Why the Buzz on Regenerative Agriculture?

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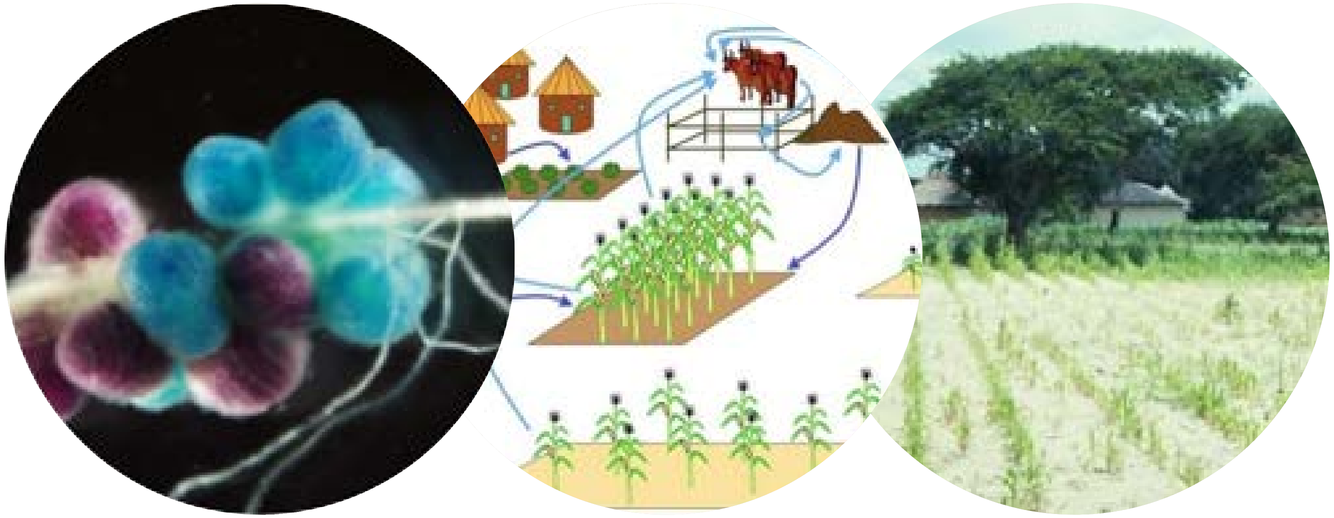

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Perspective

Outlook on AGRICULTURE

Regenerative Agriculture: An agronomic perspective

Outlook on Agriculture
2021, Vol. 50(1) 13–25

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Ken E Giller[1], **Renske Hijbeek**[1], **Jens A Andersson**[1] **and James Sumberg**[2]

Abstract

Agriculture is in crisis. Soil health is collapsing. Biodiversity faces the sixth mass extinction. Crop yields are plateauing. Against this crisis narrative swells a clarion call for Regenerative Agriculture. But what is Regenerative Agriculture, and why is it gaining such prominence? Which problems does it solve, and how? Here we address these questions from an agronomic perspective. The term Regenerative Agriculture has actually been in use for some time, but there has been a resurgence of interest over the past 5 years. It is supported from what are often considered opposite poles of the debate on agriculture and food. Regenerative Agriculture has been promoted strongly by civil society and NGOs as well as by many of the major multi-national food companies. Many practices promoted as regenerative, including crop residue retention, cover cropping and reduced tillage are central to the canon of 'good agricultural practices', while others are contested and at best niche (e.g. permaculture, holistic grazing). Worryingly, these practices are generally promoted with little regard to context. Practices most often encouraged (such as no tillage, no pesticides or no external nutrient inputs) are unlikely to lead to the benefits claimed in all places. We argue that the resurgence of interest in Regenerative Agriculture represents a re-framing of what have been considered to be two contrasting approaches to agricultural futures, namely agroecology and sustainable intensification, under the same banner. This is more likely to confuse than to clarify the public debate. More importantly, it draws attention away from more fundamental challenges. We conclude by providing guidance for research agronomists who want to engage with Regenerative Agriculture.

The origins of Regenerative Agriculture

Robert Rodale (1983) defined RA as "*one that, at* ***increasing levels of productivity, increases our land and soil biological production base****. It has a high level of built-in* ***economic and biological stability****. It has minimal to* ***no impact on the environment*** *beyond the farm or field boundaries. It produces* ***foodstuffs free from biocides****. It provides for the productive contribution of increasingly large numbers of people during a transition to* ***minimal reliance on non-renewable resources***"

Dick Harwood (1983) "*Regenerative Agriculture requires national-level planning but a high degree of local and regional* ***self-reliance to close nutrient-flow loops***"

Regenerative Agriculture Practices

Table 1. Agronomic principles and practices considered to be part of Regenerative Agriculture and their potential impacts on restoration of soil health and reversal of biodiversity loss.

Principles	Practices	Restoration of soil health	Reversal of biodiversity loss
Minimize tillage	Zero-till, reduced tillage, conservation agriculture, controlled traffic	***	–
Maintain soil cover	Mulch, cover crops, permaculture	***	*
Build soil C	Biochar, compost, green manures, animal manures	***	–
Sequester carbon	Agroforestry, silvopasture, tree crops	***	**
Relying more on biological nutrient cycles	Animal manures, compost, compost tea, green manures and cover crops, maintain living roots in soil, inoculation of soils and composts, reduce reliance on mineral fertilizers, organic agriculture, permaculture	***	–
Foster plant diversity	Diverse crop rotations, multi-species cover crops, agroforestry	**	***
Integrate livestock	Rotational grazing, holistic [Savory] grazing, pasture cropping, silvopasture	**	?
Avoid pesticides	Diverse crop rotations, multi-species cover crops, agroforestry	*	***
Encouraging water percolation	Biochar, compost, green manures, animal manures, holistic [Savory] grazing	***	–

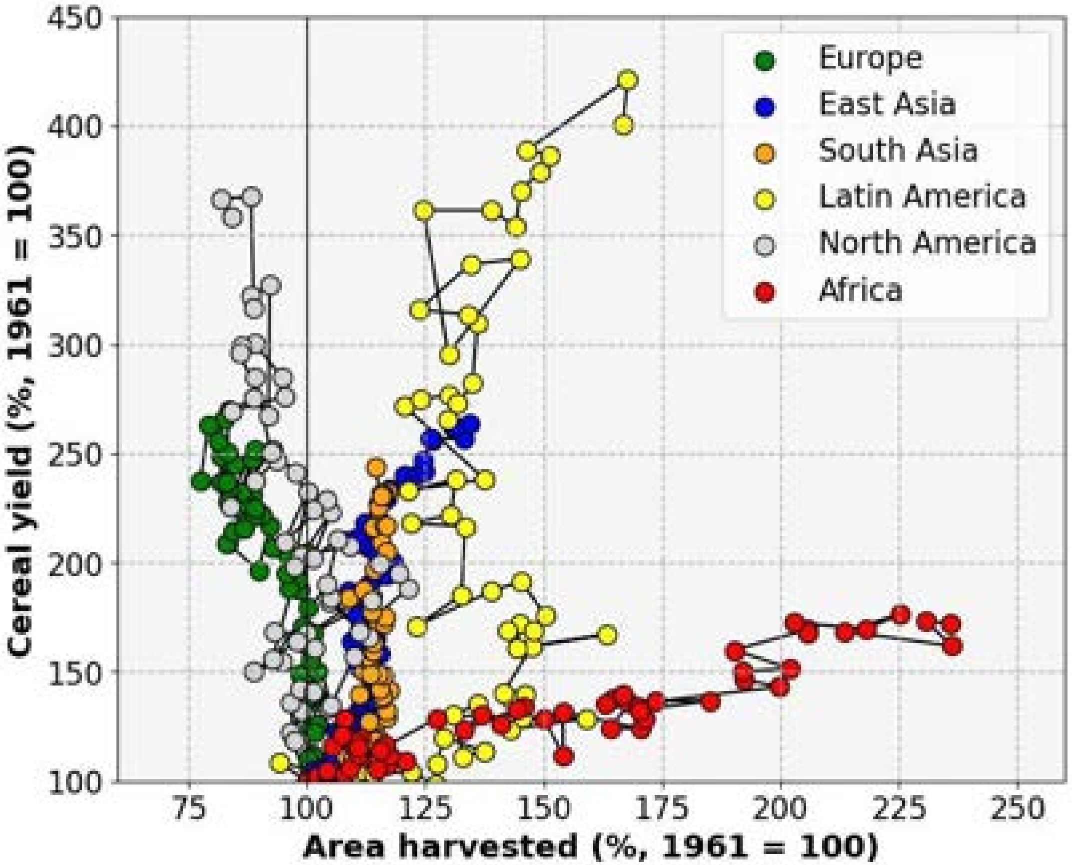
Based on McGuire (2018), Burgess et al. (2019) and Merfield (2019).

Main points of critique

Whilst agreeing that agriculture faces serious challenges

- Given the huge diversity of agricultural systems and starting points these challenges vary over time and space
- Little attention is given to the starting points and local contexts
- All agrochemicals bundled under into one – whereas concerns for human and environmental health of fertilizers and pesticides differ enormously
- Little attention to alternative methods of pest and disease control
- Focus largely 'on farm' with little consideration of the broader landscape, of ecological footprints and 'land sparing'

The future of farming: Who will produce our food?



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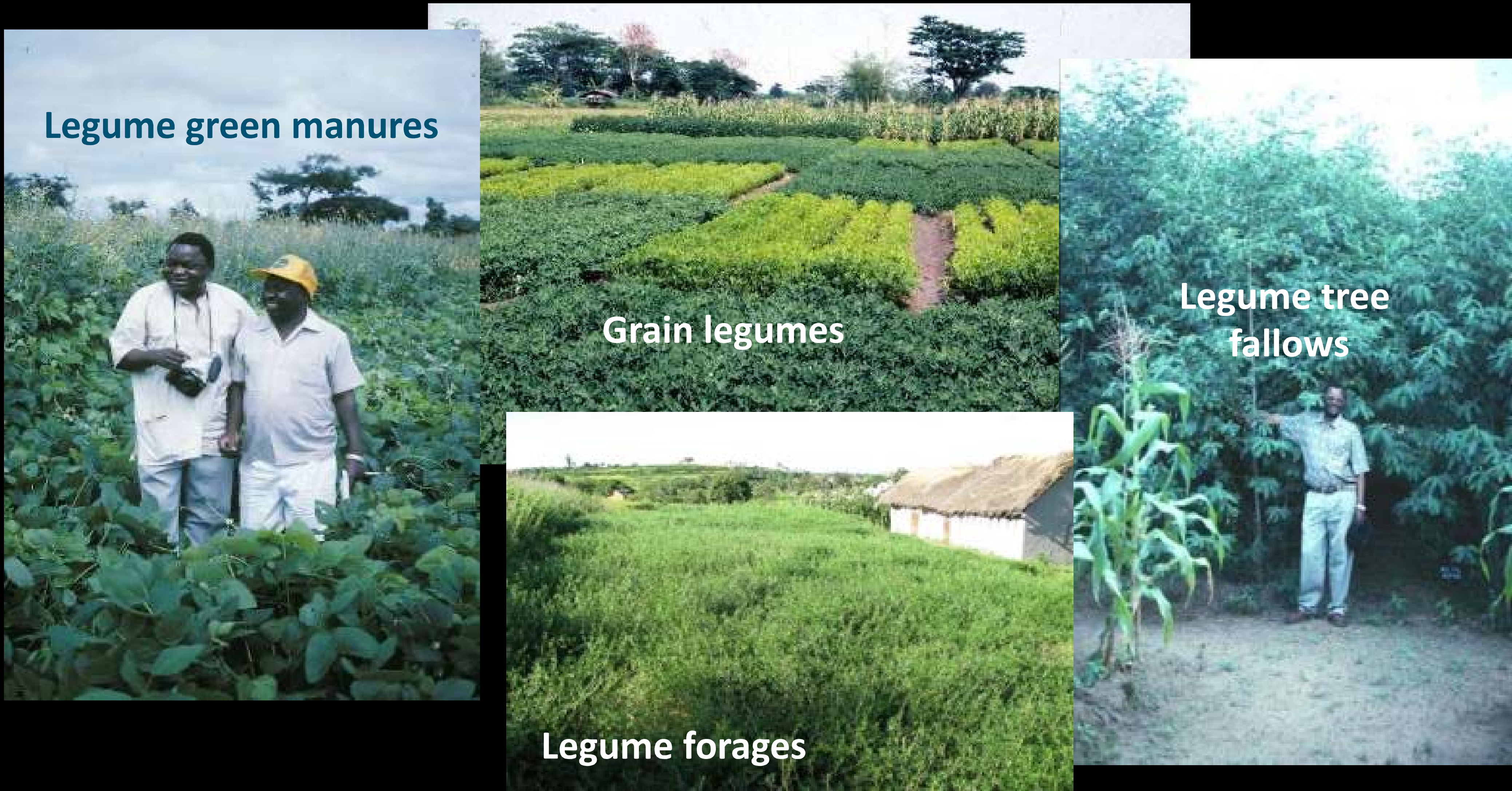
Giller *et al.* (2021) The future of farming: Who will produce our food?
Food Security - https://doi.org/10.1007/s12571-021-01184-6
http://sdg-action.org/tackling-poverty-and-hunger-within-planetary-boundaries/

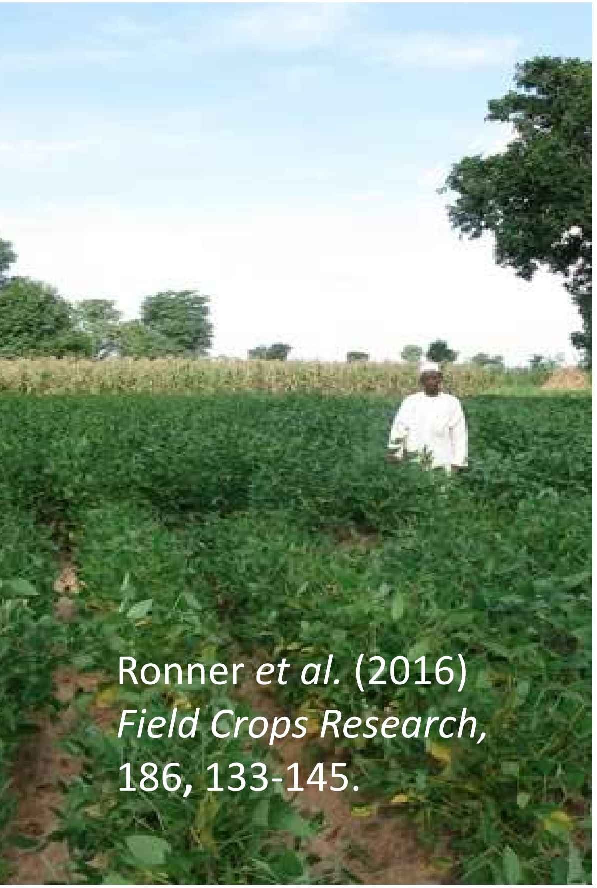
The issue in a microcosm – one farm!

