Crop and Soil Management in Cropping Systems of Rainfed Agriculture for mitigation of the climate change

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Contents

1.
Introduction:
Improvement in C sequestration through crop and soil management

- One of mitigation measures to cope with climate changes is C sequestration.
- Crop and soil management play an important role in soil C dynamics

Improvement in C sequestration through crop and soil management

- The SOC concentration in the surface soil (0-15 cm) is closely related to the total input of crop residues remaining on the ground or incorporated into the soil.
- The improvement in C sequestration implies increase in the input of plant biomass residues.
- Biomass accumulation can be enhanced by choosing appropriate cropping system through;

➢ increase in cultivation intensity,

➢ introduction of cover crops between main cropping seasons,

➢ reduction in fallow period, and so on

2.
Diversified cropping systems in rainfed agriculture

Many different types of cropping systems have been developed in rainfed agriculture in order to cope with climate extremes.

Various cropping systems in rainfed agriculture

- **Multiple Cropping**
  Growing two or more crops consecutively or at the same time on the same field in the same year.
- **Mixed Cropping**
  Growing two or more crops simultaneously on the same piece of land without any definite row arrangement.
- **Strip Cropping**
  Growing crops in alternate strips running perpendicular to the slope of the land or to the direction of prevailing winds for the purpose of reducing erosion.
- **Intercropping**
  Growing two or more generally dissimilar crops simultaneously on the same piece of land in a distinct row arrangement.

  row intercropping

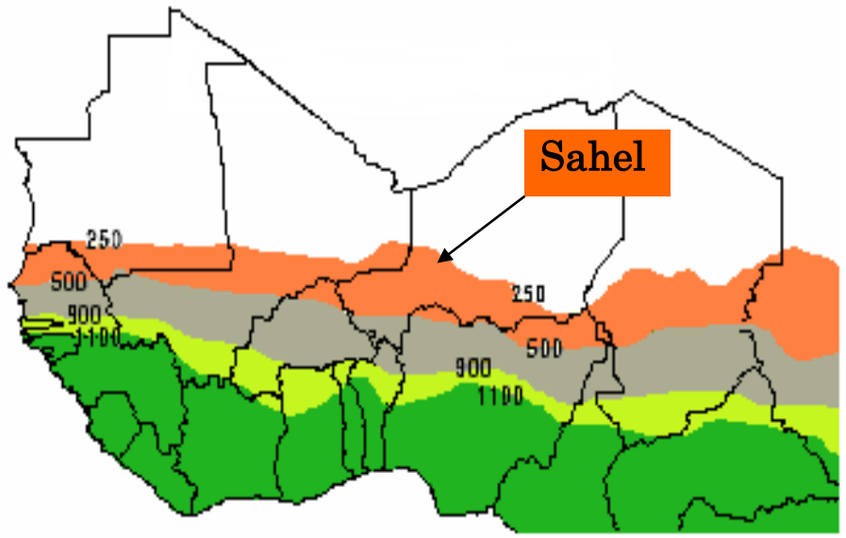
  relay intercropping
- **Alley Cropping**
  Growing crops in alleys formed by trees or shrubs.
- **Crop rotation**

  growing a series of dissimilar types of crops in the same area in sequential seasons

3.

Crop & soil management in major cropping systems in rainfed agriculture in relation to climate change mitigation

- **Intercropping**
- **Crop rotation**



Crop and soil in rainfed agriculture are managed to produce maximum yield with less risk against extreme climate using limited resources

