Soil and water conservation and nutrient use efficiencies in smallholder potato-legume intercropping systems

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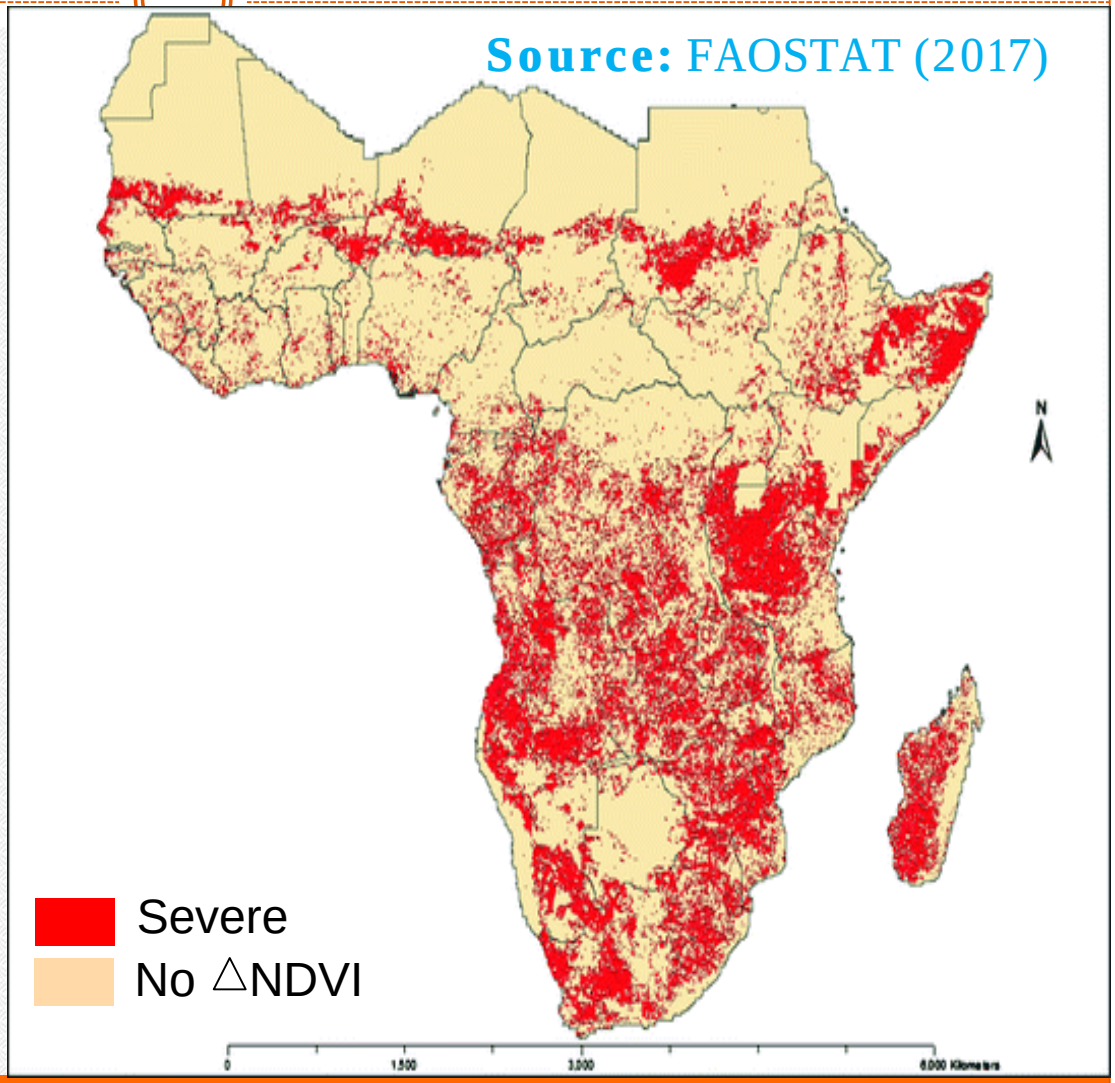
What is the problem?

- Potato yield stagnates at 13 t/ha in SSA (FAOSTAT, 2017)
  - attainable yield is 30-40 t/ha (Parker et al. 2019)
- Focus given mainly on potato diseases, nutrition quality, seed systems
- Forgetting about the mother of all these: SOIL

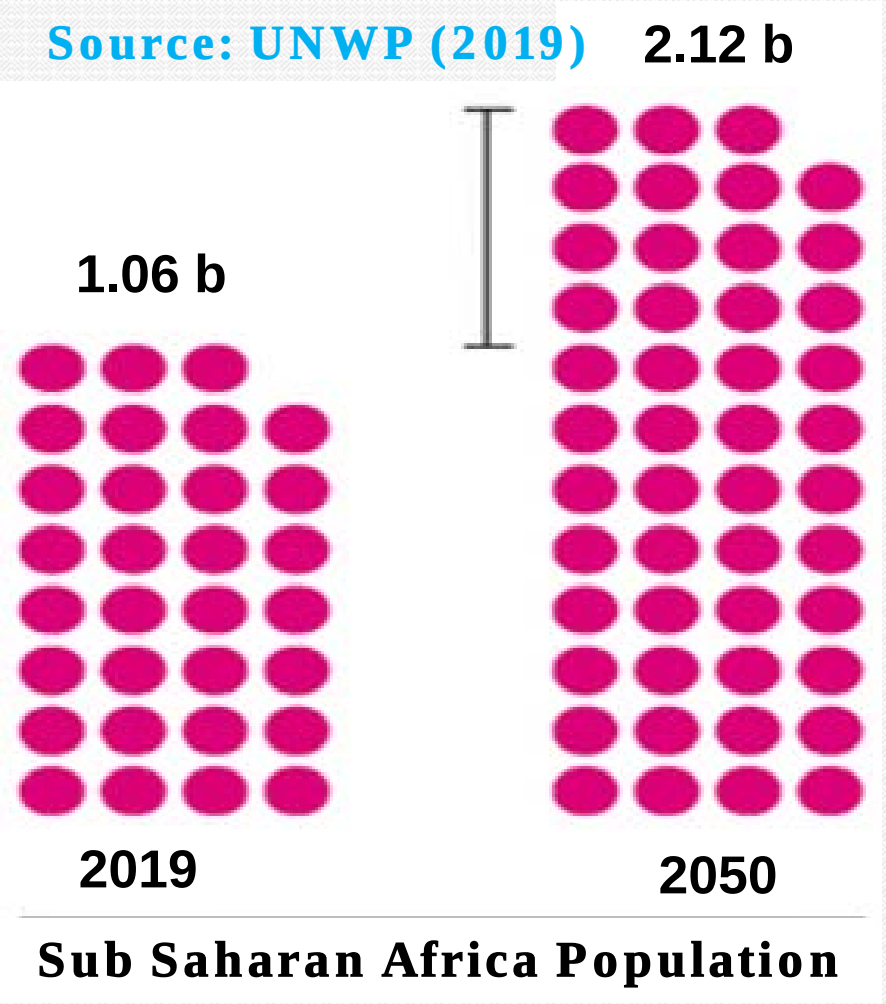
Land Degradation in SSA

- Above 80% of cropland is degraded in SSA (FAO, 2017)
- Land degradation related strongly (r=0.87) with low crop productivity (Lal et al. 2014)