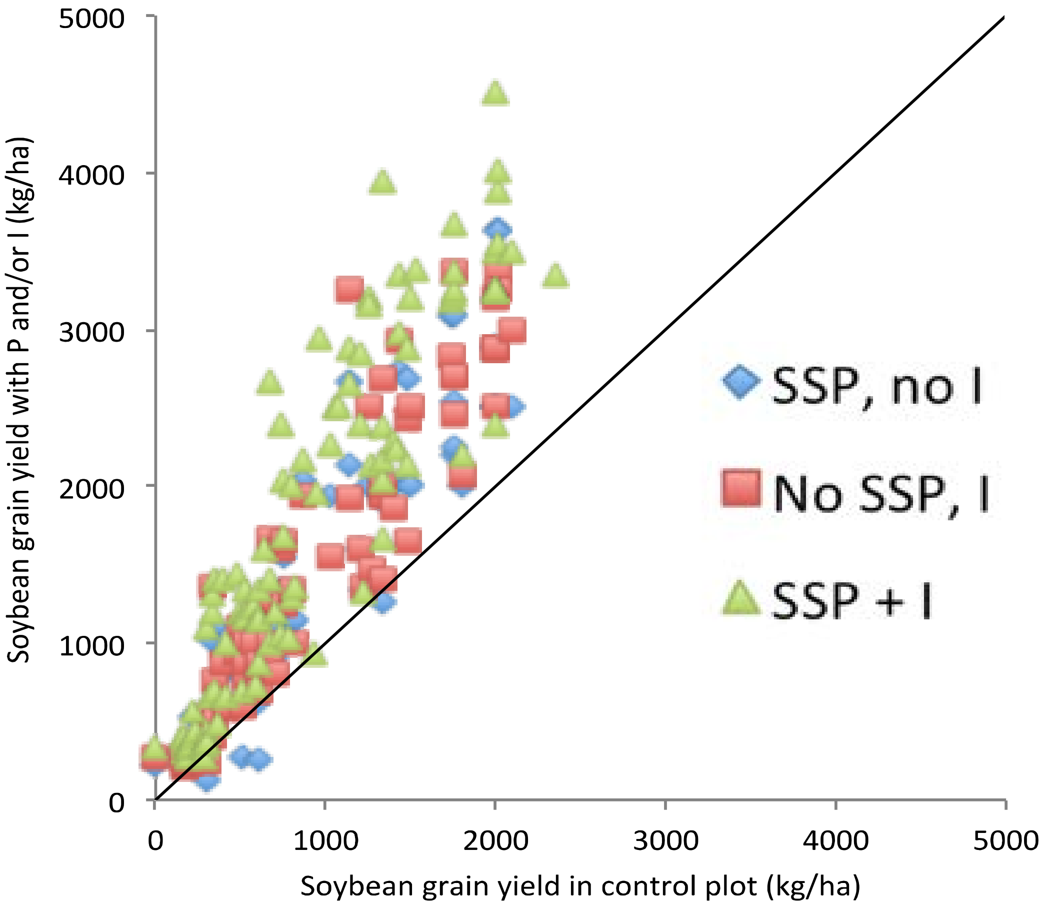
Potential solutions - Nitrogen fixing legumes



Legume green manures on smallholder farms

Effect of P-fertilizer and/or Inoculant on soybean grain yield (t ha^{-1}) in Nigeria, 2011 and 2012