Intercropping

sorghum/pigeonpea intercropping in India SAT

Increase in biomass production through intercropping

Relative yield, LER and ATER of sorghum/pigeonpea intercropping

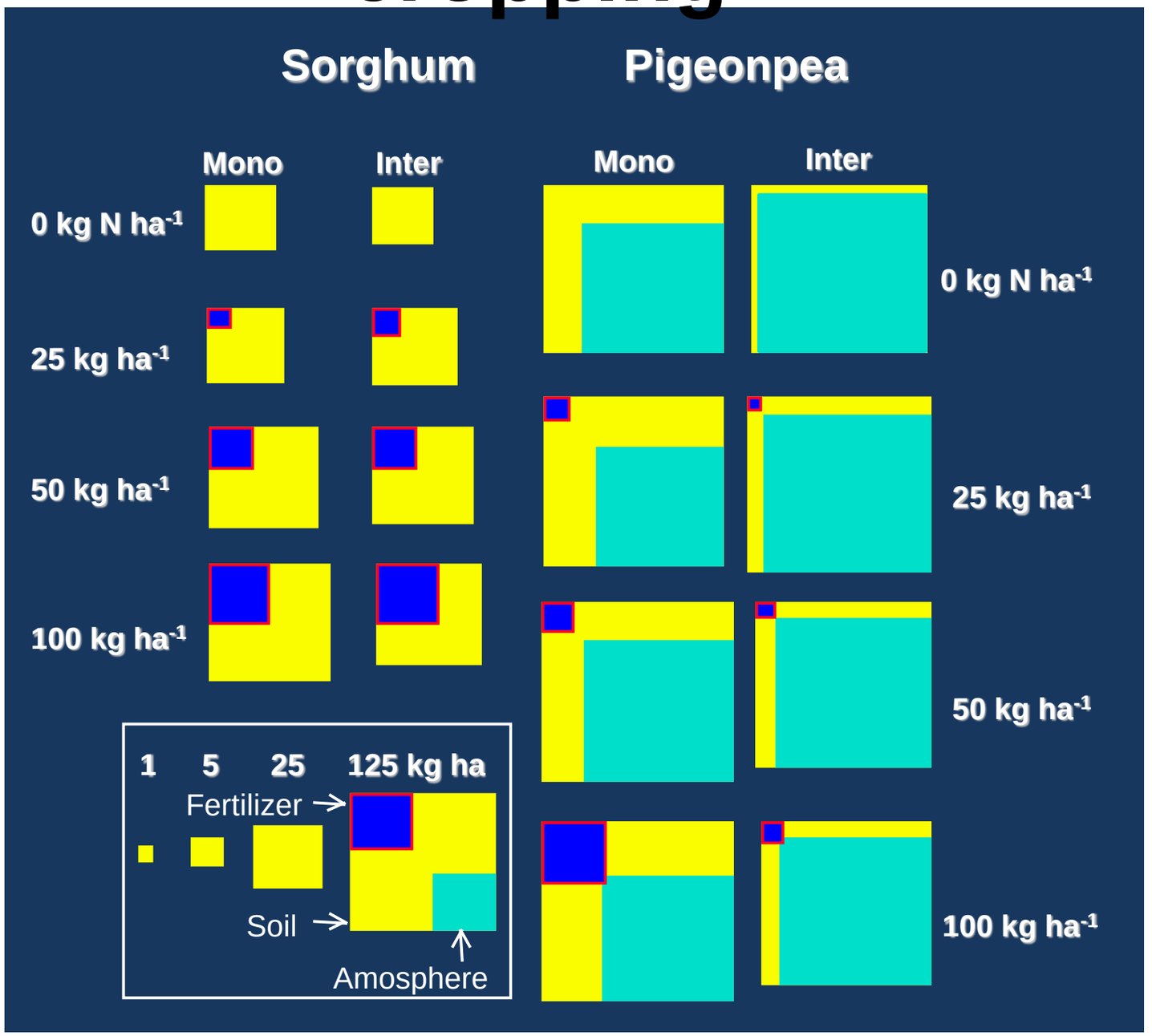
N treatment	Relative yield		LER	ATER
	Sorghum	*Pigeonpea*		
N0	***0.80***	***0.81***	***1.62***	***1.25***
N25	***1.13***	***0.75***	***1.88***	***1.37***
N50	***0.88***	***0.68***	***1.56***	***1.16***
N100	***0.78***	***0.67***	***1.45***	***1.10***