Major causes

- Population pressure
- Inappropriate land use and soil management practices



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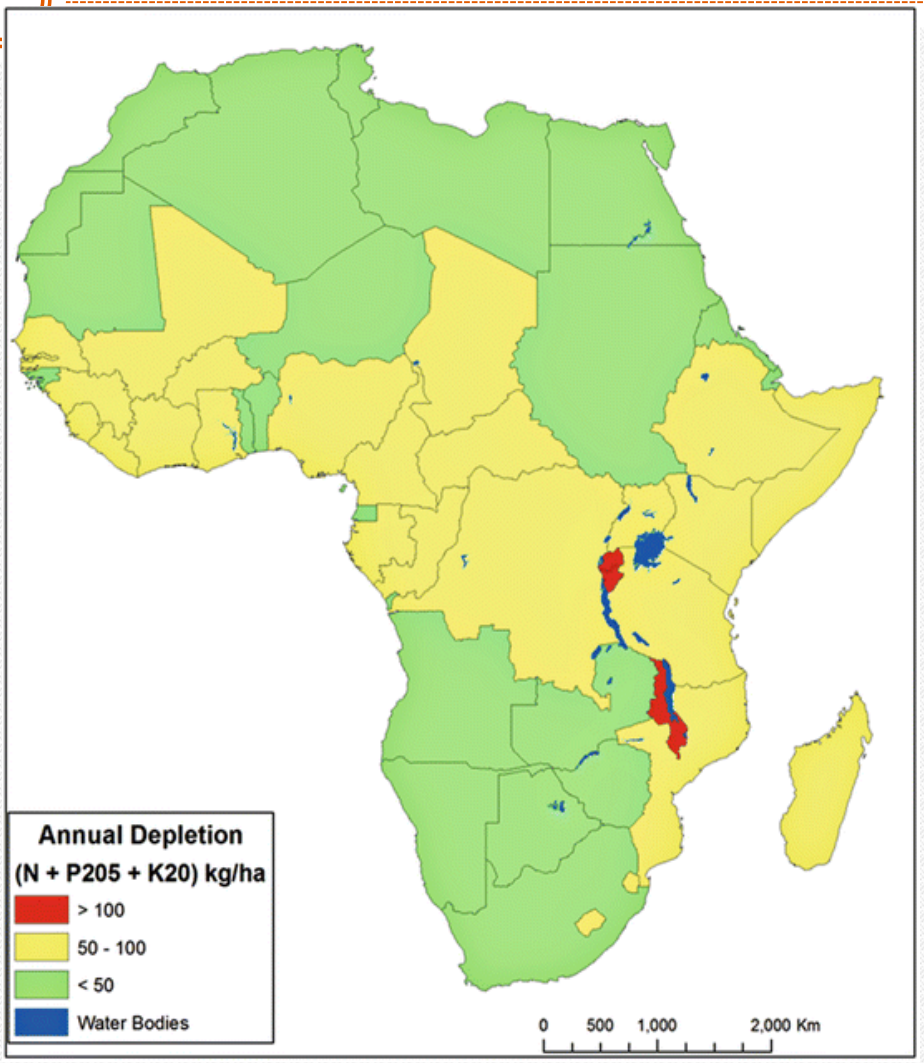
- Steady negative nutrient balances
- Hilly and mountainous terrain; exacerbated soil erosion rates



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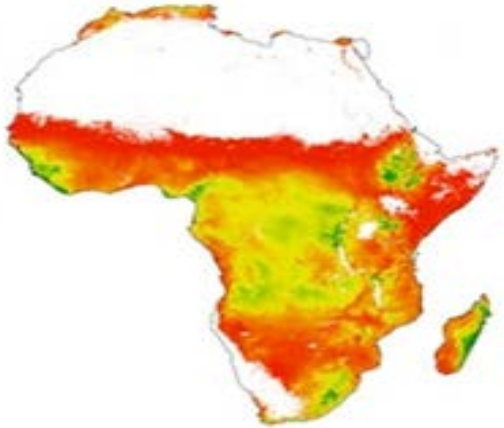
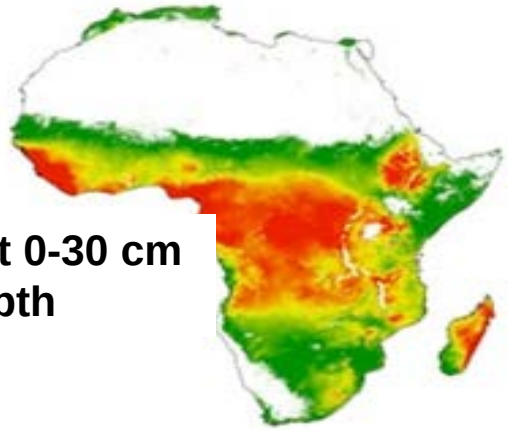
- **Maximum soil disturbance; low residue return;**

SOC at 0-30 cm depth

Source: ISRIC (2018)