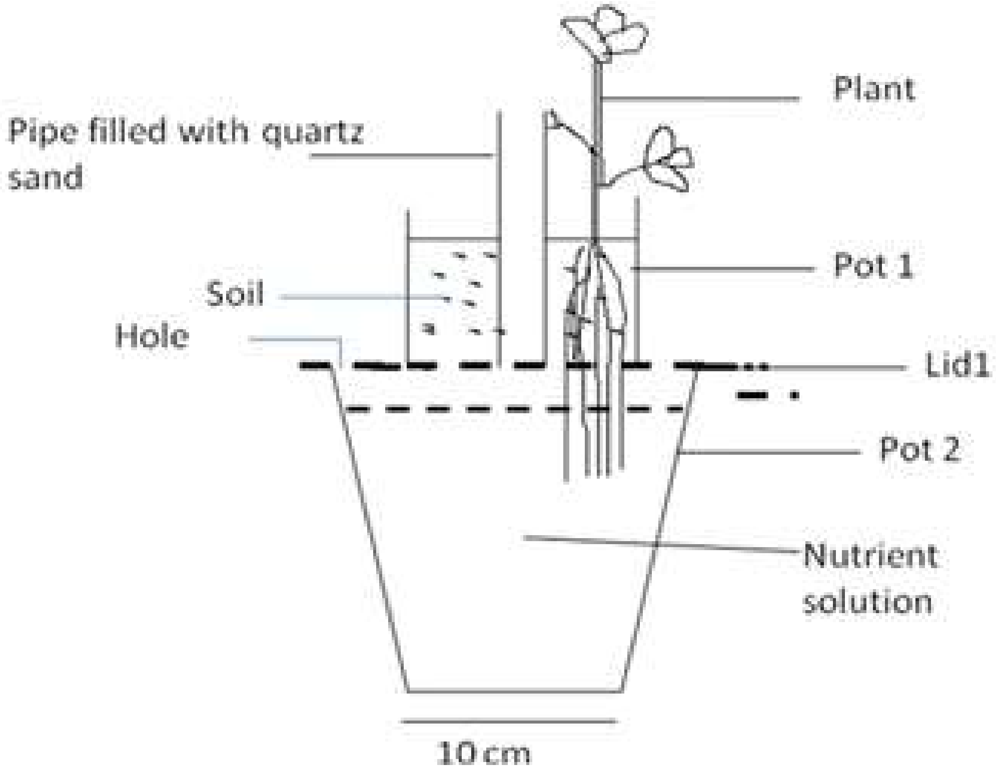


Mean effects (kg/ha)	
+P+I	1745
+P	1420
+I	1415
Control	968
SED	48

Putting nitrogen fixation to work for smallholder farmers in Africa

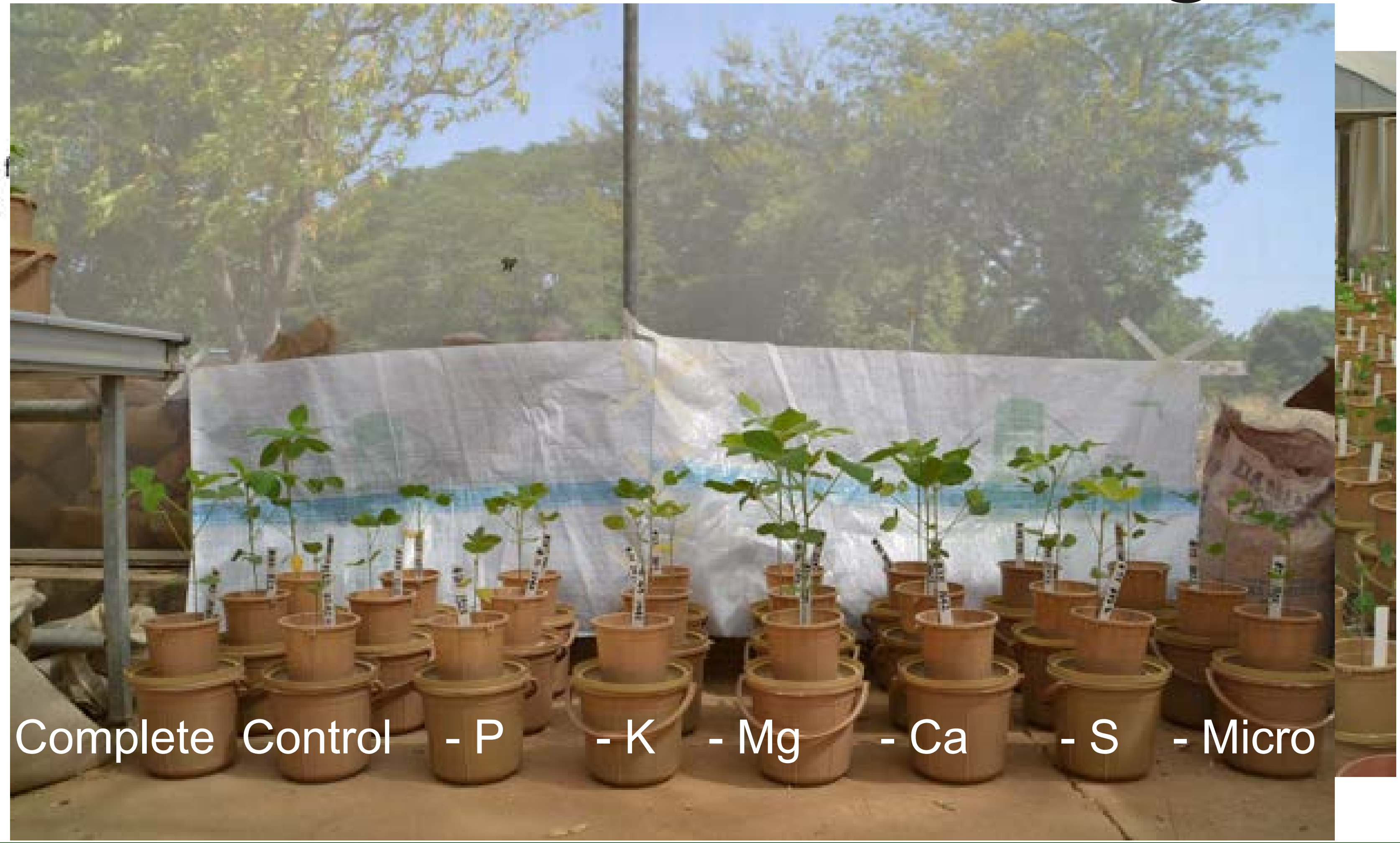
Non-responsive soils

Double pot experiments - Nigeria

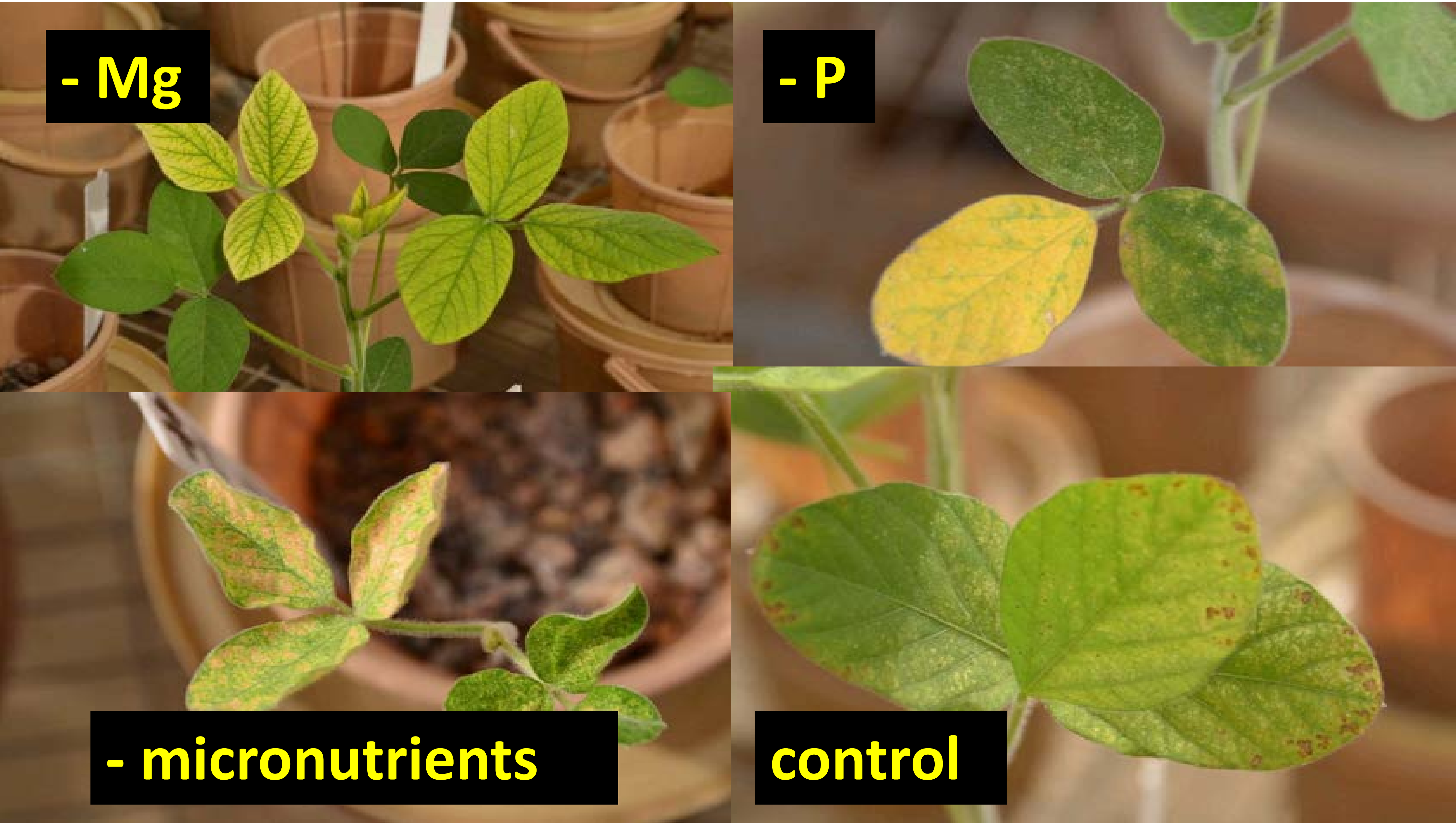


Double pot experiments - Nigeria

Pipe f
sand



Putting nitrogen fixation to work for smallholder farmers in Africa



- Mg
- P
- micronutrients
control

Climbing beans in Rwanda

No manure

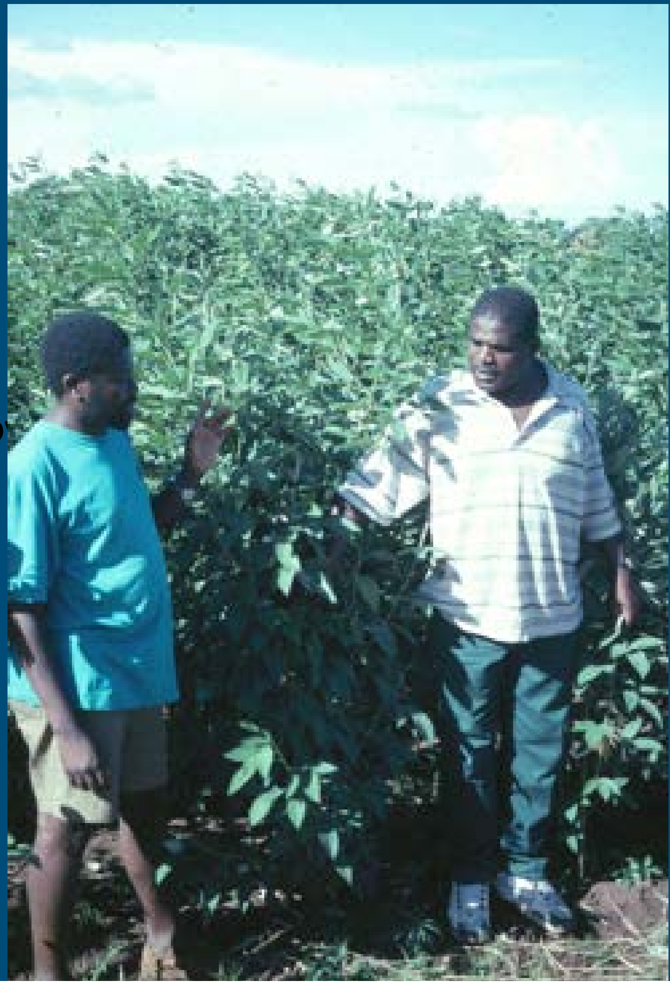
With Manure and P

Putting nitrogen fixation to work for smallholder farmers in Africa

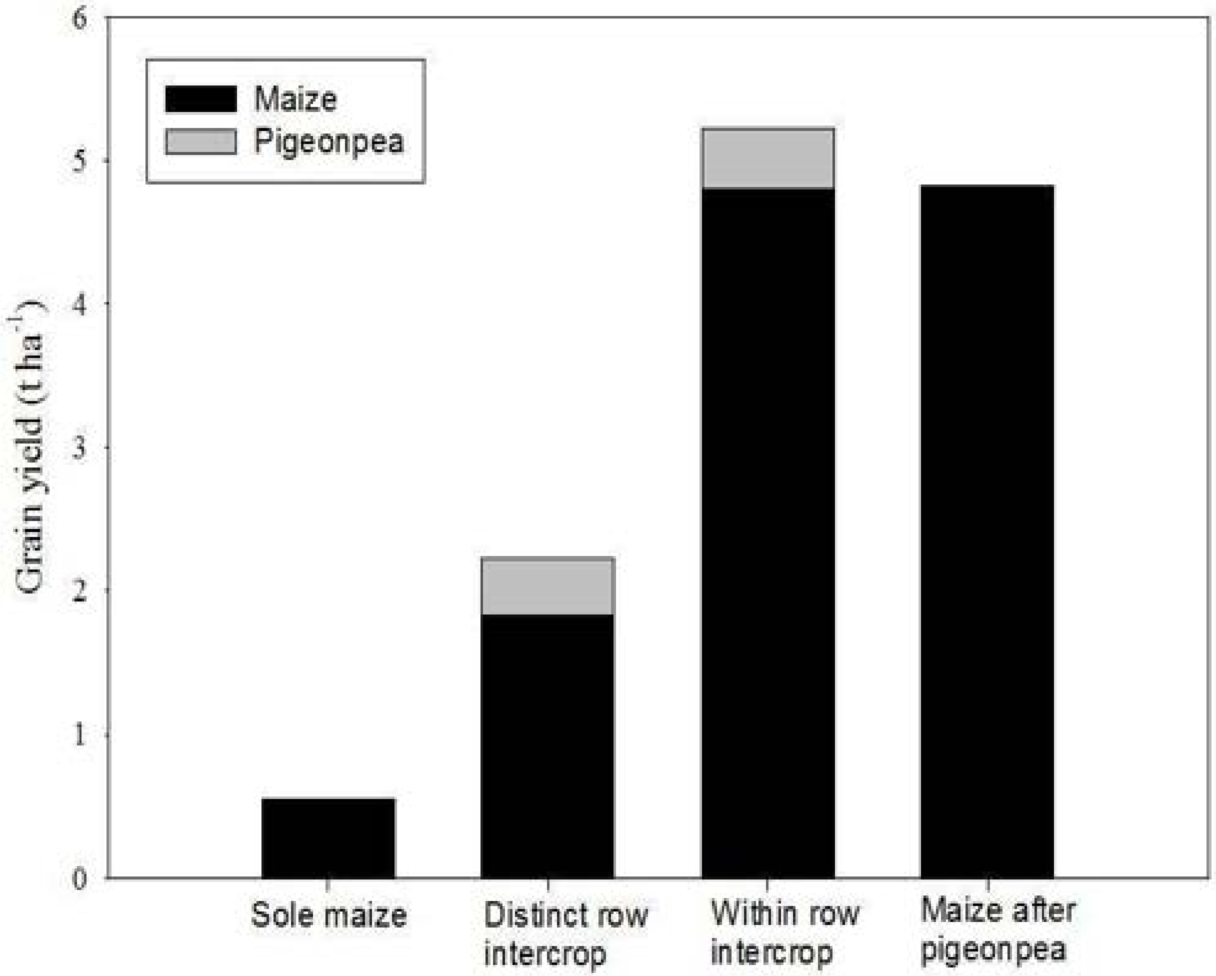

maize after maize
Maize after climbing beans

Pigeonpea-maize intercropping

emo



Residual effects of pigeonpea intercrops and sole crops on maize



Rusinamhodzi, Corbeels, Nyamangara, Giller 2012 Field Crop Res 136, 12-22

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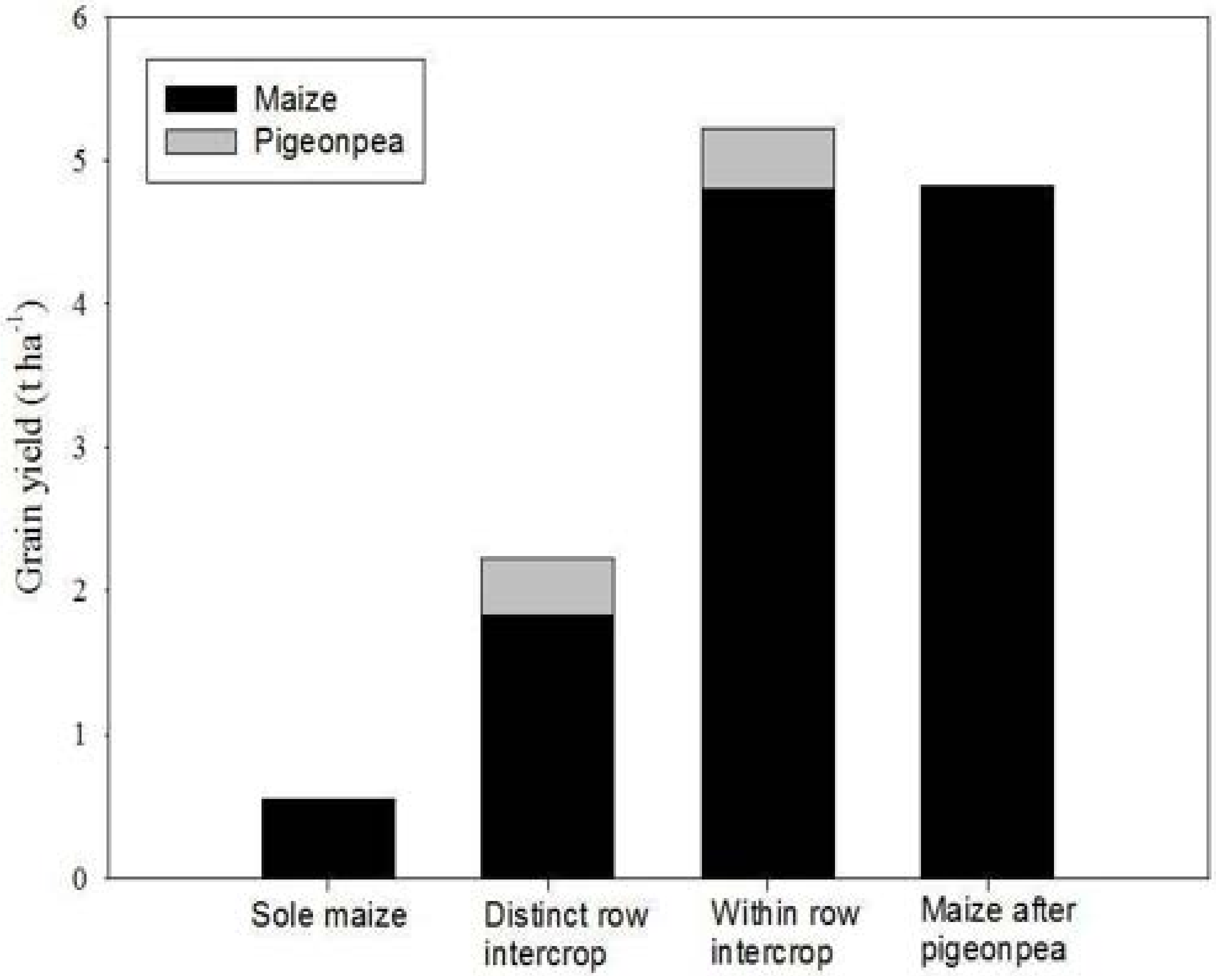

Rusinamhodzi, Corbeels, Nyamangara, Giller 2012 Field Crop Res 136, 12-22

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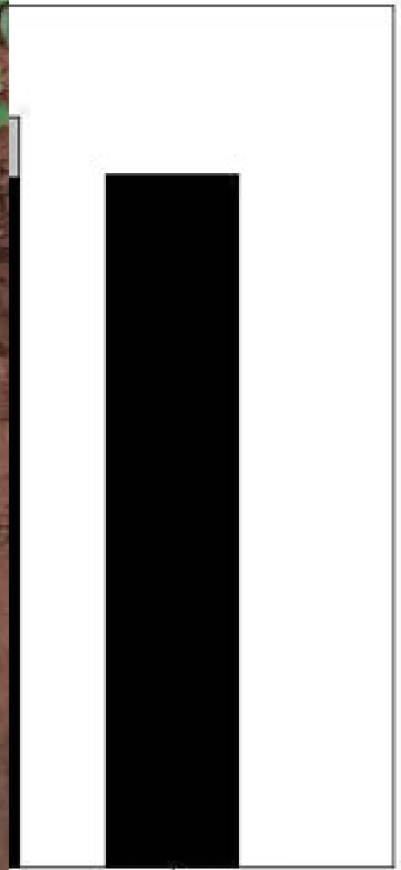
Residual ef



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Rusinamhodzi, Corbeels, Nyamangara, Giller 2012 Field Crop Res 136, 12-22

Small farm size

- Small and declining farm sizes are a critical constraint
- Median farm sizes much less than 2 ha in many locations

Giller et al. (2021) Small farms and development in sub-Saharan Africa: Farming for food, for income or for lack of better options? Food Security https://doi.org/10.1007/s12571-021-01209-0

