Sustainability of crop residue allocation options in smallholder cereal-legume-livestock farms in the dry savannas of West Africa

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Presentation outline

- Introduction
- Objectives
- Materials and Methods
- Results and Discussion
- Conclusions

Introduction

- Agricultural development in SSA is impeded by low adoption of improved agricultural technology.

- Many superior agricultural technologies were evaluated the basis of their agronomic efficiencies alone. Consequently, may not be tailored to fit the economic and social conditions of farmers.

- ‘For agricultural research to be an effective vehicle for agricultural revolution in Africa, potential ‘best-fit’ technologies for smallholder farmers should be evaluated in terms of agronomic superiority, economic viability, environmental friendliness and social acceptability’ (Bationo et al., 2004).

Introduction

The use of crop residues as soil amendment is constrained by the keen competition for it as fodder .

Figure 1: Transportation of stover

Figure 2: Stubble grazing

Objective

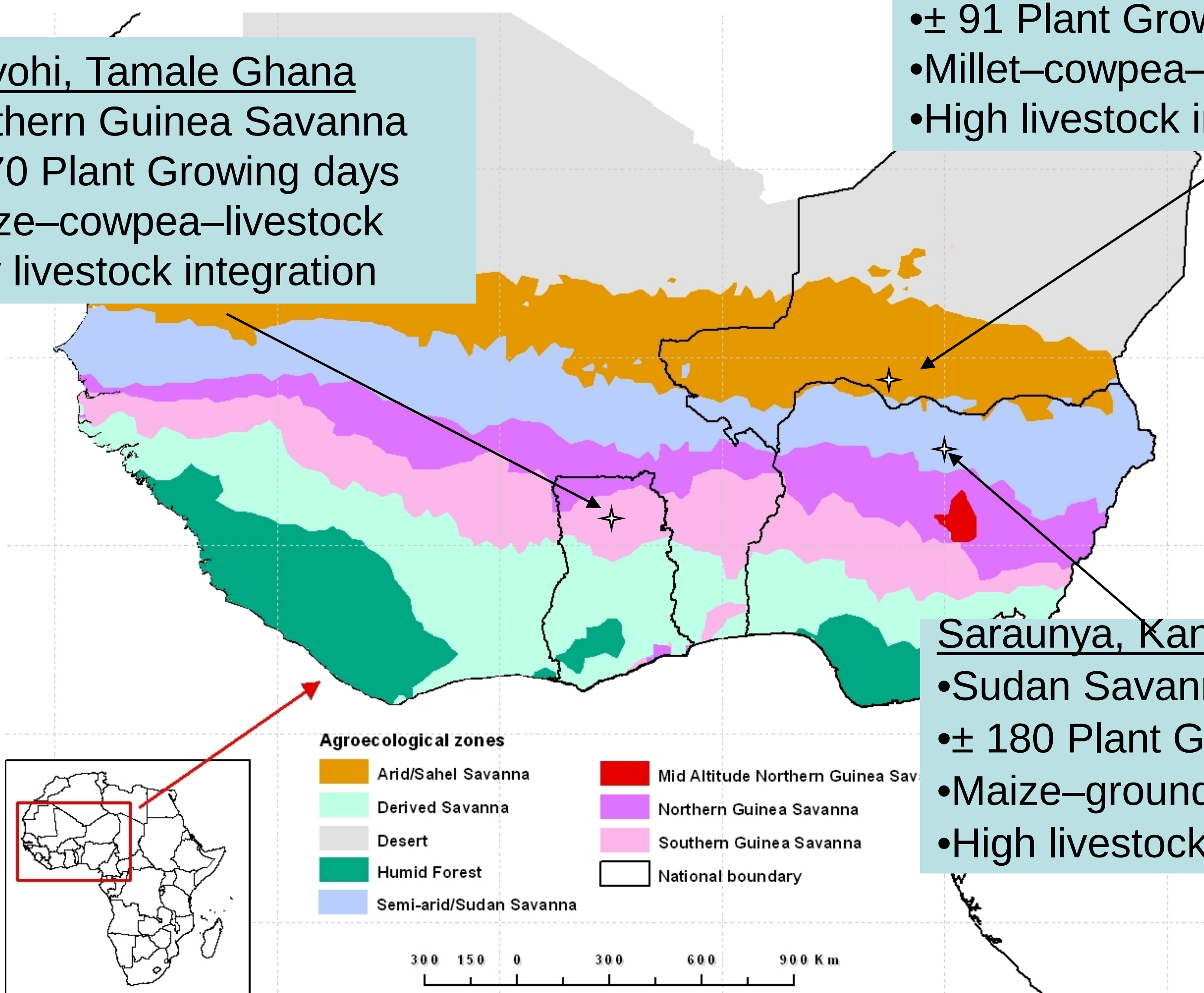
To evaluate the sustainability for using crop residues as fodder or soil amendment in the cereal-legume-livestock systems.

