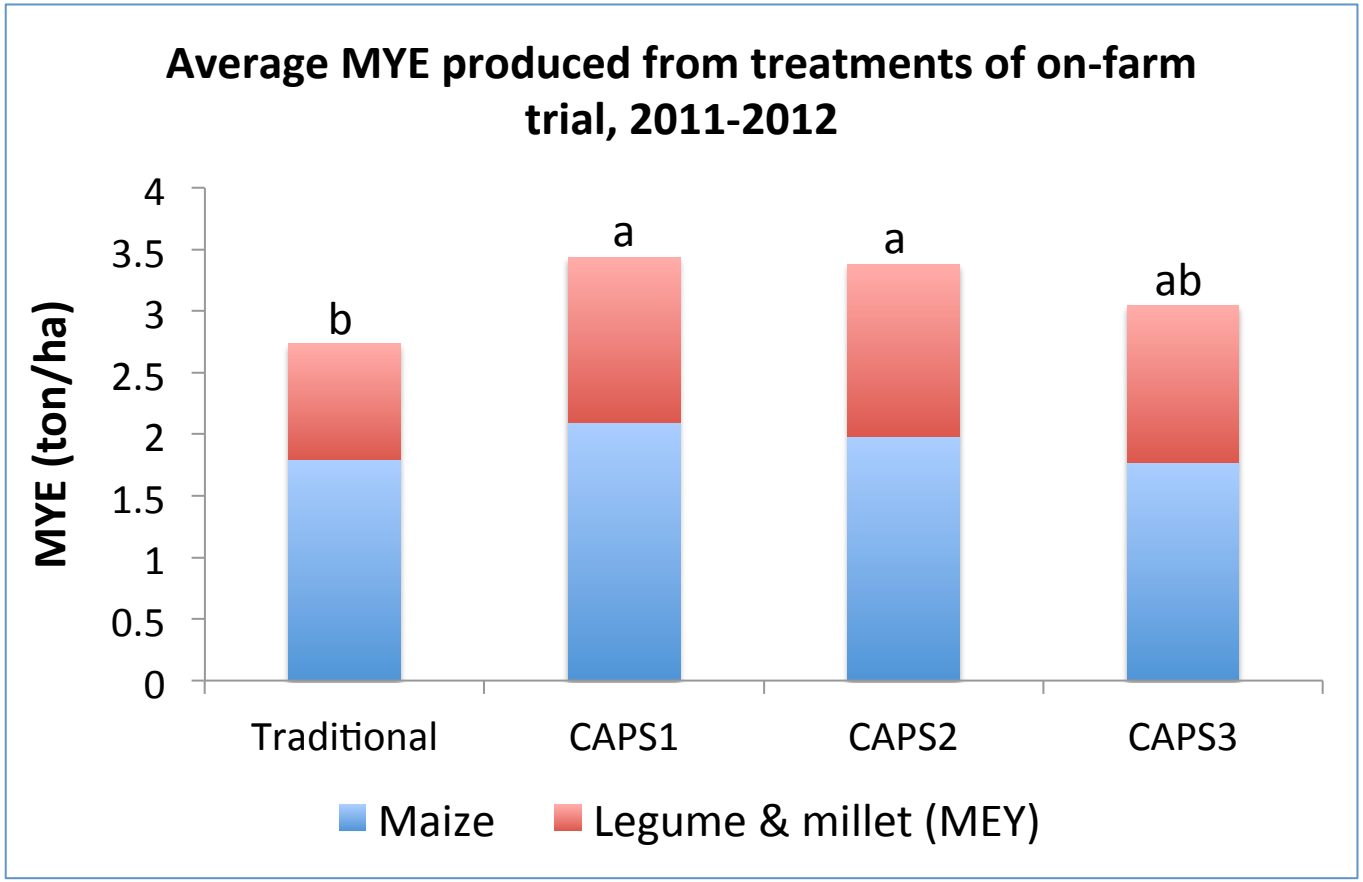
Yields of all other crops (millet, cowpea, black gram) converted to maize equivalent based on market price



Higher MYE from CAPS

- ❑ CAPS1 and CAPS2 was higher than traditional system
- ❑ CAPS3 was was not different from all other treatments

➢ CAPS with ST system did not produced significant yield advantage



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+

2nd season performance

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Maize yield equivalent

Summary & Conclusion

Summary

- ✓ CT Maize-legume (CA1) system produced highest returns
- ✓ CT Maize-millet+legume (CA2) system produced higher return than traditional system
- ✓ ST Maize-millet+legume (CA3) produced lower return than maize-legume system though it was still better than traditional system

Implication

- Some CAPS increase total return than traditional system, and none of them reduce return from the initial years of transition (from traditional to CAPS), hence it can be adopted by food-insecure farmers
- ST do not increase the return in transitional years, however, it's long run benefits to soil and environment is a reason for adoption of the ST system
- ST based CAPS do not provide enough incentive for immediate adoption, hence government support is required for faster adoption

CONCLUSION

- Though there were varying levels of incentives, CAPS were still feasible on marginal production environment dominated by poor and smallholder farmers (in Nepal)
- Strip tillage based CAPS was also better than traditional system, though there were other CAPS which had higher incentive for adoption
- A combination of ST based CAPS and other CAPS would be best for food insecure farmers

Thank you !