Relative yield
For sorghum, Ysp/Yss
For pigeonpea, Yps/Ypp

LER: Land equivalent ratio
LER = (Ysp/Yss) + (Yps/Ypp)

ATER: Area-time equivalent ratio
ATER = [(Ysp/Yss)ts + (Yps/Ypp)tp]/T

Quantitative assessment of N sources (soil, fertilizer and atmosphere) in intercropping as compared with mono cropping



Tobita, et al., Biol. Fertil. Soils (1994)

C/N ratio of crop residues in sorghum/pigeonpea intercropping

	N yield (kg/ha) (-grain, +fallen leaves)			C/N ratio		
	Sor	Pig	S + P	Sor	Pig	S + P
N0	30	215	182	63	16	20
N25	32	210	194	67	16	23
N50	49	262	189	66	16	24
N100	59	259	188	52	17	24

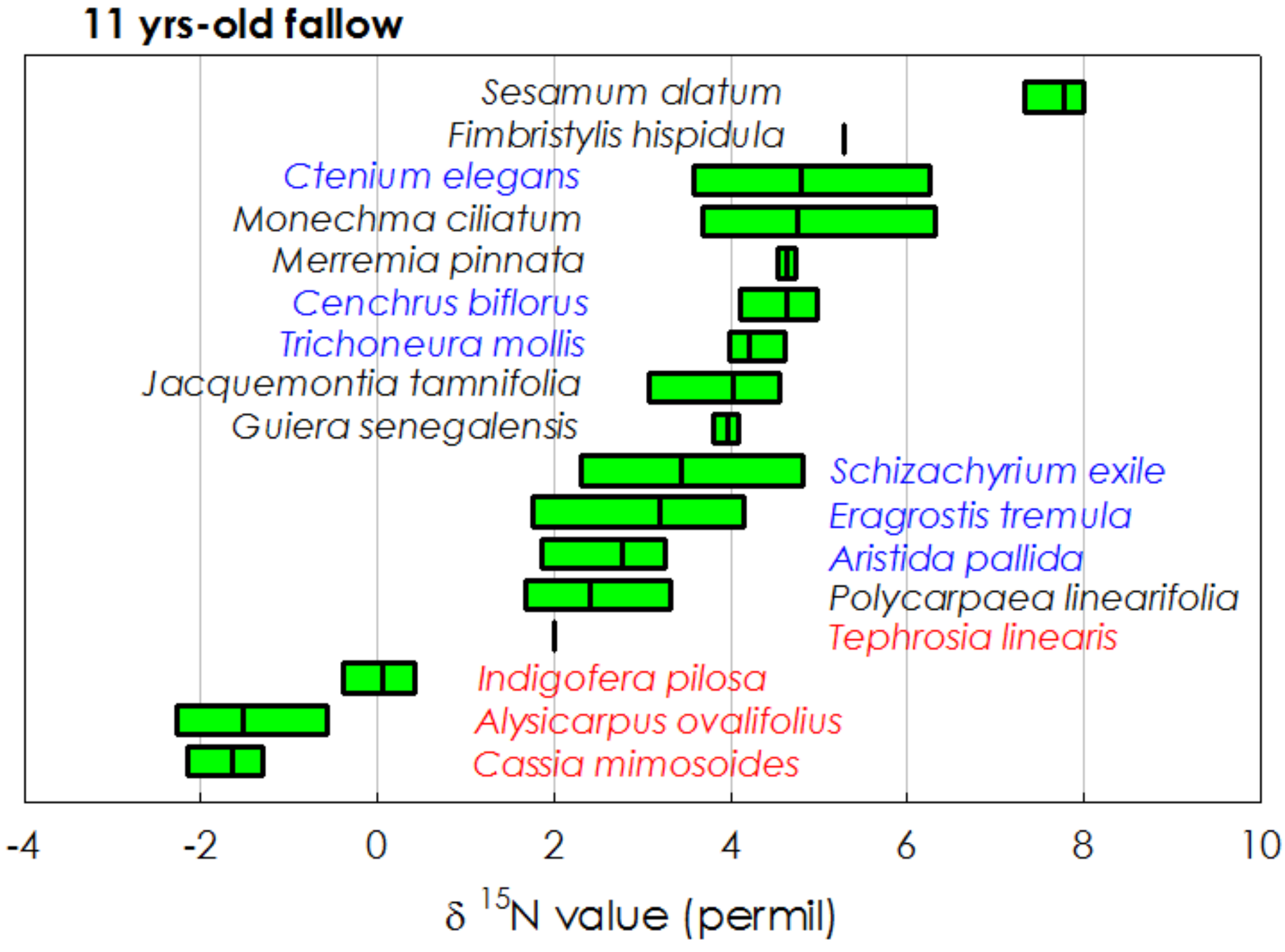
C content is assumed to be 40% of dry matter.