Materials and Methods

Study locations

Cheyohi, Tamale Ghana
- Northern Guinea Savanna
- ± 270 Plant Growing days
- Maize–cowpea–livestock
- Low livestock integration

Garin Labo, Maradi, Niger
- Sahel Savanna
- ± 91 Plant Growing days
- Millet–cowpea–livestock
- High livestock integration



Saraunya, Kano, Nigeria
- Sudan Savanna
- ± 180 Plant Growing days
- Maize–groundnut–livestock
- High livestock integration

Materials and Methods…

Treatments:

Table 1: Amount of CR allocated to crop and livestock production units

Scenario	CR applied (%)	CR fed (%)
1	0H 0S	100H 100S
2	25H 75S	75H 25S
3	50H 50S	50H 50S
4	75H 25S	25H 75S
5	100H 100S	0H 0S

Experimental design: The design was a randomized complete block design with three replications. Adjacent plots within the blocks were separated by 1m wide.

Materials and methods:…

Data Collection

Incorporation of crop residues

Feeding of crop residues to livestock

Materials and methods:…

Selection of indicators

1) Ecological benignity

    i) Soil quality

    ii) Crop performance

    iii) Livestock performance

2) Economic viability

3) Social acceptability

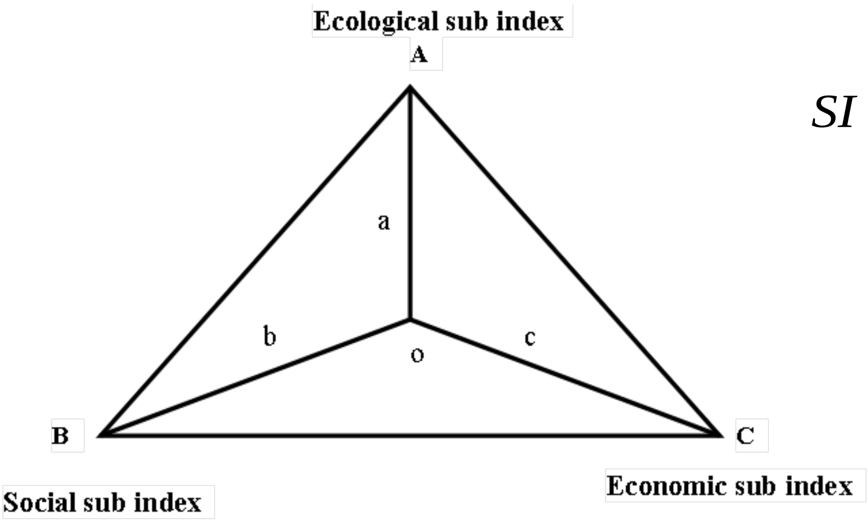
Materials and methods: Sustainability study…

- Transformation of indicators: linear scoring functions

- Integration of indicators into sub indices

$$SSI = \left(\frac{\sum_{t=i}^{n} S_i}{n} \right)$$

- Integration of sub indices into sustainability index



$$SI = \frac{(\Delta ABC)}{10} = \frac{(\Delta AoB + \Delta BoC + \Delta CoA)}{10}$$

$$= \frac{\left(\frac{1}{2} ab \sin(120^\circ) + \frac{1}{2} bc \sin(120^\circ) + \frac{1}{2} ca \sin(120^\circ)\right)}{10}$$

$$= \frac{\frac{\sqrt{3}}{4}(ab + bc + ca)}{10}$$

Kang et al. (2005)

Results:

Table 2: Impact of crop residues application on soil quality

CR applied (%)	Soil quality indicators						SQS
	OM	TN	BD	MBC	AMSC	β-glu	
0H 0S	0.85	630	1.25	1100	89.7	89.0	3.2
25H 75S	0.88	662	1.32	1200	101.3	109.7	4.5
50H 50S	0.94	705	1.29	1300	147.3	91.7	5.0
75H 25S	0.96	623	1.26	1267	167.3	85.5	5.1
100H 100S	0.98	638.0	1.23	1500	177.0	112.3	8.4
Pr	0.86	0.94	0.45	0.43	0.19	0.002	nd
LSD (0.05)	0.32	245.60	0.11	434	91.2	11.7	nd
CV %	18.6	20	4.6	17.8	35.5	6.4	nd

- OM: organic matter (%), TN: total nitrogen (kg ha^{-1}), BD: bulk density (g cm^{-3}), MBC: microbial biomass carbon (mg kg^{-1}),
- AMSC: Arbuscular mycorrhiza spore count (spore $100g^{-1}$), β-glu: β-glucosidase activity (mg PN kg^{-1} h^{-1}), SQS: soil quality score.

Results:

Table 3: Indigenous knowledge on crop residue uses (N =10).

Indicator/issue	No respondents (%)		
	Cheyohi	Sarauniya	Garin Labo
Knowledge (awareness)			
All crop residues left on the field	100	20	0
All crop residues incorporated into soil	0	0	0
All crop residues harvested and fed to livestock	0	100	100
Crop residues shared between crop and livestock uses	50	40	30
Knowledge (Practice)			
All crop residues left on the field	80	0	0
All crop residues incorporated into soil	0	0	0
All crop residues harvested and fed to livestock	0	80	90
Crop residues shared between crop and livestock uses	20	20	10

Results: Sustainability study…

Table 4: Economic assessment of crop residue uses at Cheyohi.