low

high

Soil pH at 0-30 cm depth

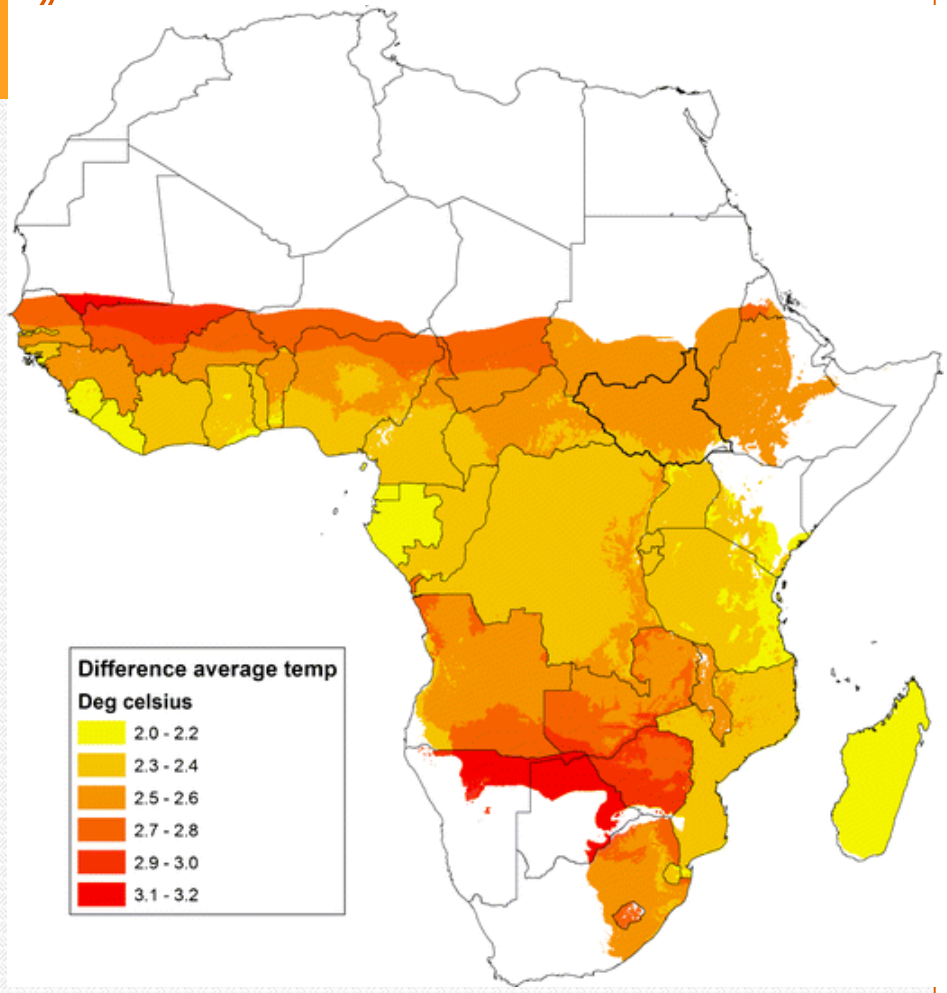
Cont…

➢Climate change

Increasing temperatures

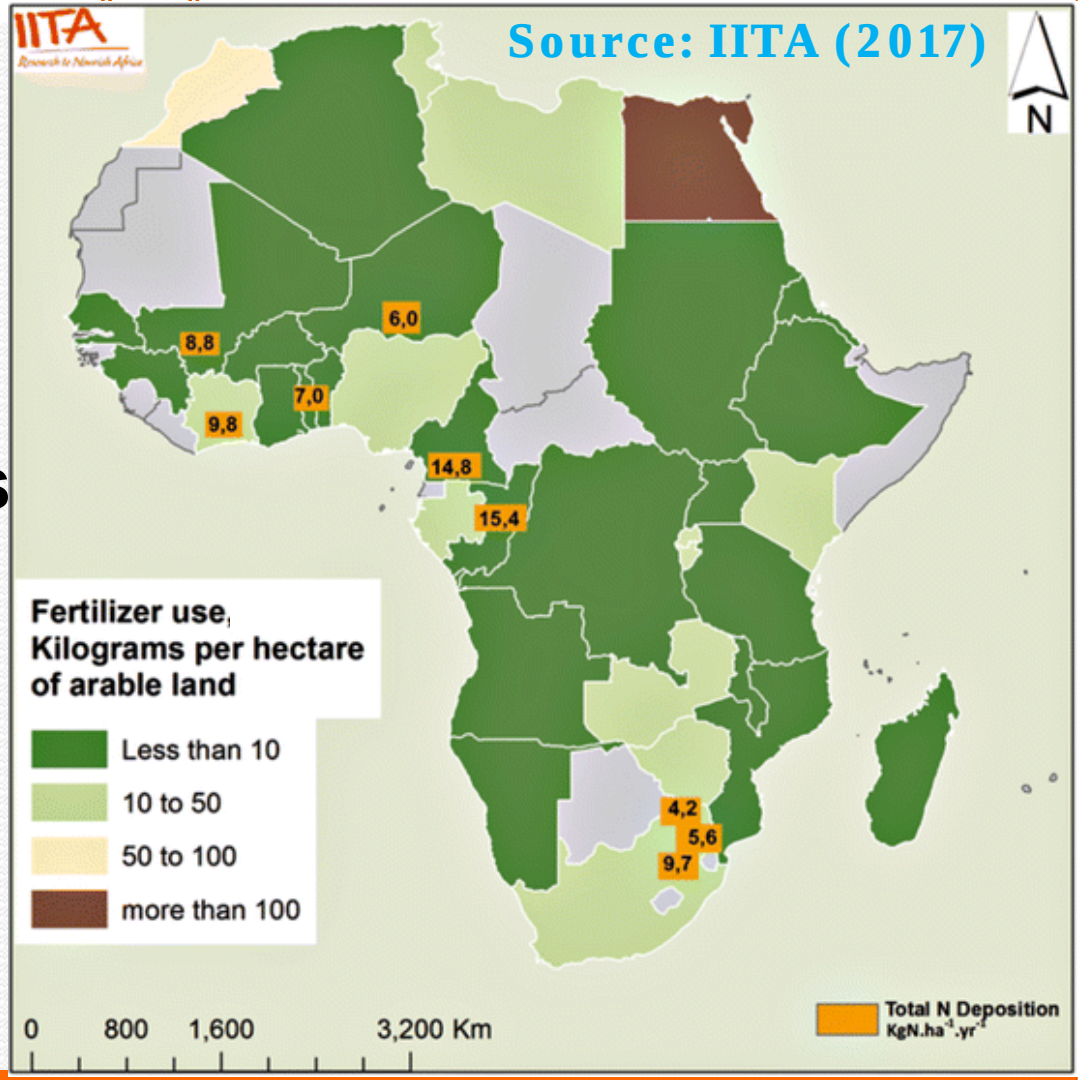
Erratic rainfall

Recurrent droughts



Cont…

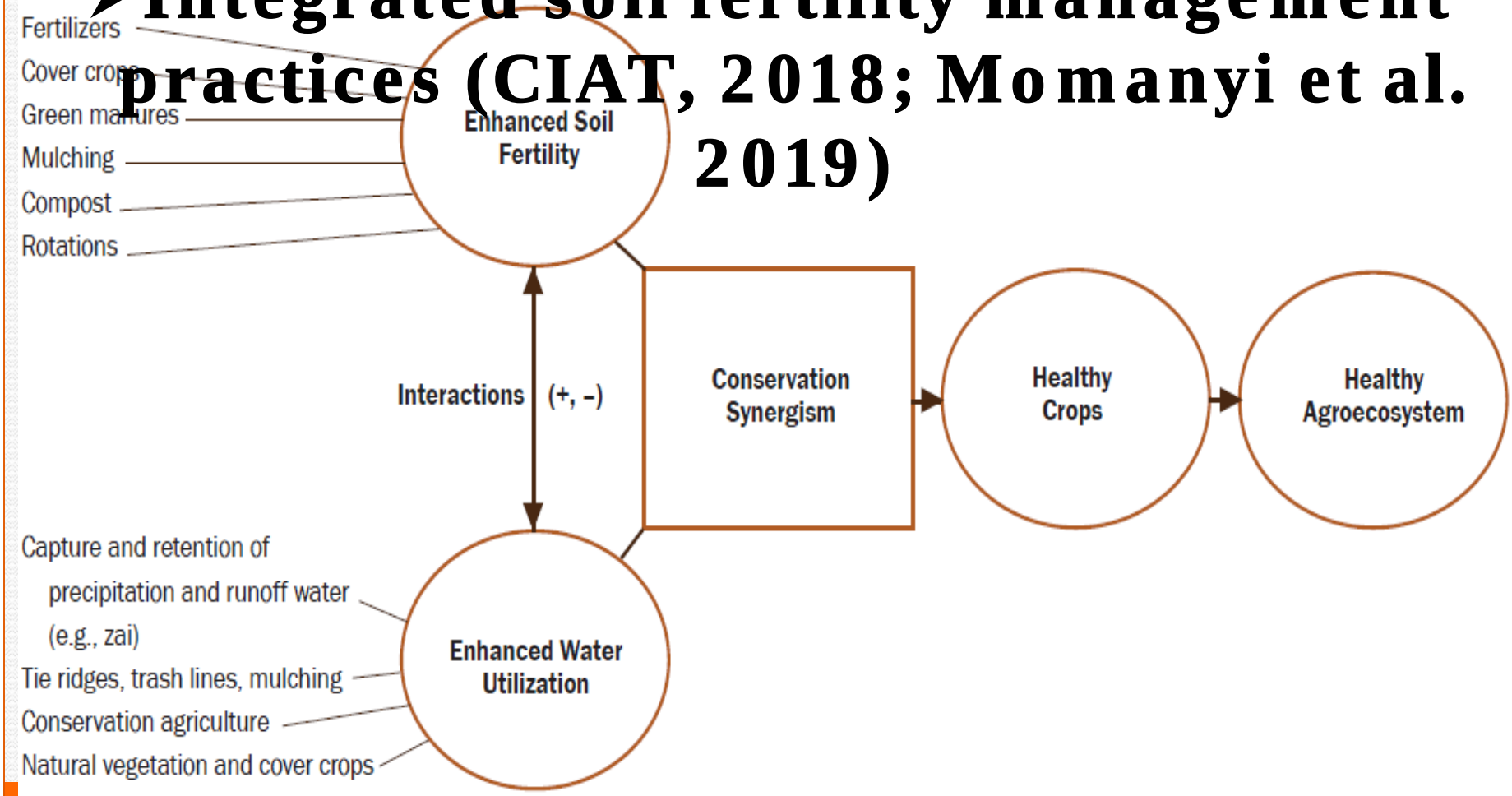
- dominant low-input agricultural systems