The lower C/N ratio must be more favorable for the crop N utilization because of less competition with micro organisms against inorganic N. Thus mixed application of crop residues in cereal/legume intercropping may increase quality of residues in terms of N availability.

Crop rotation

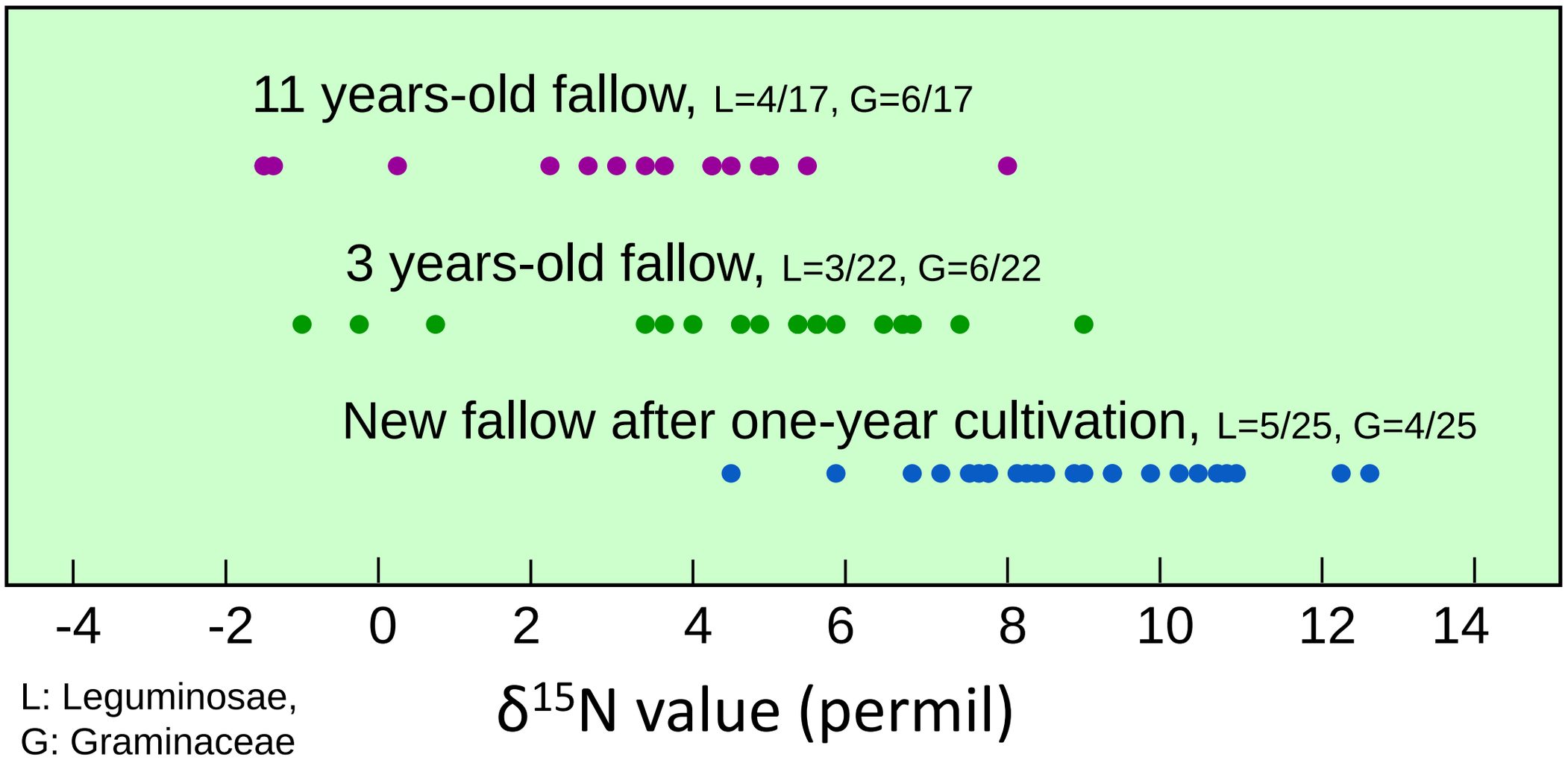
- improves biomass production and soil C sequestration, especially for **fallow rotation** as one of a primitive example.
- reduces N input as chemical fertilizers, leading to saving the fossil fuel consumption in fertilizer manufacturing.
- effective by reducing bare fallow period.