Scenario	CR applied (%)	CR fed (%)	Net Benefit CPU (¢ ha^{-1})	Net Benefit LPU (¢ head^{-1})	VCR CPU	SSI $_{\text{Economics}}$
1	0H 0S	100H 100S	251.6	3.1	0.0	5.4
2	25H 75S	75H 25S	237.3	2.3	2.3	7.0
3	50H 50S	50H 50S	245.8	1.6	2.2	5.6
4	75H 25S	25H 75S	266.9	1.1	2.5	7.0
5	100H 100S	0H 0S	282.4	-0.7	1.7	4.0

Results:…

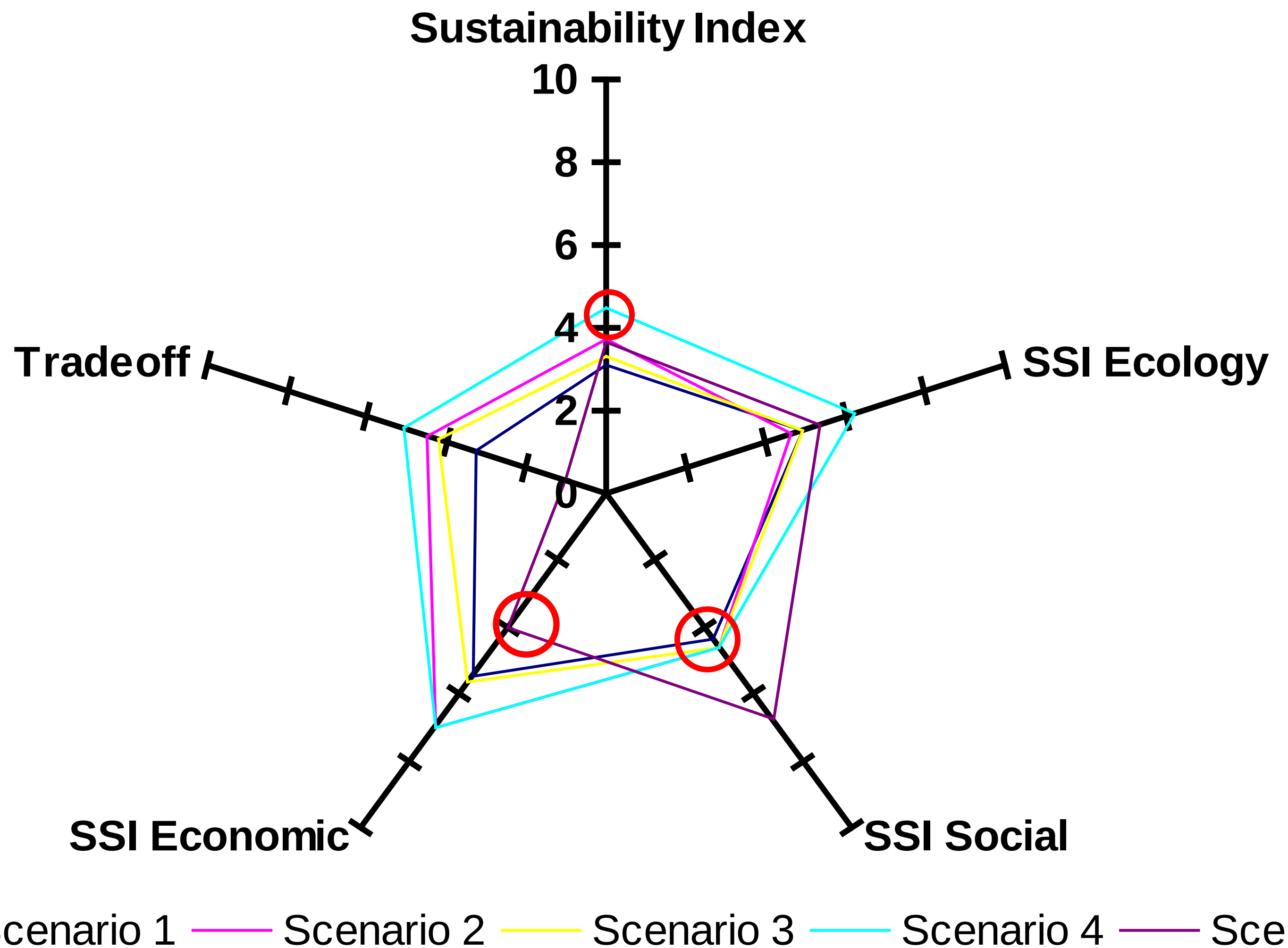


Fig 1: Sustainability of crop residues allocation options at Cheyohi

Conclusions

The most sustainable options for using crop residue as soil amendment were 75 % of haulm at Cheyohi, 25 % of haulm at Sarauniya and none at Garin Labo.

Implication of the study:

The study highlighted the need to include economic and social parameters in the evaluation of agricultural technologies.

THANK YOU