What works?

Interactions of soil and water management practices used by farmers, some of which may result in synergism leading to healthy and productive crops and agroecosystems.

- **Integrated soil fertility management practices (CIAT, 2018; Momanyi et al. 2019)**



Window for intercropping

Only 5% of potato farmers in SSA practice intercropping

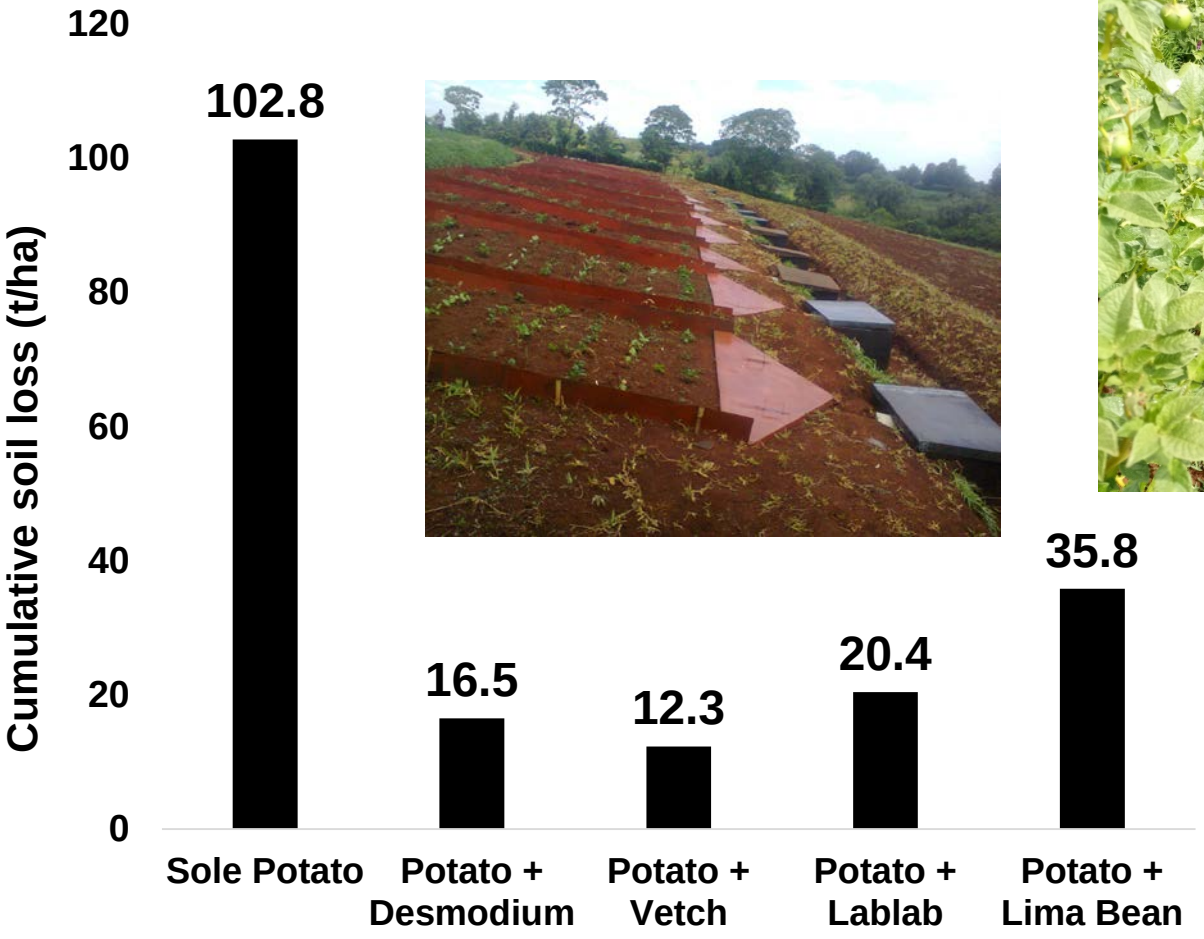
Where is the problem?

- lack of science-based evidence?
- more value on short-term benefits
- lack of extension information
- land tenure systems
- lack of supply of high quality legume seeds
- socioeconomic factors e.g. gender, income, legume attributes

Intercropping increases Potato DM yield

- Potato + vetch increased PEY from 12 t/ha to 19 t/ha in highland Kenya (Nyawade et al. 2019c)
- Potato + lablab increased PEY from 6 t/ha to 12 t/ha in lowland Kenya (Gitari et al. 2018)
- Potato + Lucerne intercropping increased yield by 4 t/ha over sole potato in UH AEZ (Nyawade et al. 2019b)