Contribution of natural fallow plant species to the fallow rotation system in Sahelian SAT



Tobita et al, in “Innovations as Key to the Green Revolution in Africa” (2011)

Distribution of $\delta^{15}N$ among the plants collected from three types of fallow plots



Dominant native plant species

Leguminosae species

Cassia mimosoides

Alysicarpus ovalifolius

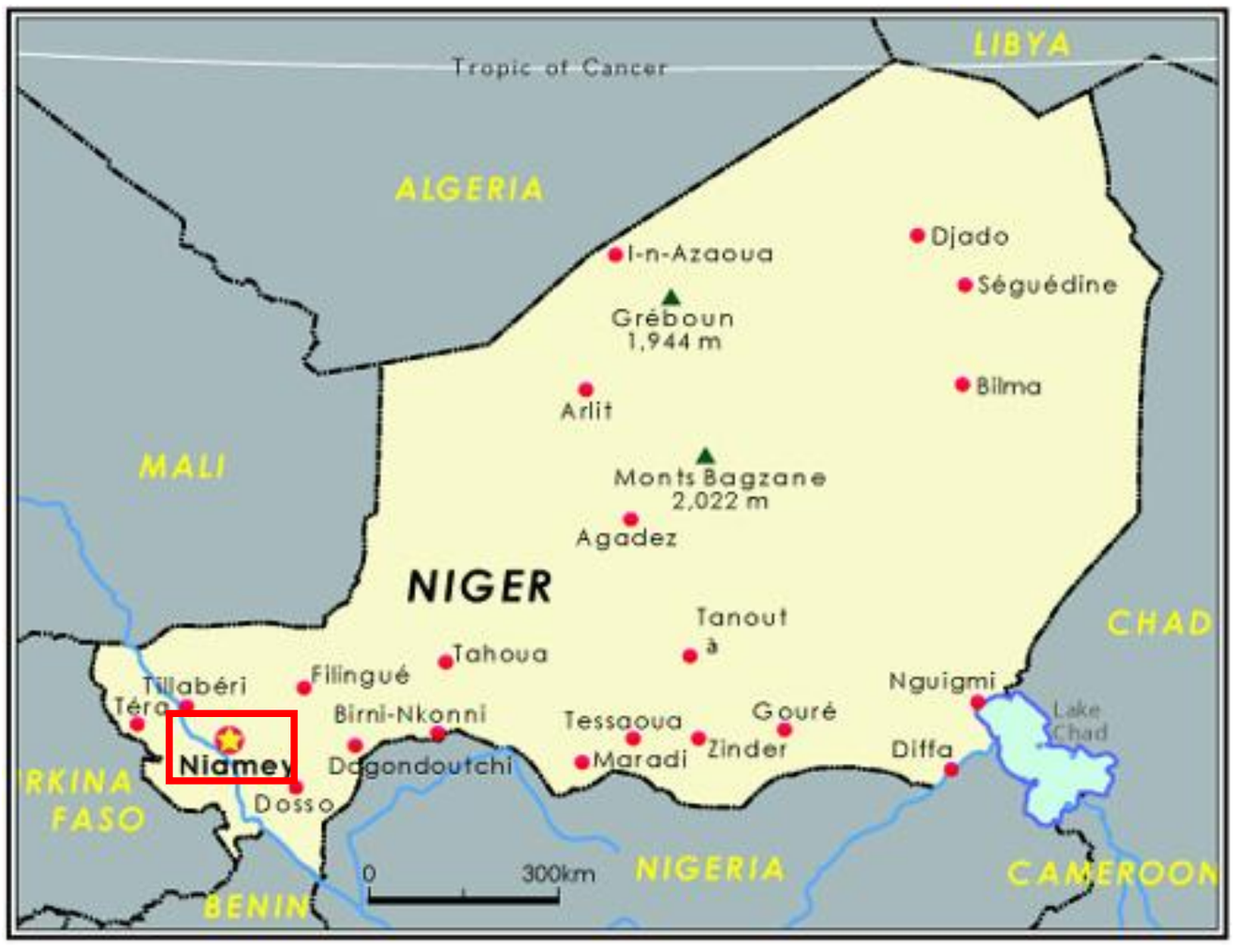
Graminaceae species

Schizachyrium exile

Ctenium elegans

Fakara Plants
-A photographic guide to common plants of Sahel
http://www.jircas.affrc.go.jp/project/africa_dojo/FakaraPlants/Fakara_Plants_home.html