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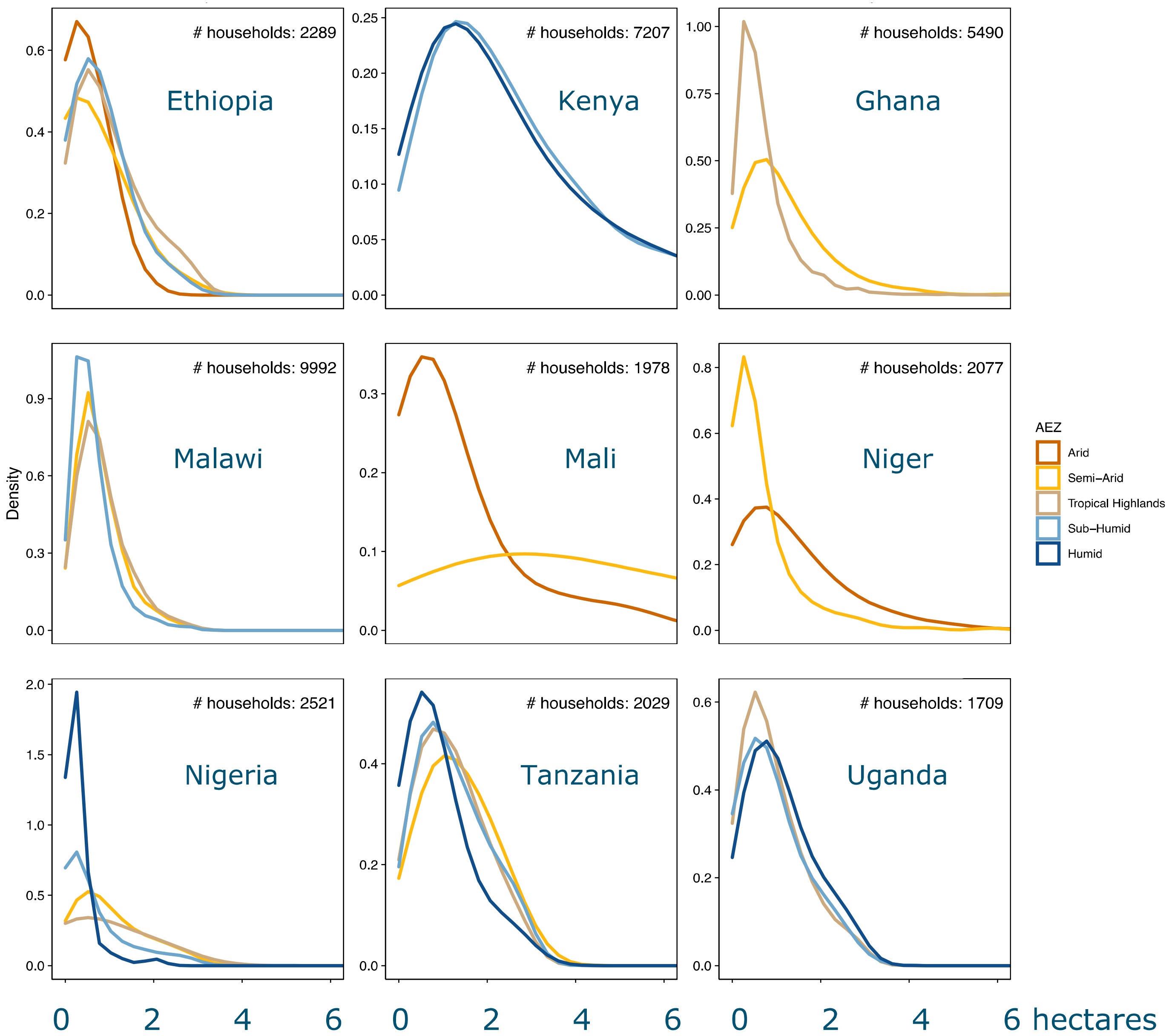

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Agronomy for Sustainable Development (2022) 42:41
https://doi.org/10.1007/s13593-022-00768-6

REVIEW ARTICLE

Indifferent to difference? Understanding the unequal impacts of farming technologies among smallholders. A review

Eva S. Thuijsman[1] · Harmen J. den Braber[1] · Jens A. Andersson[1] · Katrien Descheemaeker[1] · Frédéric Baudron[2] · Santiago López-Ridaura[3] · Bernard Vanlauwe[4] · Ken E. Giller[1]

Accepted: 1 March 2022

Abstract

With many of the world's poor engaged in agriculture, agricultural development programmes often aim to improve livelihoods through improved farming practices. Research on the impacts of agricultural technology interventions is dominated by comparisons of adopters and non-adopters. By contrast, in this literature study, we critically review how technology evaluation studies assess differentiated impacts in smallholder farming communities. We searched systematically for studies which present agricultural technology impacts disaggregated for poor and relatively better-off users (adopters). The major findings of our systematic review are as follows: (1) The number of studies that assessed impact differentiation was startlingly small: we were able to identify only 85, among which only 24 presented empirical findings. (2) These studies confirm an expected trend: absolute benefits are larger for the better-off, and large relative benefits among the poor are mostly due to meagre baseline performance. (3) Households are primarily considered as independent entities, rather than as connected with others directly or indirectly, via markets or common resource pools. (4) Explanations for impact differentiation are mainly sought in existing distributions of structural household characteristics. We collated the explanations provided in the selected

holds: 2077
er
holds: 1709
da
4 6 hectares

Agroecology – 13 principles (HLPE)

1. Recycling
2. Input reduction
3. Soil health
4. Animal health
5. Biodiversity
6. Synergy
7. Economic diversification
8. Co-creation of knowledge
9. Social values and diets
10. Fairness
11. Connectivity
12. Land and natural resource governance
13. Participation

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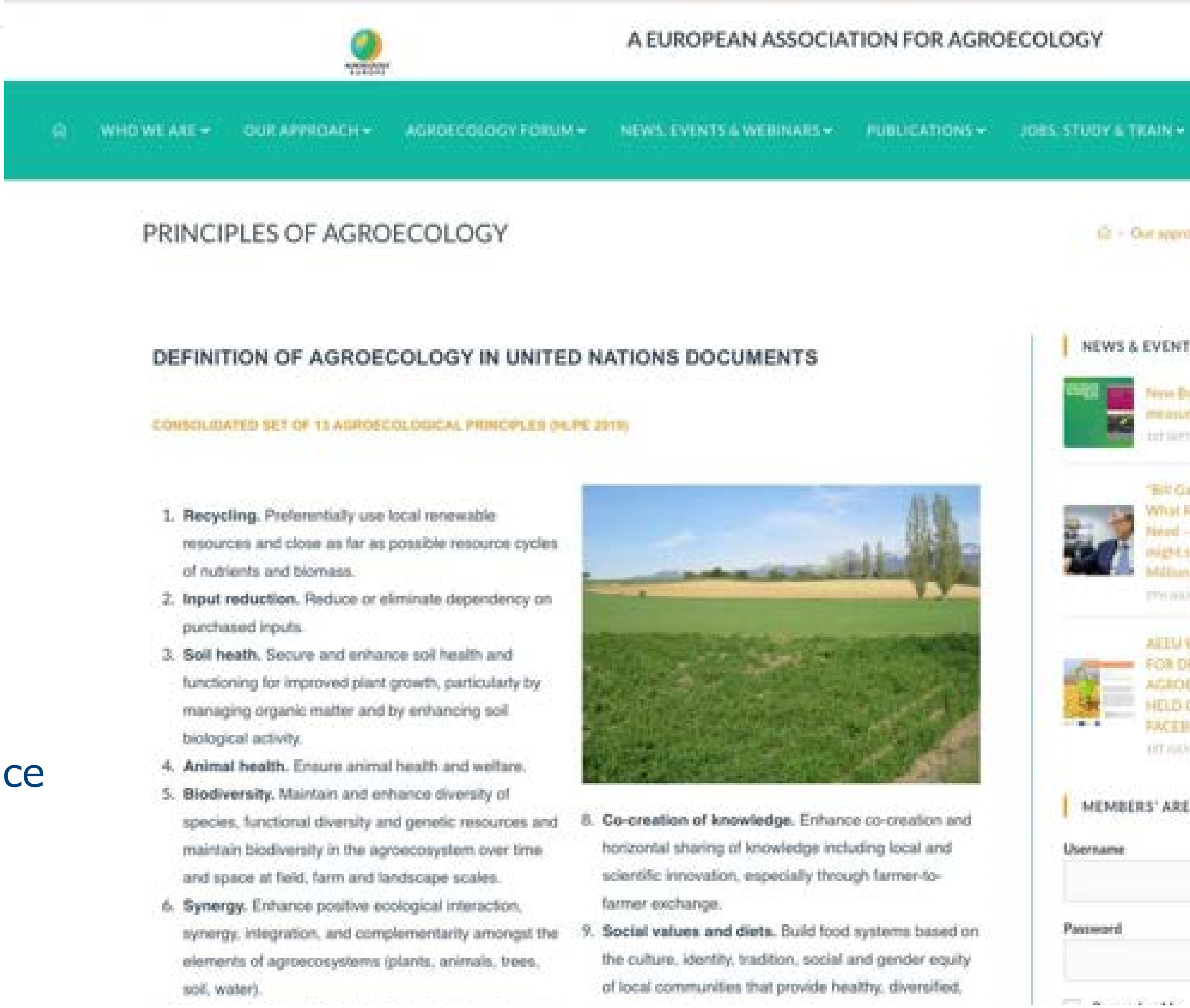

Some guidance for engagement

Five questions:

1. What is the problem to which Regenerative Agriculture is meant to be the solution?
2. What is to be regenerated?
3. What agronomic mechanism will enable or facilitate this regeneration?
4. Can this mechanism be integrated into an agronomic practice that is likely to be economically and socially viable in the specific context?
5. What political, social and/or economic forces will drive use of the new agronomic practice?

Regenerative agriculture is here to stay

How can we build on the huge positive momentum?

- Regenerative Agriculture moves the goalposts from ‘do no harm’ to ‘do better’
- A clear definition is lacking - which may be more help than hindrance?
- A common set of **principles** for Regenerative Agriculture can be identified
- The huge diversity of farms, farming systems and take-off points means that a tailored approach is needed for implementation of **practices**
- Measuring and monitoring progress will remain a challenge
- Need a farming systems level understanding – to generate the organic resources required need nutrient inputs

With thanks to

Renske Hijbeek

Jens Andersson

Jim Sumberg

All our many N2Africa collaborators:

www.N2Africa.org

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TABLE

Exploring evidence and values in global food systems debates

A collaboration between

OXFORD SLU WAGENINGEN

- Why do people hold the views they do about food?
- TABLE is a new food dialogue platform that aims to **set out the evidence, assumptions, and values** underpinning views on food systems controversies

Check out FEED, our food systems podcast:
https://tabledebates.org/podcast

Subscribe to FODDER, our weekly newsletter
https://tabledebates.org/fodder

www.tabledebates.org @TableDebates

Regenerative Agriculture Practices in Action - a case from Ethiopia

Walking with the Farmer

Fentahun Mengistu

Soils For Food Security In Africa - Potential of Regenerative Agriculture

TICAD8 side-event Webinar

05 August 2022

SASAKAWA AFRICA ASSOCIATION

Background

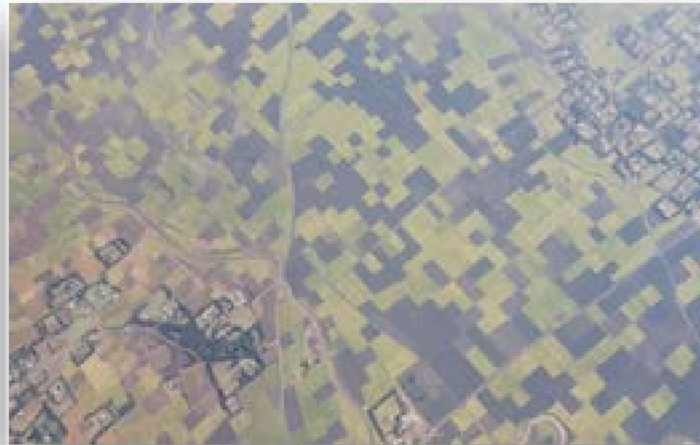

Center of crop origin and diversity

Diverse agro-ecologies: 32 AEZs


Abundant water resources


Large livestock population


Natural forests

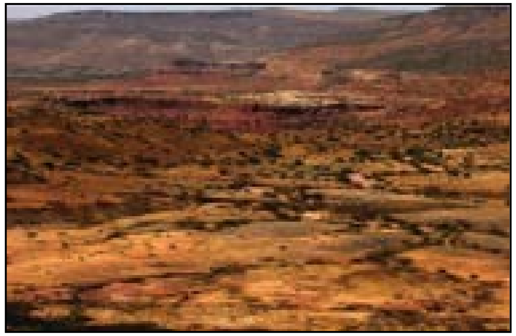

Large agricultural land

A change of Ethiopian landscape since the late 20th C

Challenges:

- Land degradation, de-forestation, ecological imbalances
- Soil related problems
  - Soil erosion: 1.5BT topsoil /year
  - Acidity (28% of agricultural land)
  - Salinity (11m ha)
  - Poor drainage (12.6m ha)
- Biotic factors: pests, diseases, weeds
- Abiotic factors: climate change, drought
- Poor farming practices
- Socio-economic: market, credit, etc.