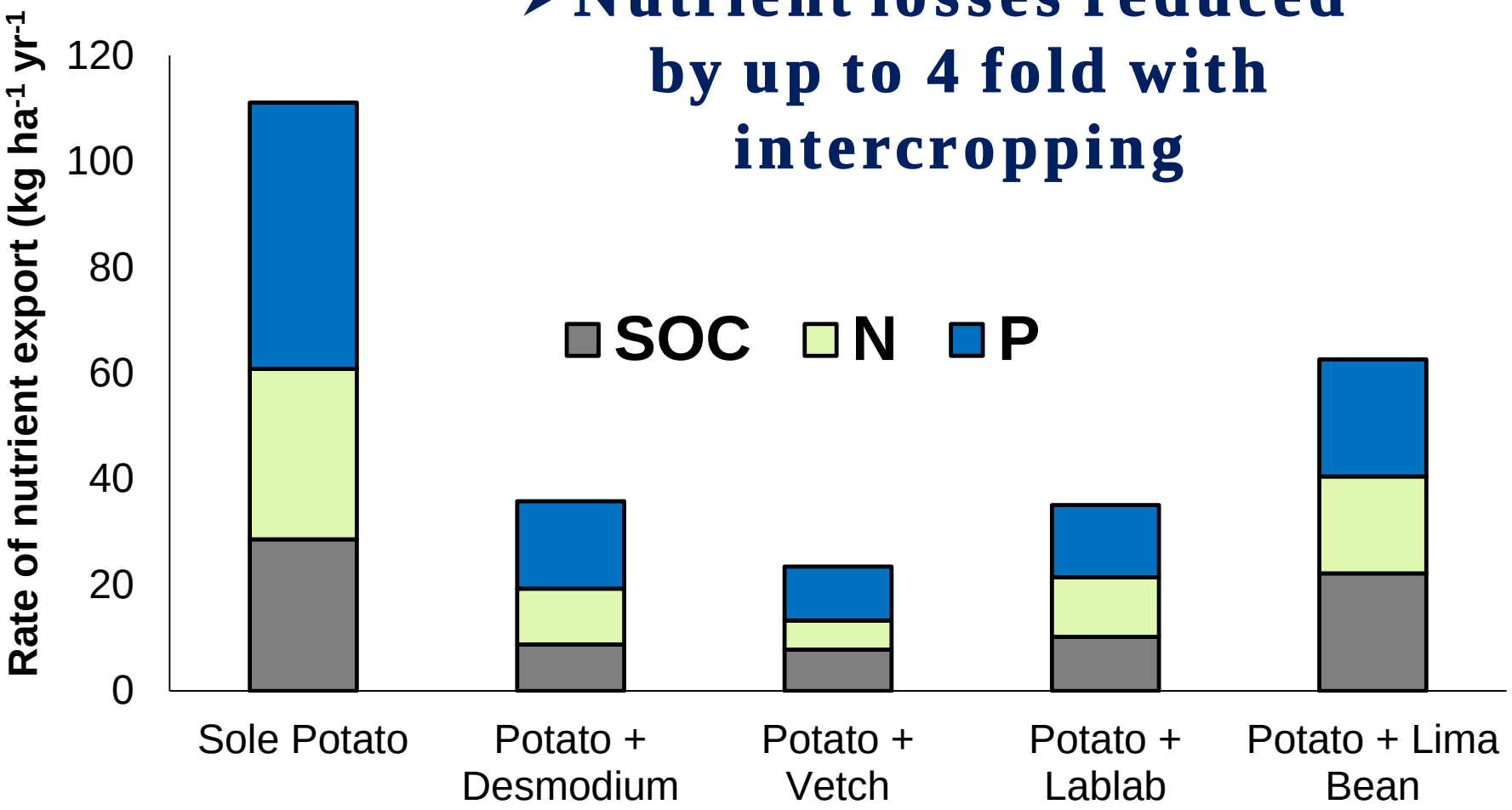
Intercropping controls soil erosion



Source: Nyawade et al. 2018b

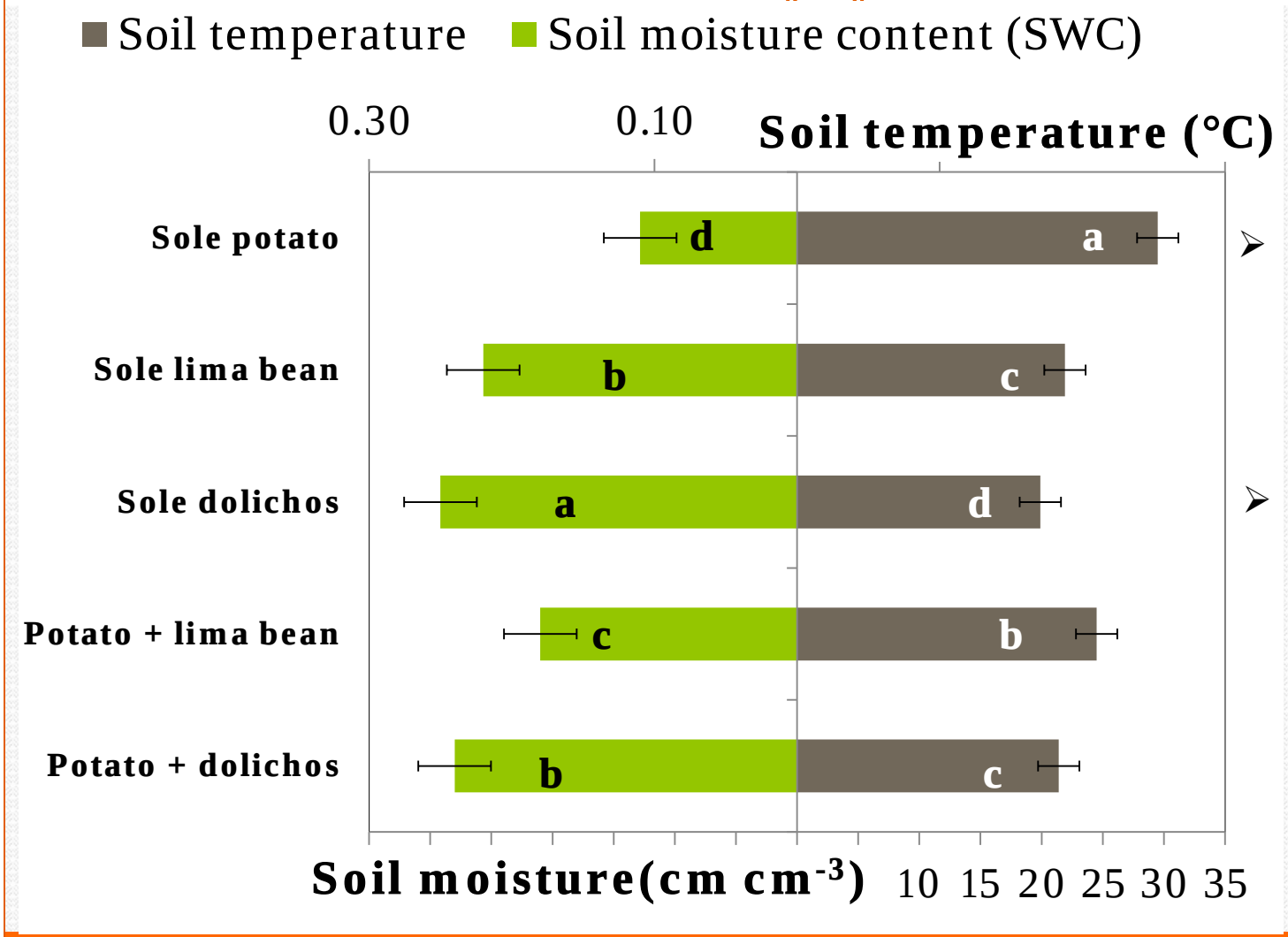
Nutrient losses are reduced

- **Nutrient losses reduced by up to 4 fold with intercropping**



Nyawade et al. (2019)