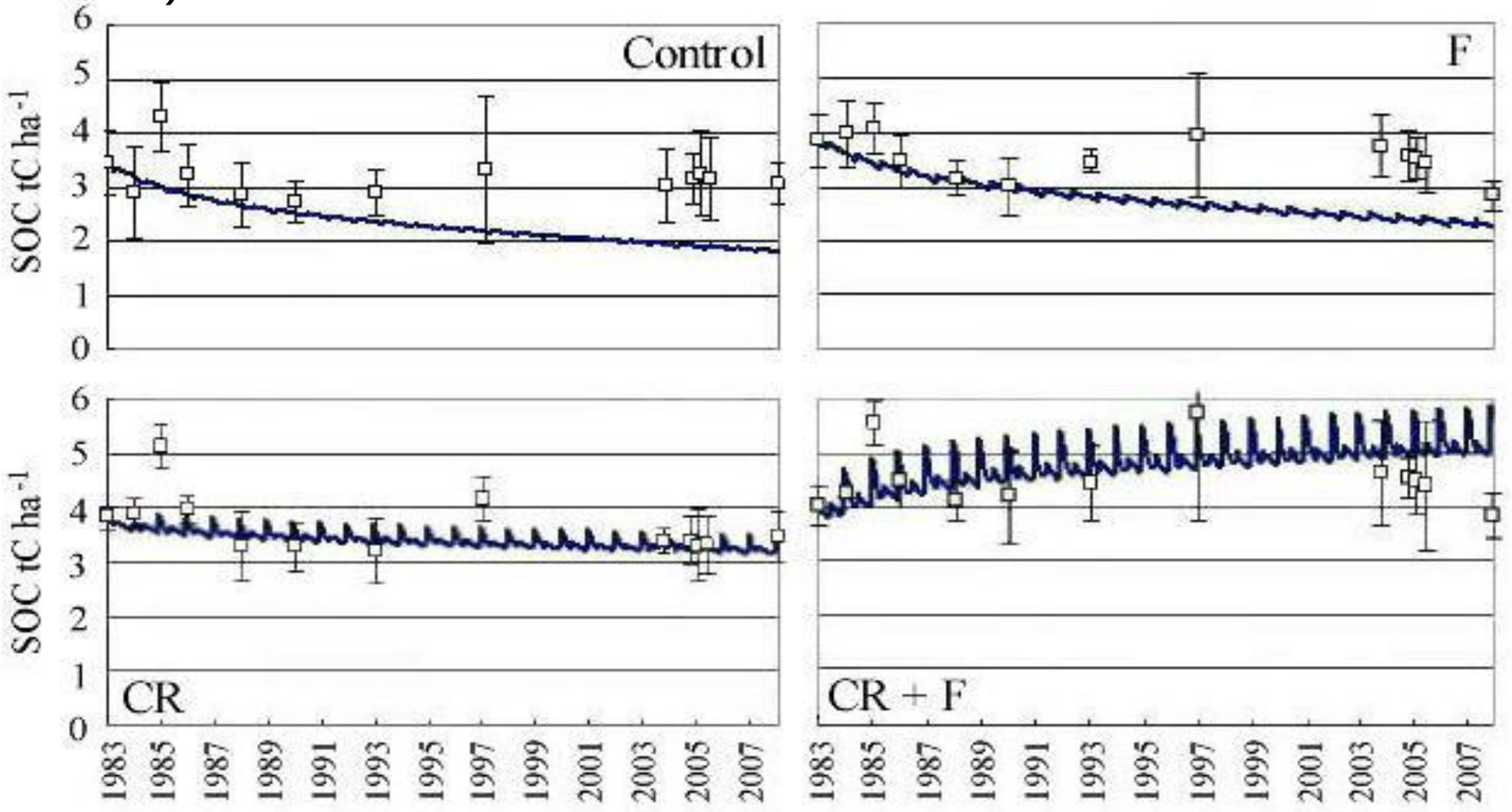
4.
Annual C requirement for SOC maintenance: A model prediction



Nakamura, S. et al. Agron. Sustain. Dev.
DOI 10.1007/s13593-012-0100-2 (2012)