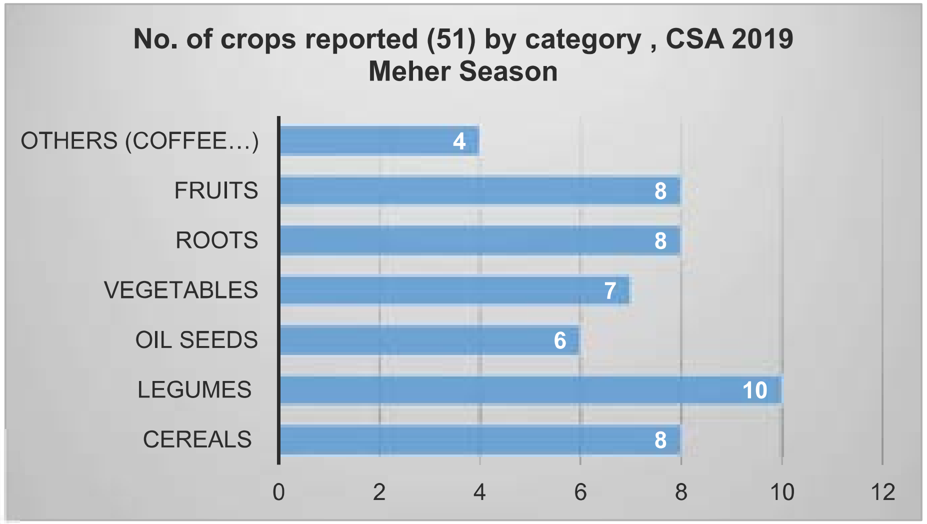


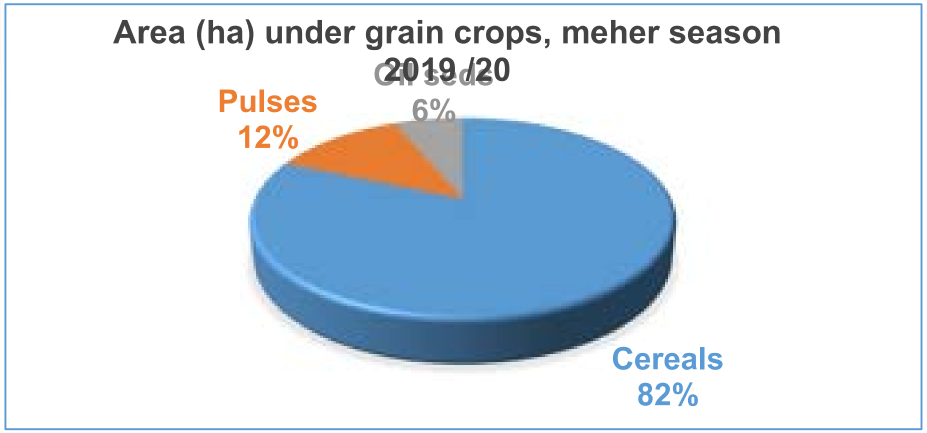



Bio/agrobiodiversity on decline

Diverse

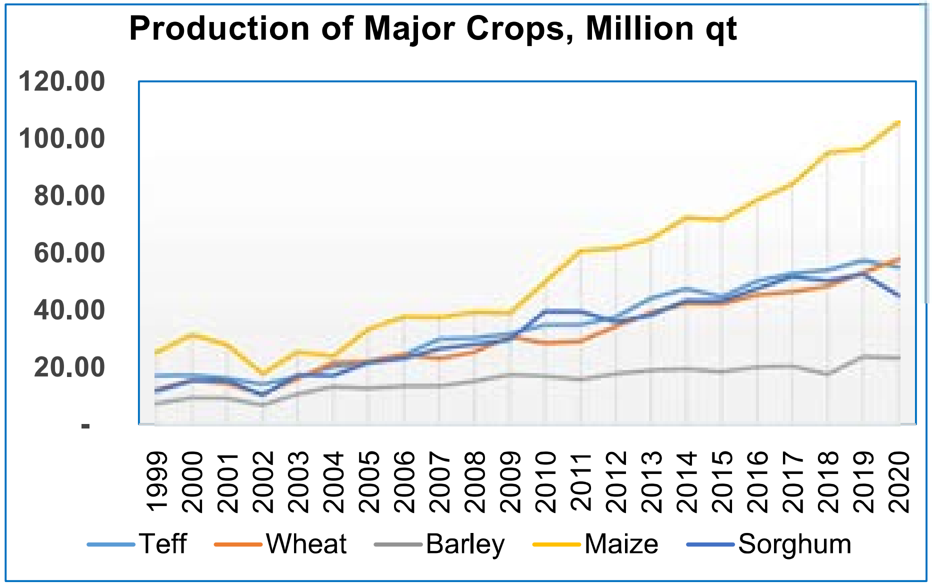
Less diverse





Co-existence of subsistence, and emerging commercial agriculture

- Agriculture is predominantly Subsistence
  - ➢ Not able to meet the desired productivity; but moderately sustainable
- Emerging commercial Agriculture; NRM
  - ➢ Significant productivity gain; less/ unsustainable



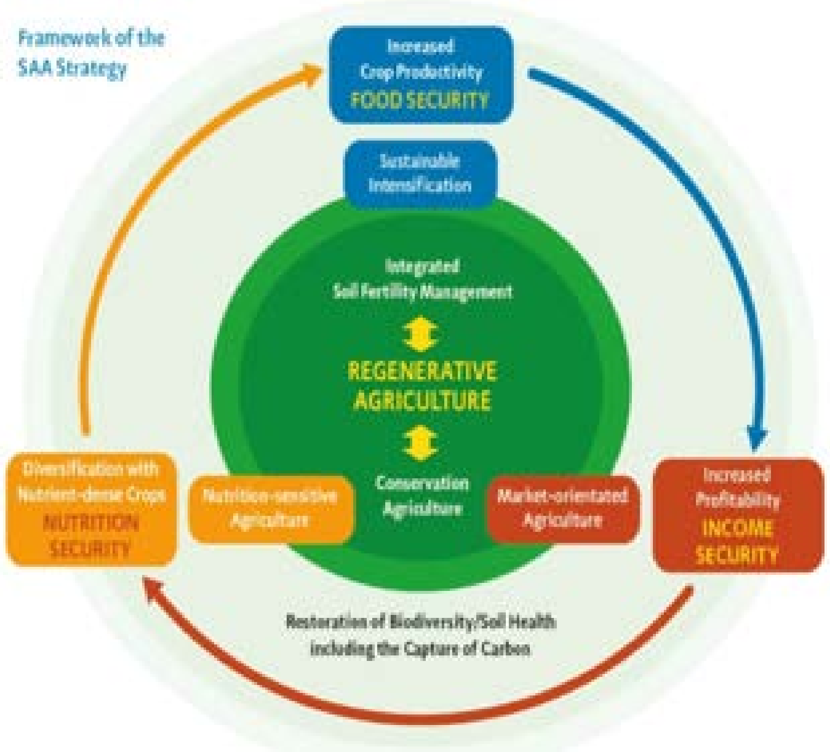
Regenerative Agriculture (RA) as a potential solution- SAA's Approach

- *Neither subsistence nor emerging commercial agriculture-achieve productivity and environmental sustainability objectives*
- Drawing from existing & emerging agriculture

RA need for Ethiopia/Africa is:

- *Not primarily to reduce excessive use of external inputs, or reducing GHGs emissions*
- Rather, *reduce environmental degradation, achieve resource use efficiency, increase productivity, reduce agriculture's environmental footprints*
- **SAA**: CT in 1998; RA as a pillar in 2021-25 strategy

❖**RA:** *principles/practices conserving, protecting, regenerating, and enhancing **soils & agroecosystems**, and increasing **agricultural productivity***



- Balancing agro-ecology and -technology practices
- PU: whole community; AVCs

SAA's Regenerative Agriculture framework and on-the-ground practices

On-farm interventions

Conservation Agriculture(CA)
- Minimal mechanical soil disturbance
- Permanent soil cover
- Crop diversification

Integrated soil fertility management (ISFM)
- Inorganic inputs
- Organic inputs
- Genetics, GAPs
- Best-fitting/ contextualization

Agroecosystem/ Landscape-level interventions

Understanding the system
- Site identification-villages/mini-watersheds
- Rapid assessment/Baseline
- Soil sampling & analysis
- Identify entry point

Capacity building
. ToT for EAs

. Cascading training to farmers

Setting up demonstrations
- Experimentation and learning at FTCs & host farmers' clustered farms
- Collaborating with farmers & other actors at the landscape level for ccollective action and synergies and complementarities

Monitoring/ tracking
. Measuring agricultural output (yield, income)

. Measuring environmental/social outcomes

Learning
. Gathering feedbacks

. Identify typologies and recommendation domains for scaling

SAA

Conservation Agriculture (CA): Reducing soil mechanical disturbance

- **Tillage reduction**

❖ Frequent tillage is an established practice

❖ Frequency varying by: crop, agro-ecology, cropping history

Cereals- farms tilled more repetitively

SAA promotes:

❖ Zero/minimum tillage

❖ "*Berken Maresha*" to reduce tillage frequency

Conservation Agriculture (CA): Maintaining permanent soil cover

Crop residue management:

- **Put into competing uses**

SAA promotes:

- Leaving crop residues on soil surface
- Harvesting cereals at higher height
- Mulching with crop residues
- Reducing free grazing

Cover crops

- cowpea, vetch, etc.






Conservation Agriculture (CA): Fostering plant diversity

- Traditional diversification practices exist
- Trending towards landscape simplification in favor of high yielding/marketable crops

SAA promotes:

Spatial and temporal farm diversification

- Inter-cropping, relay-cropping, rotation, agro-forestry

❖ **Factoring in:** crop compatibility, agroecology, value (fertility, pest suppression, food/feed), market demand, profitability (LER), etc.

Conservation Agriculture (CA): Fostering plant diversity

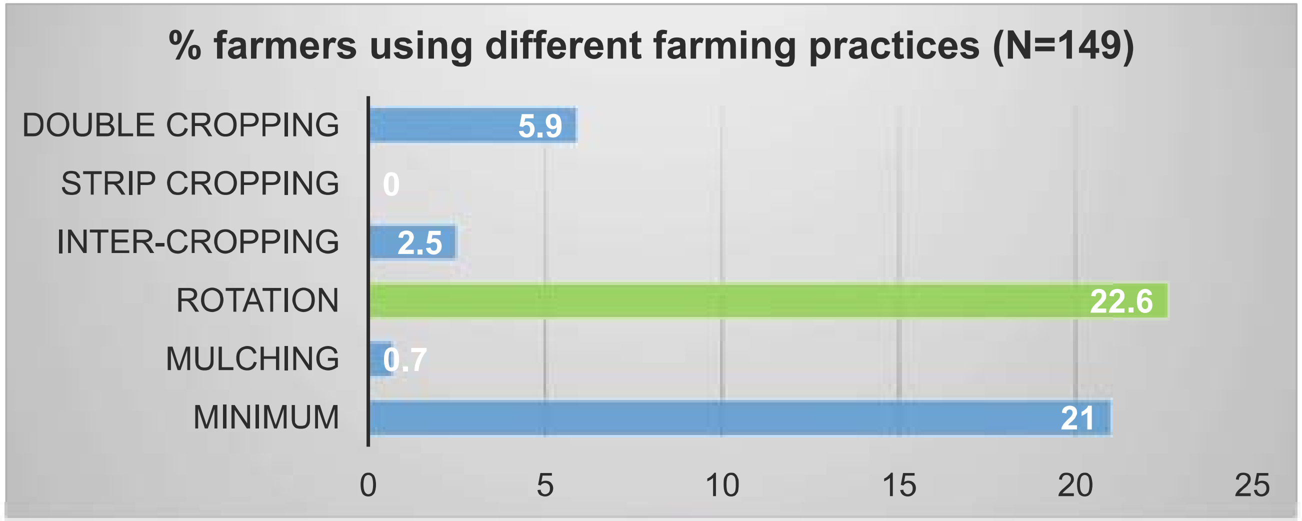
Crop Rotation

- Declining due to land shortage & commercial-orientation
- Shortened to 2-3 years
- Monocropping: alternative crops are limited or not known

SAA promotes:

- Longer duration rotations
- Inclusion of pulses

Diversifying crops/varieties



Conservation Agriculture (CA)-Permaculture/permagardening

Permanent gardens in homesteads

- Addressing nutrition, gender, income, environmental problems
- Vegetables, herbs, spices; perennial plants
- Minimal soil disturbance
- Water saving practices
- Organic inputs
- Shelf-life extending technologies




Conservation Agriculture (CA)- Climate- Smart Agriculture

Climate –Smart Villages

- Water harvesting activities
- Climate smart practices
- Climate resilient crops
- Landscape restoration with the community
- Cooling facilities for perishable items
- Food processing
- SBC training
- Nutrition training

Integrated soil fertility management (ISFM)- Inorganic inputs

In Ethiopia, Sub-Saharan Africa:

- Fertilizer application rate is very low
- Ethiopia- 36kg /ha
- Russia-Ukraine war exacerbated- availability and price of chemical fertilizers
- Low agronomic efficiency

SAA promotes:

- Optimal and efficient use of Inorganic Fertilizers
- Along with organic inputs, and good agronomic practices

Integrated soil fertility management (ISFM)- Organic inputs

Practices/inputs building SOM, SC, CCS

- Compost/vermicompost
- Manure/ Farmyard Manure
- Green manuring crops
- Nitrogen-fixing legumes
- Bio-fertilizers
- Liming

Integrated soil fertility management (ISFM)- Genetics, Good Agronomy, and local adaptation

- **Indigenous/Local crop cultivars**
- **Improved varieties-** high yielding, nutrient-responsive, pest-tolerant, etc.
- **Improved input/agronomic efficiency**: fertilizer, water; AI tool: E-ekakashi
- **IPM/IDM/IWM**
- **GAPs**: options by context (OXC), line planting, crop targeting, water harvesting, vertisol management, soil erosion control, etc.

❑ **Livestock management**

- High biomass crops or varieties
- Forage-crop integration
- *In situ* manuring

Enabling conditions, challenges, and success factors for RA

Favorable conditions for RA transition

- Existence of farmers IK & practices
- Labor and oxen shortage, and price
- Rise in inorganic fertilizers price
- Existence of enabling policies: 10 years PP, FST, ICBWM, CRGE, irrigation, Green legacy initiative, CA, NSA

Challenges

- Unlearning framers' repetitive tillage practices
- Uncontrolled livestock grazing
- Balancing short-term and long-term objectives
- Incentives for transitioning
- Collective action, solidarity- at landscape, AVCs
- Conflict with commercial agriculture interest

Success factors in putting RA into practice

- Meeting both farmers' aspirations and national development goals
- Building on existing practices and adapting to emerging commercial agriculture
- Economic incentives to persuade farmers to change their practices
- Beyond the individual farmer/farm & into the community/landscape level
- Going beyond production into the agri-food system level
- Creating adequate enabling policy, multi-institution alliances


Thank you.