Intercropping optimizes soil temperature and soil moisture



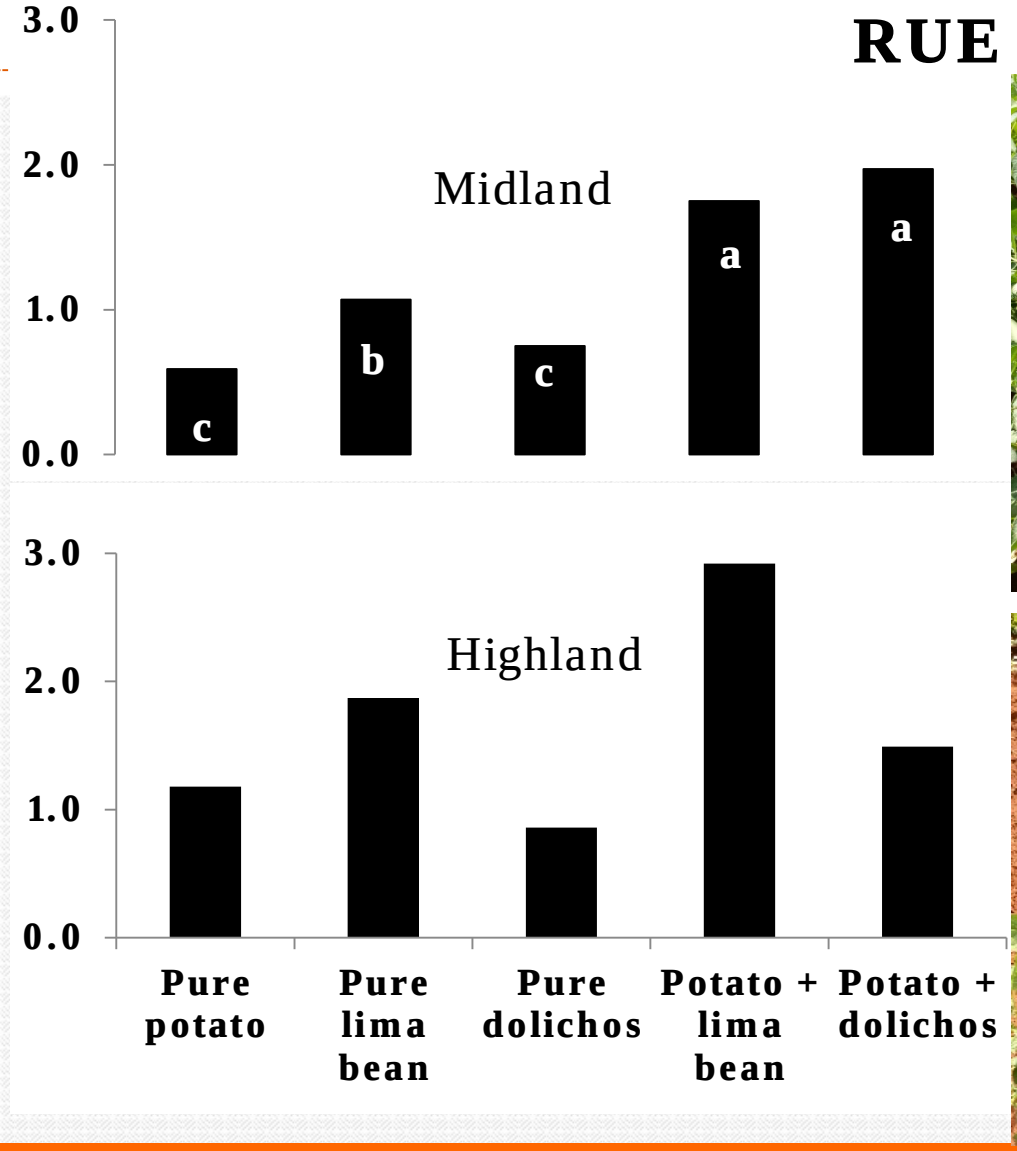
- SWC was 26-46% greater with intercropping
- Intercropping lowered soil temperature to 15-20°C

Nutrient use efficiencies

Agro-ecology	Cropping system	N	P	Reference
		kg PEY kg^{-1} nutrient supply		
Midland	Sole potato	98.1a	109.2a	Gitari et al. 2018
	Potato + lablab	**164.8c**	**287.4c**	
	Potato + garden pea	131.9b	198.1b	
	Potato + bean	128.7b	187.7 b	
Upper highland	Sole potato	126.2b	135.6a	Nyawade et al. 2019
	Potato + vetch	198.2d	305.4c	
	Potato + desmodium	189.3cd	299.8b	
	Potato + lucerne	172.3c	295.8b	
	Potato + lupin	187.2cd	**367.5d**	
	Potato + lablab	**44.2a**	298.5b	

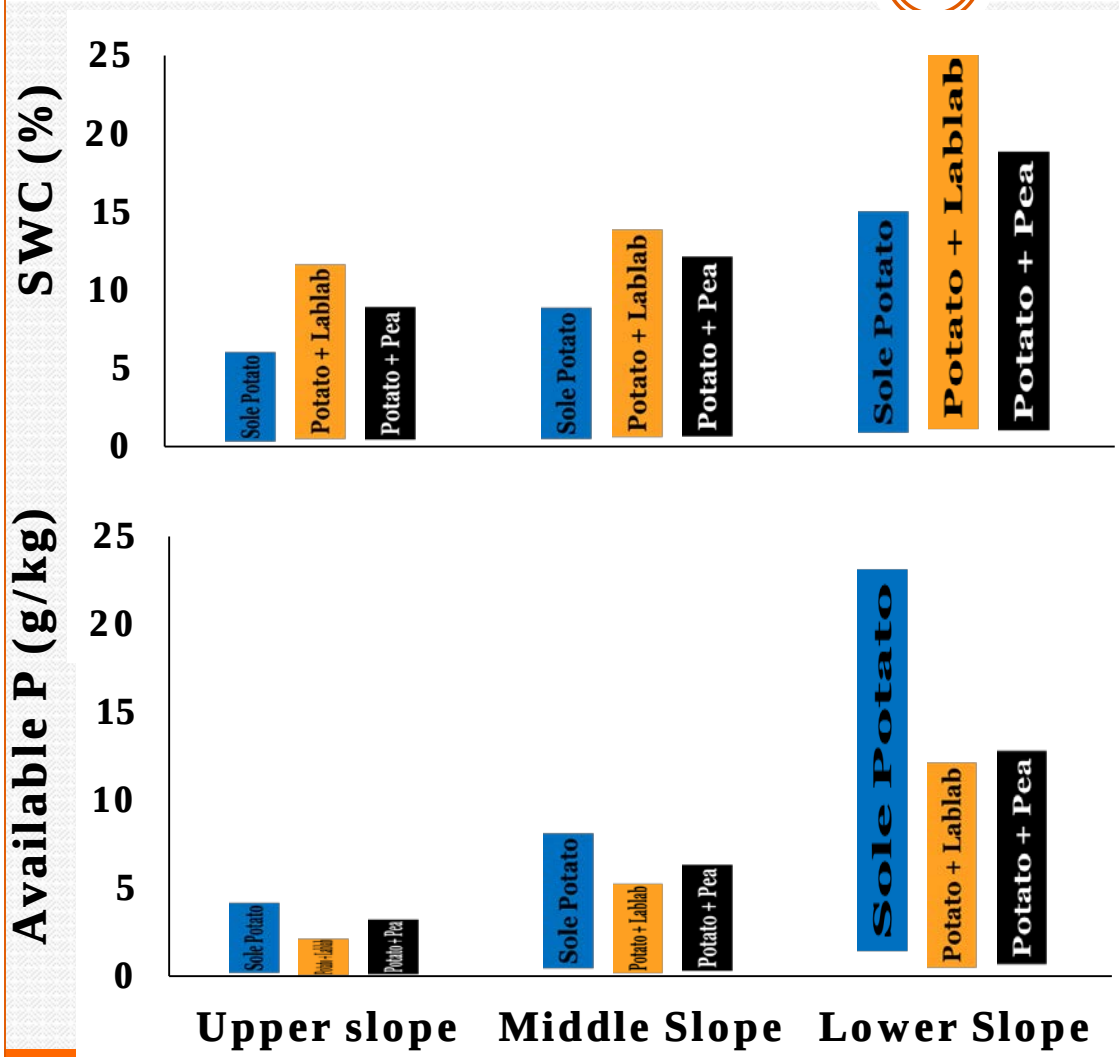
Intercropping increases radiation use efficiency