Prediction of SOC dynamics in Sahelian SAT by Roth-C model

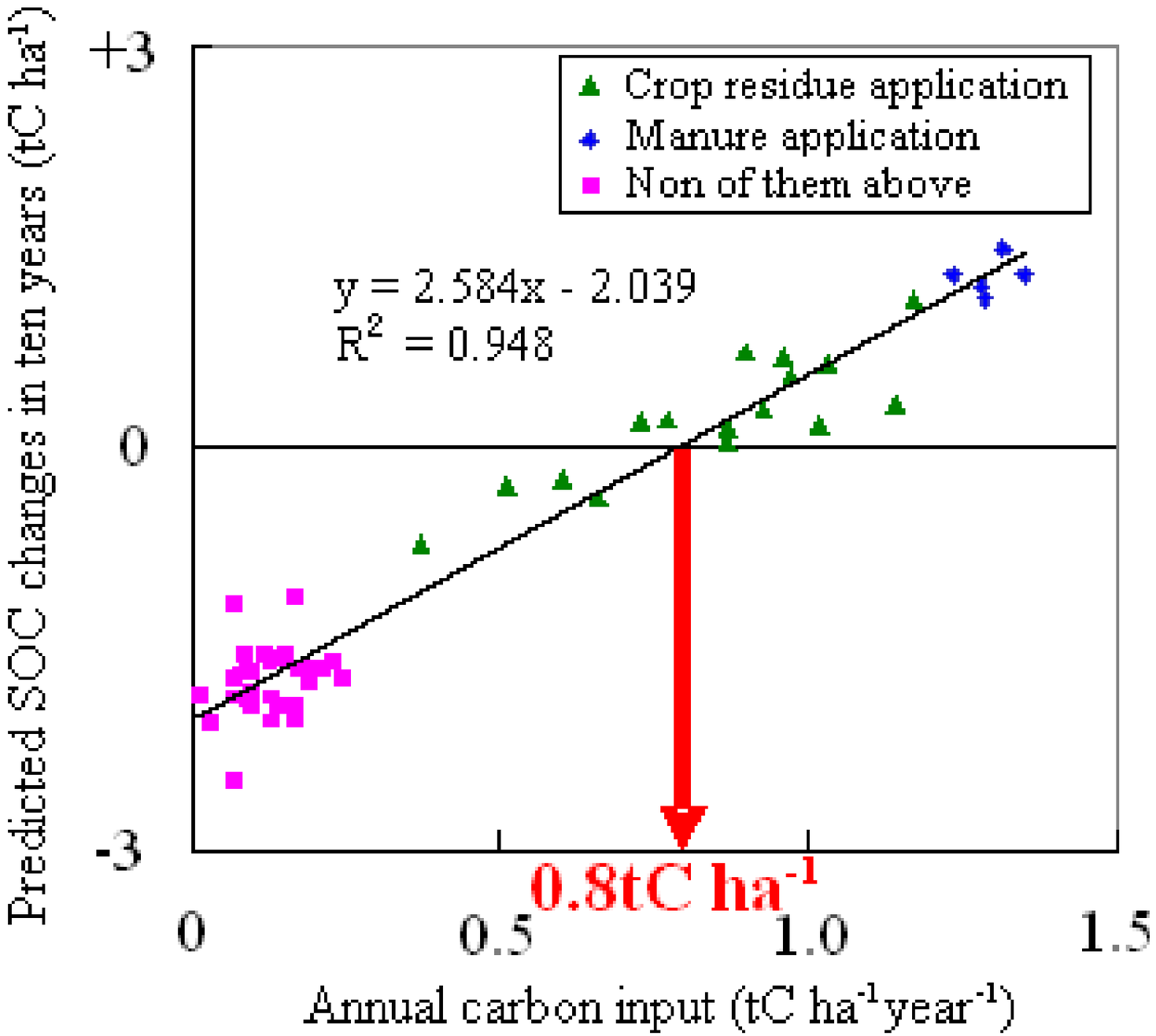
Long-term trial on millet/cowpea cropping system (intercropping and rotation) with/without application of crop residue and manure (28 combinations)



Predicted (line) and observed (box) SOC changes in long-term experiment

Nakamura, S. et al. Nutr Cycl Agroecosyst DOI 10.1007/s10705-010-9402-4

Annual C requirement for SOC maintenance



In order to keep SOC level for another ten years in this region, about 0.8tC ha^{-1} (equivalent to 1.6 ~ 2.0t ha^{-1} of crop residues and 2.0 ~ 4.0t ha^{-1} of manures should be applied annually.

5. Conclusion

Intercropping in Indian SAT
- Cereal/legume intercropping
  - Sorghum/pigeonpea intercropping

Crop rotation in Sahelian SAT
- Fallow rotation

SOC dynamics in Sahelian SAT

C and N in cropping systems in SAT (intercropping and rotation)

- **In cereal/legume intercropping, C/N ratio of whole crop residues is much closer to that of legume. Mixed application of residues of both crops is recommended for improved N availability to the crops.**

- **In fallow rotation, contribution of BNF to N budget in the system increases with fallow period.**

- **Application of about 0.8t C is required in order to keep SOC at the same level for ten years.**

Thank you
for
your attention