Conservation Agriculture (CA) Practices in Ghana

K. Boa
Centre for No-Till Agriculture

Ghana

- Ghana
  - Predominantly agricultural nation (70%)
  - Smallholder farming (85%)
  - Smallholder
    - Declining yields
      - Negative impact on food security and overall livelihoods
- Problem – Land degradation, exacerbated by climate change
  - Bare lands at planting (slash & burn and ploughing)
    - Loss of SOM
    - Reduced resilience in soils
- Centre for No-Till Agriculture (CNTA)
  - Non-profit NGO, set up to show
  - Benefits, evidence and processes of Conservation Agriculture
    - Improve and sustain the productivity of farmlands in an environmentally friendly and profitable manner

Key field practices

Keeping in mind the three interlinked principles

No-Tillage Land Preparation

Minimum tillage - Ripping

Using the traditional hoe to create rip lines

2-Tine tractor mounted ripper

Planting through the mulch - manual

Using the dibbling stick

Using the cutlass

Planting through the mulch - mechanical

Uaing the Jab planter

Tractor mounted 2-row no-till planter

Permanent soil cover

Crop diversification - intercropping and crop rotation

Other Practices

Alley cropping

Retention of Dispersed trees on farmland

Permanent flatbed and the furrow system

Use of A-frame to mark contours

Key strategies for ensuring farmers understanding and acceptance of CA

Building the understanding of farmers on the concept of CA

Showing farmers the evidence

Hands-on practical training

THANK YOU

Advances in soil health monitoring for food and nutrition security, climate change action and ecosystem restoration

Leigh Winowiecki & Tor-G Vågen
CIFOR-ICRAF Scientists
SAA & JIRCAS Symposium
5 August 2022

World Agroforestry

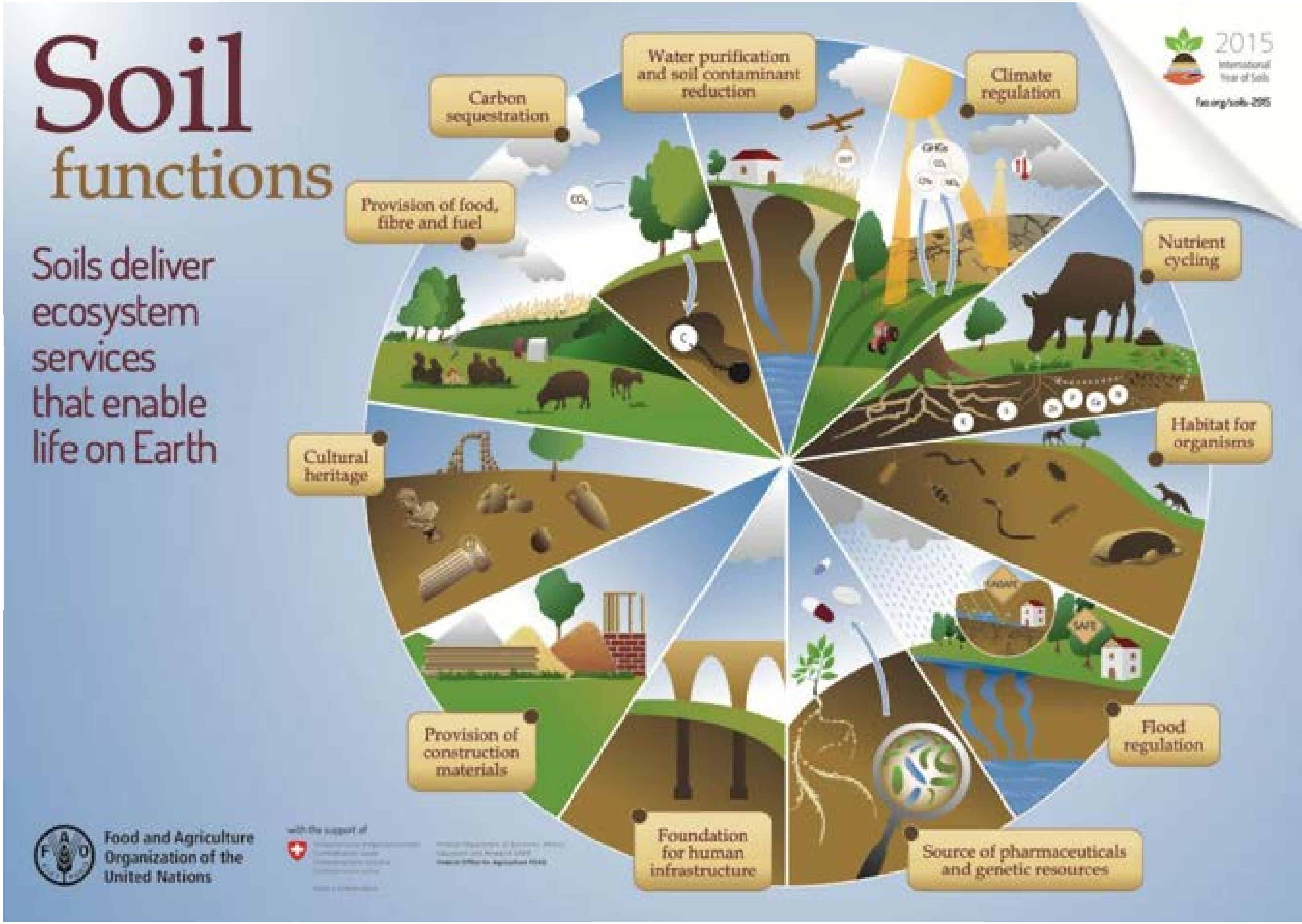
CIFOR

UNITED NATIONS DECADE ON ECOSYSTEM RESTORATION 2021-2030

Key messages

- We can translate science into action to inform decisions
- We have the tools and methods to measure and track soil health, as well as the underlying processes of land degradation
- Through stewardship, we can improve soil health
- Encouraging farmer innovation – to tailor the healthy soil practices to meet farmer needs is critical for scaling and for accelerating impact on the ground
- Public-private sector engagement is needed to bring equitable financial incentives to the famer to overcome economic barriers, for example the Coalition of Action 4 Soil Health (CA4SH)

Healthy soil provides multiple ecosystem services & functions

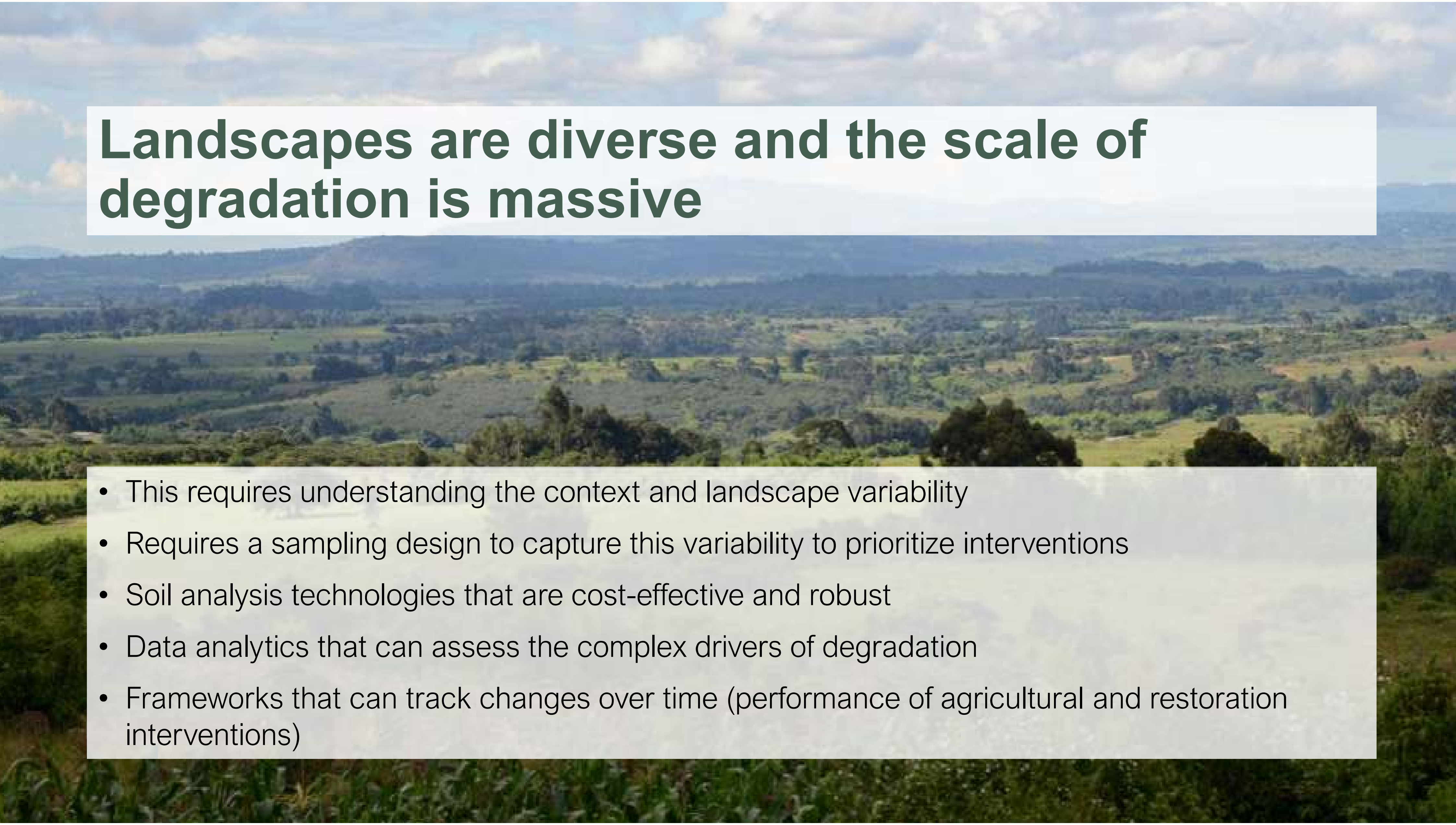



>25% of the Earth’s surface is degraded, impacting 3.2 billion people (GLO2, 2022, IPBES, 2018)
Soil erosion is the most widespread form of degradation
Photo credit Joakim Vågen

Targeted investments in soil health are urgently needed

- To reverse and prevent land and soil degradation
- To provide nutritious food
- To contribute to climate change mitigation with soil carbon sequestration
- To realize the Sustainable Development Goals (SDGs)
- To reach ecosystem restoration targets

CIFOR World Agroforestry



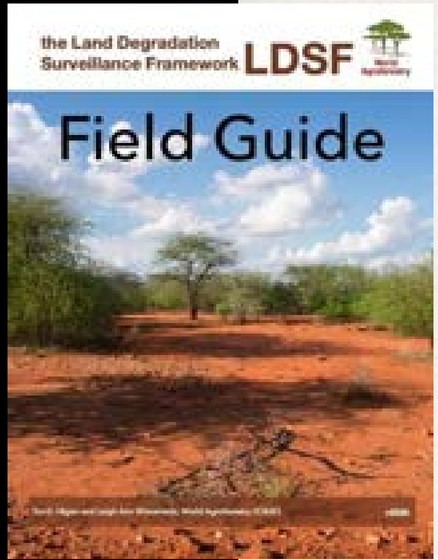
Landscapes are diverse and the scale of degradation is massive

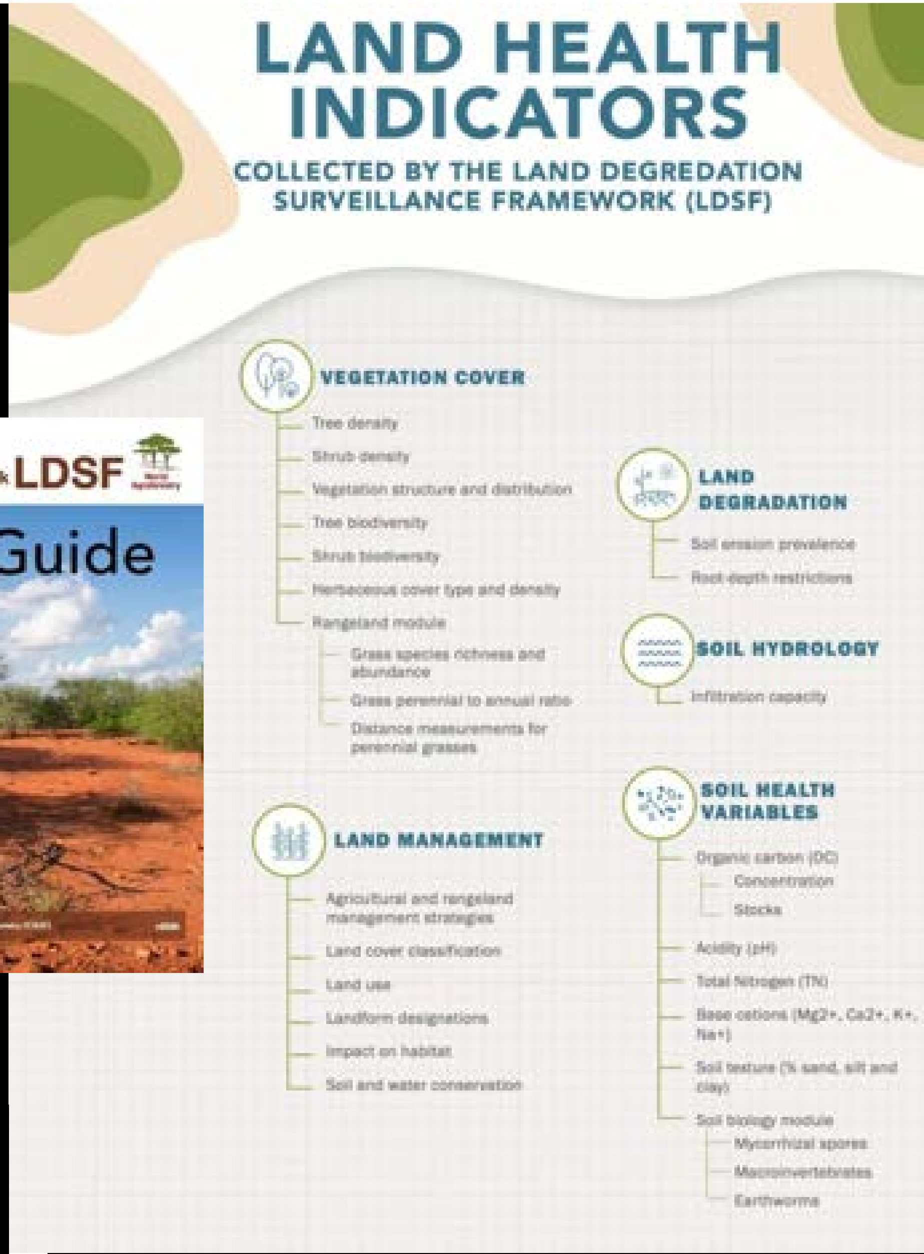
- This requires understanding the context and landscape variability
- Requires a sampling design to capture this variability to prioritize interventions
- Soil analysis technologies that are cost-effective and robust
- Data analytics that can assess the complex drivers of degradation
- Frameworks that can track changes over time (performance of agricultural and restoration interventions)

The LDSF was developed in response to the need for…

Systematic and science-based assessment and monitoring of soil and ecosystem health at scale, using a robust and consistent indicator framework to:

- Assess of variability of and conduct a rapid assessment of multiple variables across landscapes
- Conduct robust statistical analysis on drivers of degradation and relationship between variables
- Produce high quality maps of key indicators
- Set a baseline that can be used to monitor changes over time