- Intercropping increased RUE by 21-70%



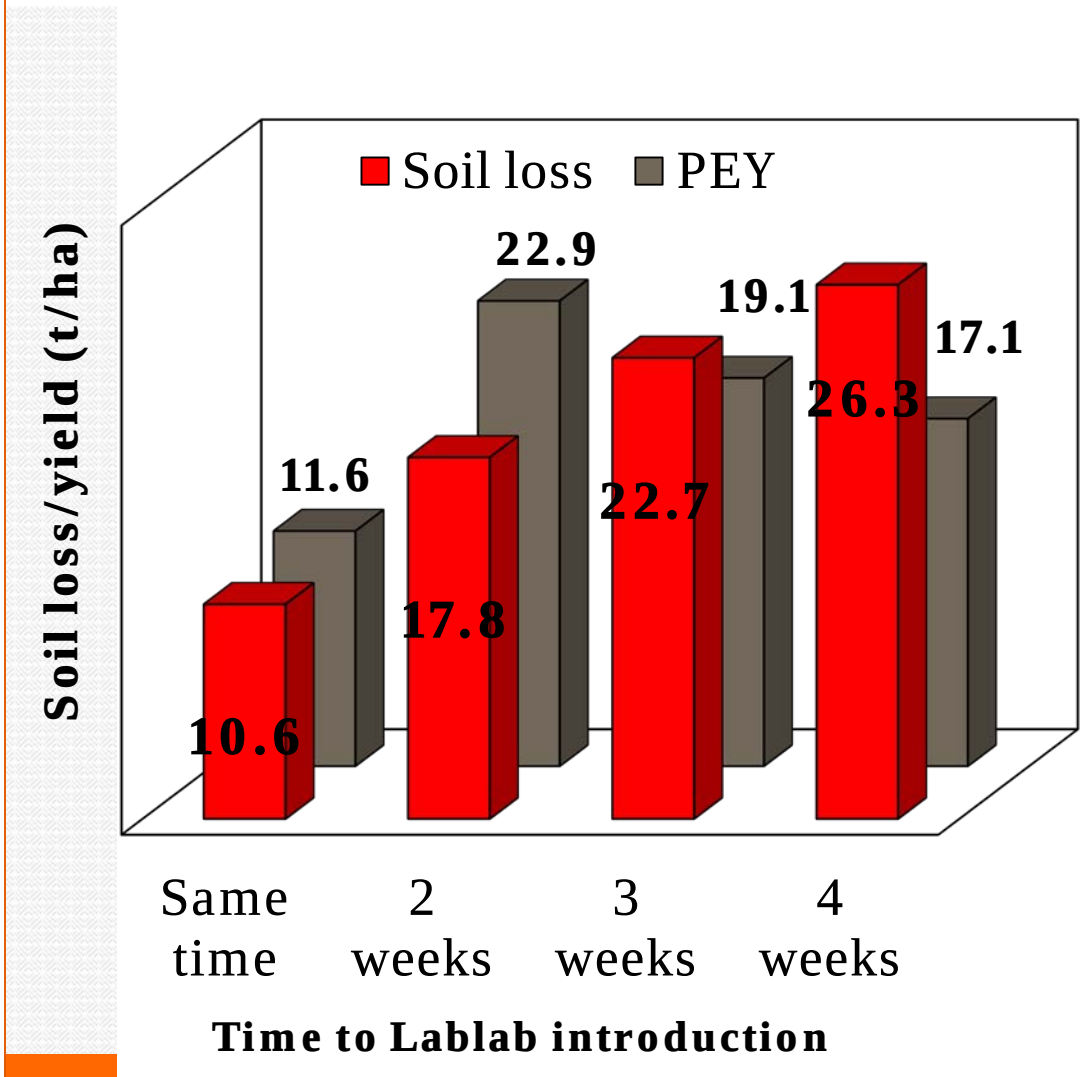
Considerations?

When the slope is greater than 20%?



- Integrate with structural SWC
- This increases soil water capture downslope

When crops differ in maturity, growth patterns?



➢ **Do relay intercropping**

➢ Adjust spatial arrangement

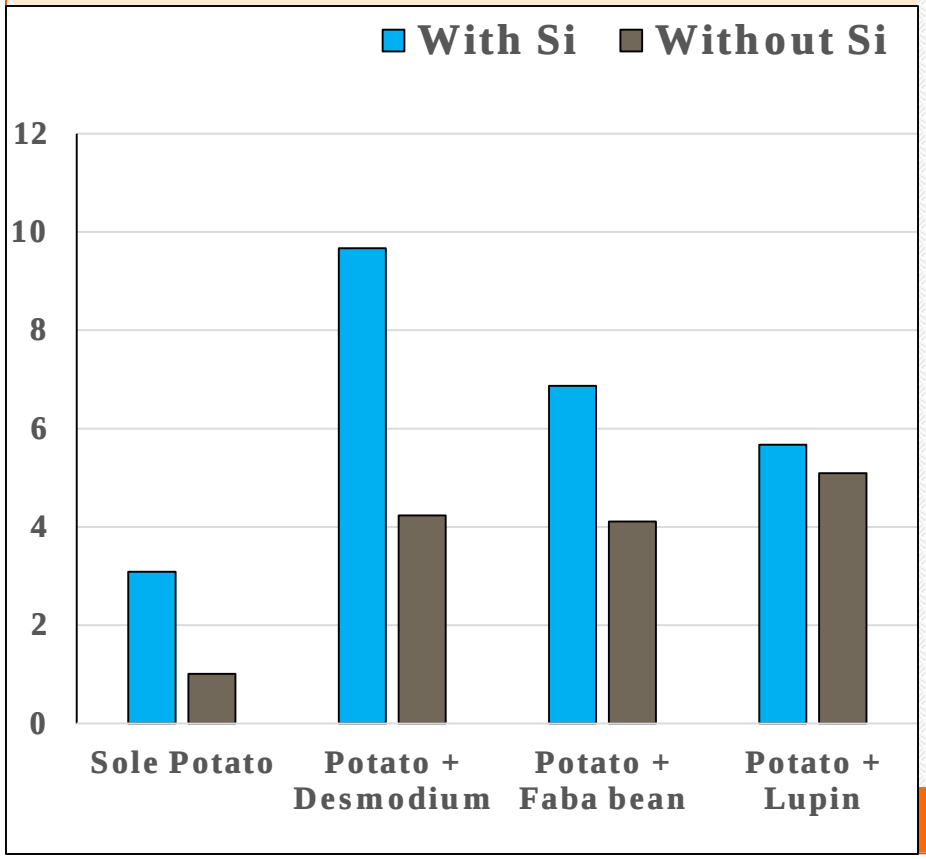
➢2:2 row ratio gave greater yield

Intercropping system	Yield increment (%)
Potato + Desmodium in 2:1 row ratio	12.5
Potato + Desmodium in 2:2 row ratio	**30.5**
Potato + Lablab in 2:1 row ratio	8.5
Potato + Lablab in 2:2 row ratio	**16.9**
Potato + Lucerne in 2:1 row ratio	11.2
Potato + Lucerne in 2:2 row ratio	**18.2**

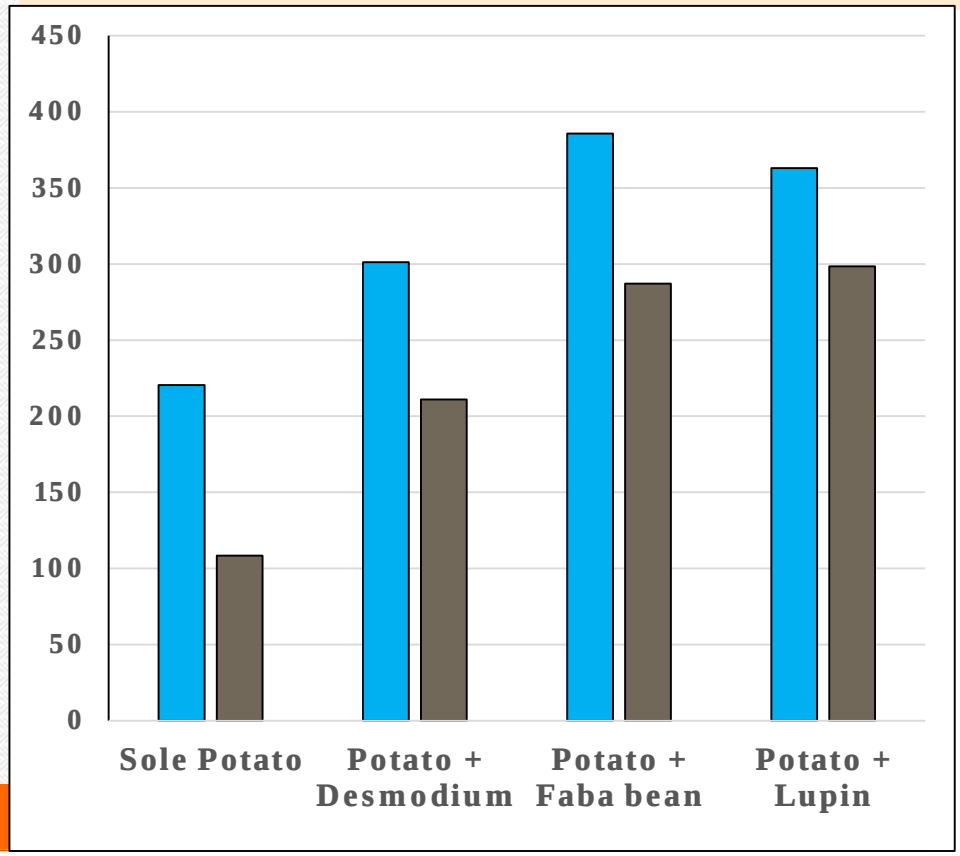
Is soil P fixed, too low?

- **Integrate intercropping with Si**

Crop water productivity (kg ha^{-1} m^{-3})

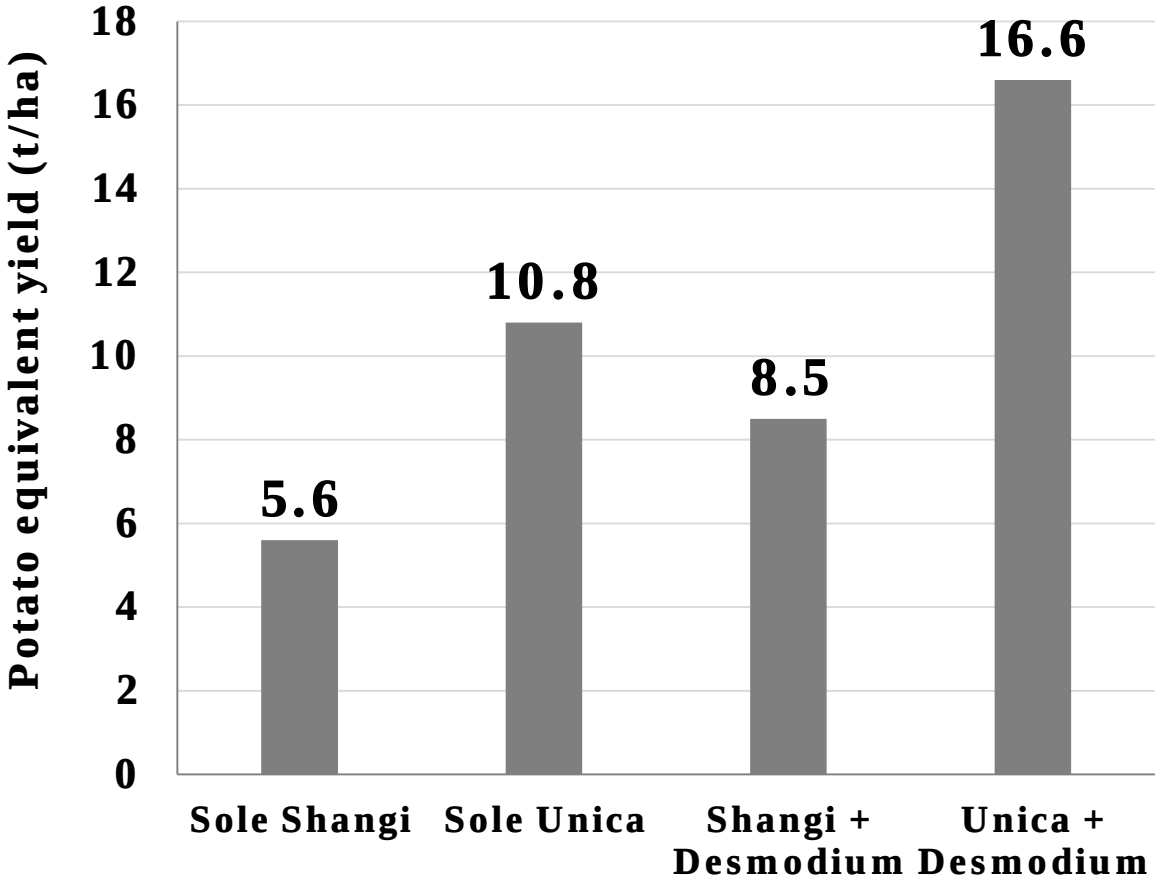


P use efficiency (kg PEY kg^{-1} P supply)



Does Potato Cultivar choice matter?

- Greater yield recorded with Unica than Shangi in midland (Nyawade et al. 2018)



Way forward

- Is legume intercropping a sole replacement for fertilizer use?
- Legume intercropping vs economics?
- What constitutes a desirable combination?
- Scaling readiness?>challenges?

- CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)
- CGIAR Research Program on Roots, Tubers and Bananas (RTB)
- Syngenta Foundation for Sustainable Agriculture
- BMZ/GIZ
- CIP and University of Nairobi

Thank You