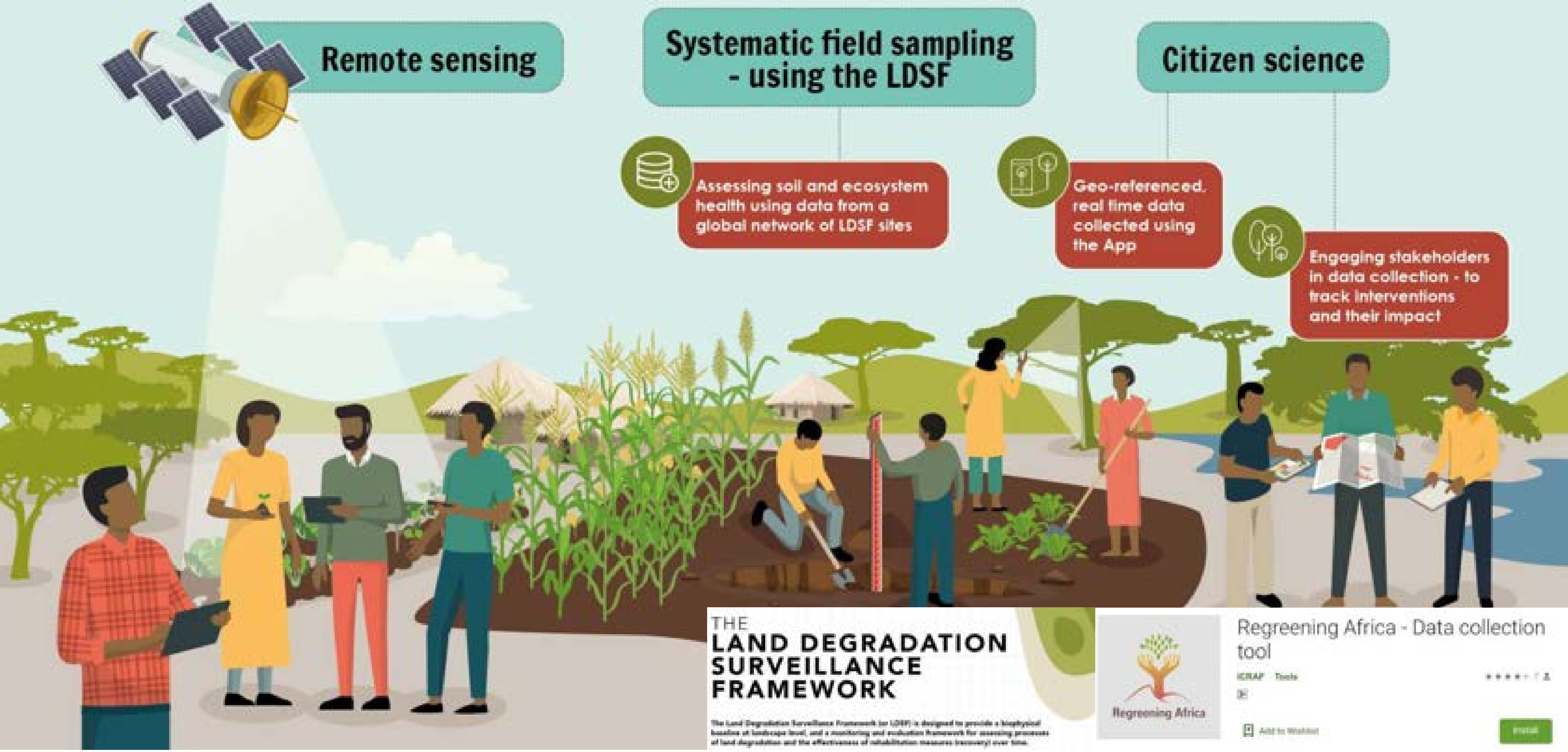
http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

Robust and rapid monitoring systems to inform and de-risk investments
For example: The Land Degradation Surveillance Framework (LDSF)

http://landscapeportal.org/blog/2015/03/25/the-land-degradation-surveillance-framework-ldsf/

Data-driven network of LDSF sites (each site is 100 km^2, with 160 sampling plots). One systematic framework across multiple projects, donors, initiatives.

By combining multiple innovative monitoring techniques, we can understand drivers of land degradation and better target and track restoration progress in real time with multiple partners



Soil organic carbon (SOC) is a key indicator of soil health

- **It influences many key processes** such as water holding capacity of the soil, overall soil fertility, and it also influences land (and agricultural) productivity.

- In addition, **it responds to management.** For example**,** poor agricultural management can decrease organic carbon in the soil, while regenerative ag practices can increase SOC.

- It is quantifiable and rapid to measure (and we can map it spatially).

- It is not the only indicator, and hence monitoring frameworks must assess multiple indicators simultaneously.

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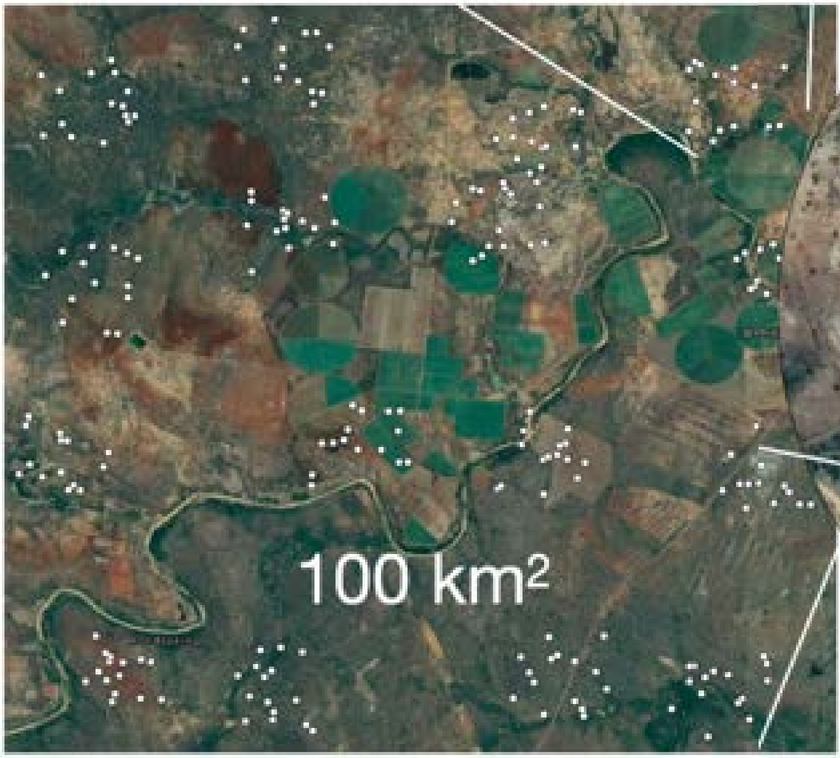
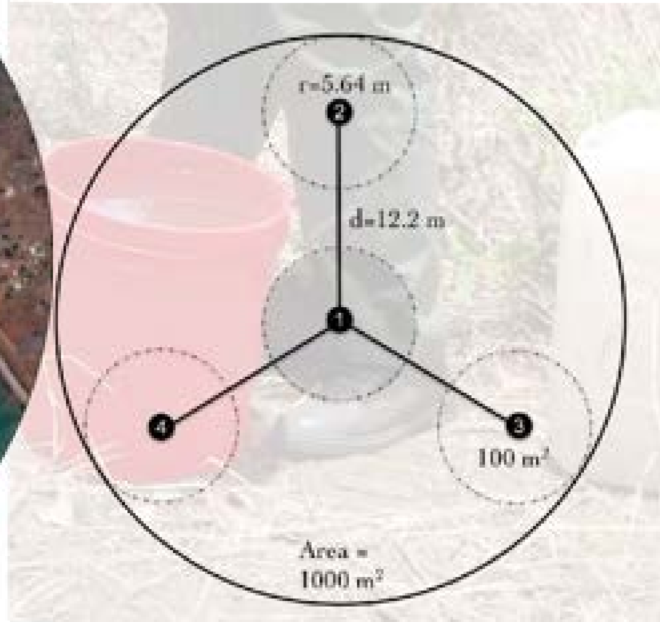
LDSF: Nested Sampling Scales

Unbiased sampling



Site Level (10km * 10km)

Cluster Level
16-1km^2 per site



Plot Level
10-1000m^2 per cluster

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Collecting Soil Samples in the LDSF

- Soil samples are collected in the field
- Soil samples are taken from each subplot (n=4) and composited at the plot level at two depths
  - 160 topsoil (0-20 cm) samples per site
  - 160 subsoil (20-50 cm) samples per site
- All soil samples are analyzed using mid-infrared spectroscopy – which enables landscape scale analysis
- Reference soil samples are analyzed using traditional wet chemistry (pH, organic carbon, total nitrogen, base cations, etc)
- Predictions are made using the spectra
- Soil cumulative mass samples (0-20,20-50,50-80,80-110 cm) for carbon stock calculations

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- MIR &NIR spectroscopy for accurate, robust, low-cost analysis of multiple properties, simultaneously
- Can be used to analyze plants, compost, manure, fertilizers, liquids and yes soil!
- Enables landscape scale sampling- which was previously limited by costs of analysis
- This has transformed research and **requires NEW skills of soil scientists**
- ICRAF has invested **>20 yrs to build a consistent spectral library (database) for a number of spectrometers**
- Investment in spectral data analytics

https://wle.cgiar.org/solutions-and-tools/science-driven-solutions/shining-a-light-on-soils-for-land-restoration/

Elvis Weullow of the ICRAF Soil and Plant Spectroscopy Lab demonstrating how to use th Spectrometer. Photo: World Agroforestry/Ann Wavinya

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MIR Spectroscopy is Accurate, Robust and Cost-efficient

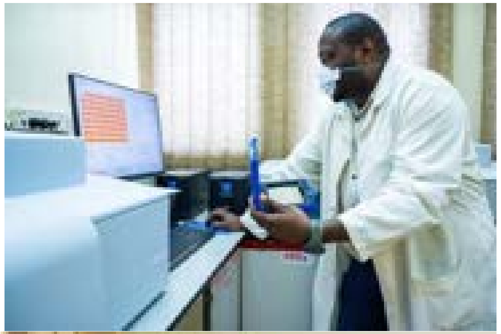

Table 1. Summary of soil properties and model results for the for the mid-infrared spectroscopy predictions.

Soil property	Range measured (range predicted)	R^2	RMSEP†
Soil organic C (g kg^{-1})	1.75–30.31 (2.41–28.10)	0.98	1.3
pH	5.32–8.28 (5.52–8.07)	0.95	0.2
Sand (%)	6.4–78.3 (9.2–72.7)	0.94	5.0
Clay (%)	12.6–76.8 (15.6–74.2)	0.97	3.6

† RMSEP, root mean squared errors of prediction.

Vågen, T., L. A. Winowiecki, W. Twine, and K. Vaughan. 2018. Spatial Gradients of Ecosystem Health Indicators across a Human-Impacted Semiarid Savanna. J. Environ. Qual doi:10.2134/jeq2017.07.0300

https://dl.sciencesocieties.org/publications/jeq/articles/0/0/jeq2017.07.0300

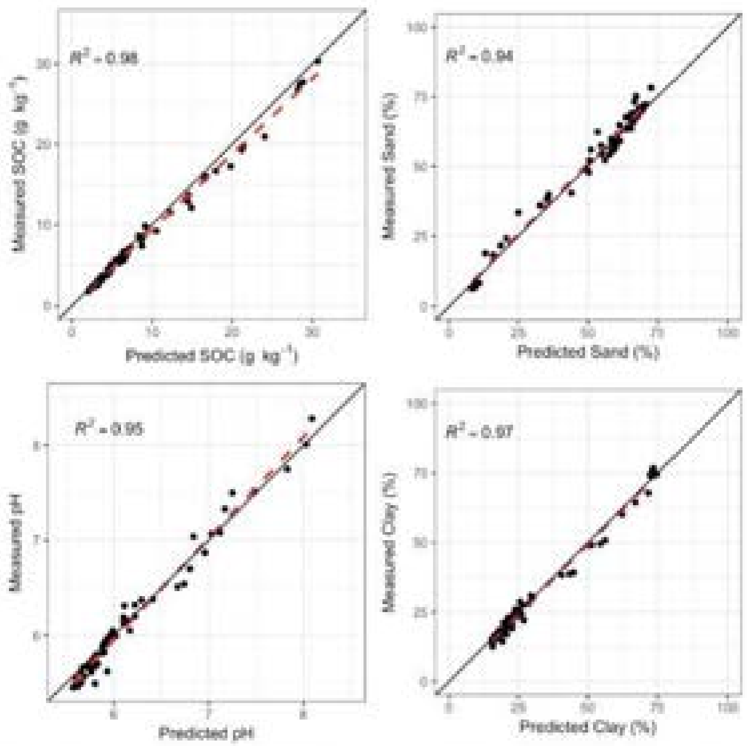

Fig. 3. Prediction results for soil organic carbon (SOC), pH, and texture according to mid-infrared spectral data from the two study sites combined. The red dashed lines represent the regression lines, and the 1:1 abline is the solid black line.

- Visit our webpage to learn more about what we are doing: https://www.cifor-icraf.org/research/theme/soil-and-land-health/

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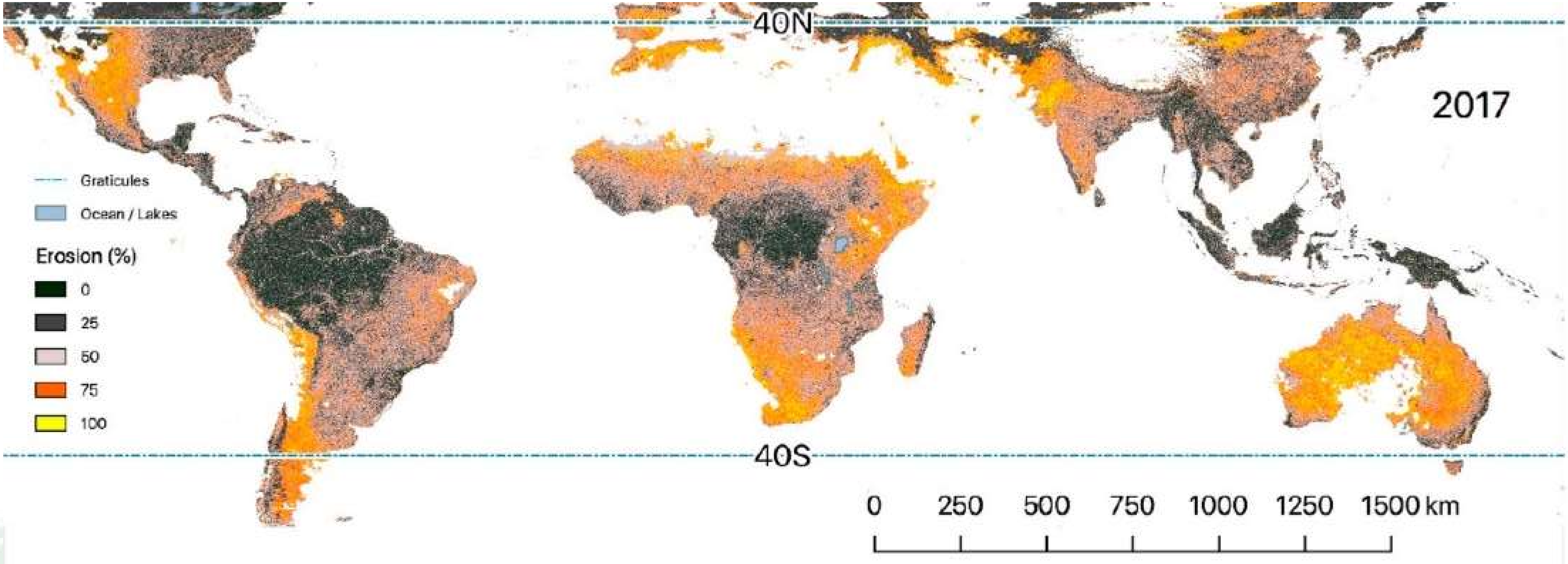
Applications of the LDSF

Photo: Kelvin Trautman

Soil erosion is a key indicator of land degradation



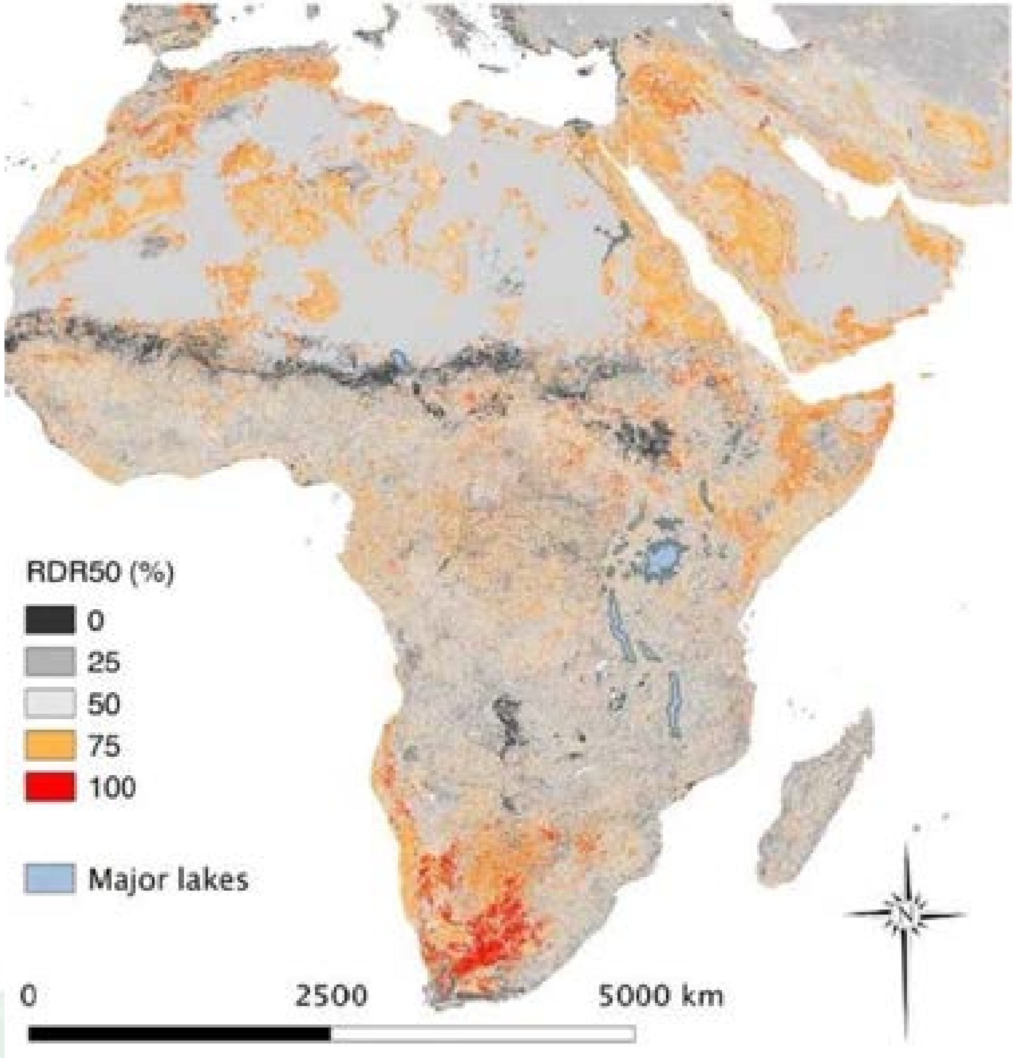
Global-level assessments for global crop and climate models

Vågen, T.-G.; Winowiecki, L.A. Predicting the Spatial Distribution and Severity of Soil Erosion in the Global Tropics using Satellite Remote Sensing. *Remote Sens.* **2019**, *11*, 1800. https://www.mdpi.com/2072-4292/11/15/1800

Mapping of Root Depth Restriction (RDR50) at 50 cm depth at 500-m Resolution

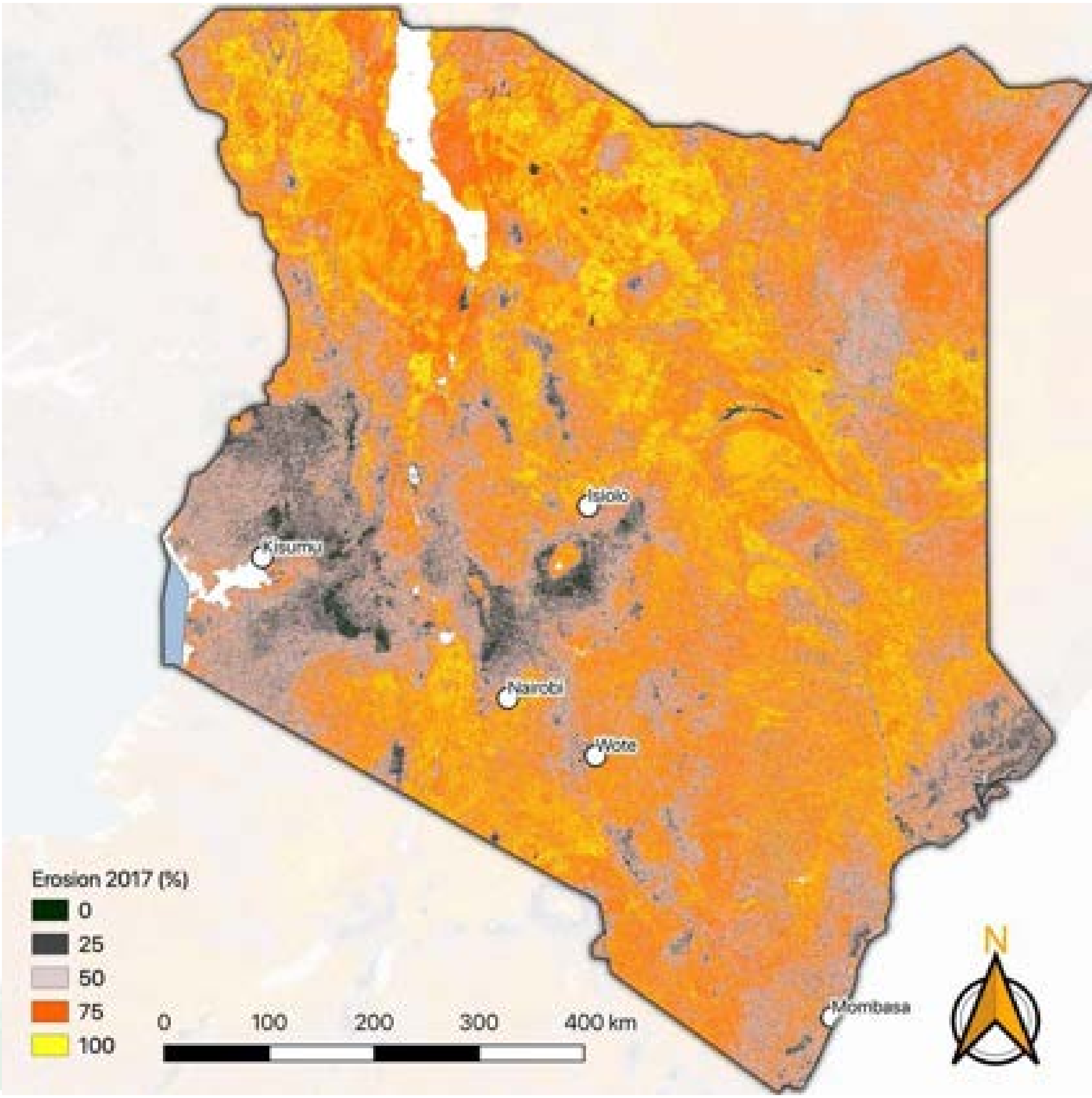
Advances in data analytics, soil spectroscopy and digital soil mapping have allowed for more accurate and real-time assessments of of soil and land health, including land degradation status.

Vågen, Tor-G., Winowiecki, L., Tondoh, J.E., Desta, L.T. and Gumbricht, T. 2016. **Mapping of soil properties and land degradation risk in Africa using MODIS reflectance.** Geoderma. http://dx.doi.org/10.1016/j.geoderma.2015.06.023
http://www.sciencedirect.com/science/article/pii/S0016706115300082



National-level Assessments for reporting on national commitments.

Example showing soil erosion in Kenya



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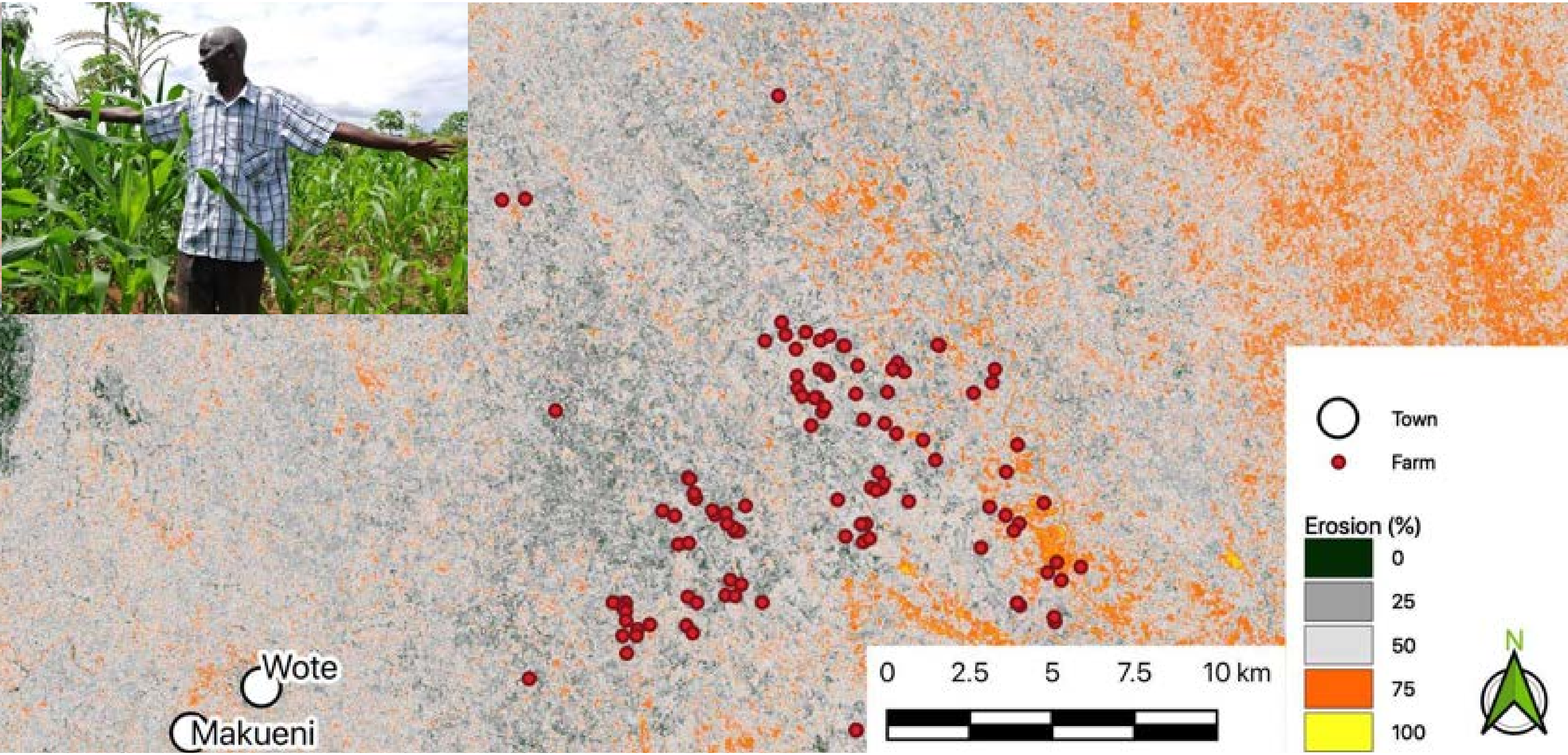
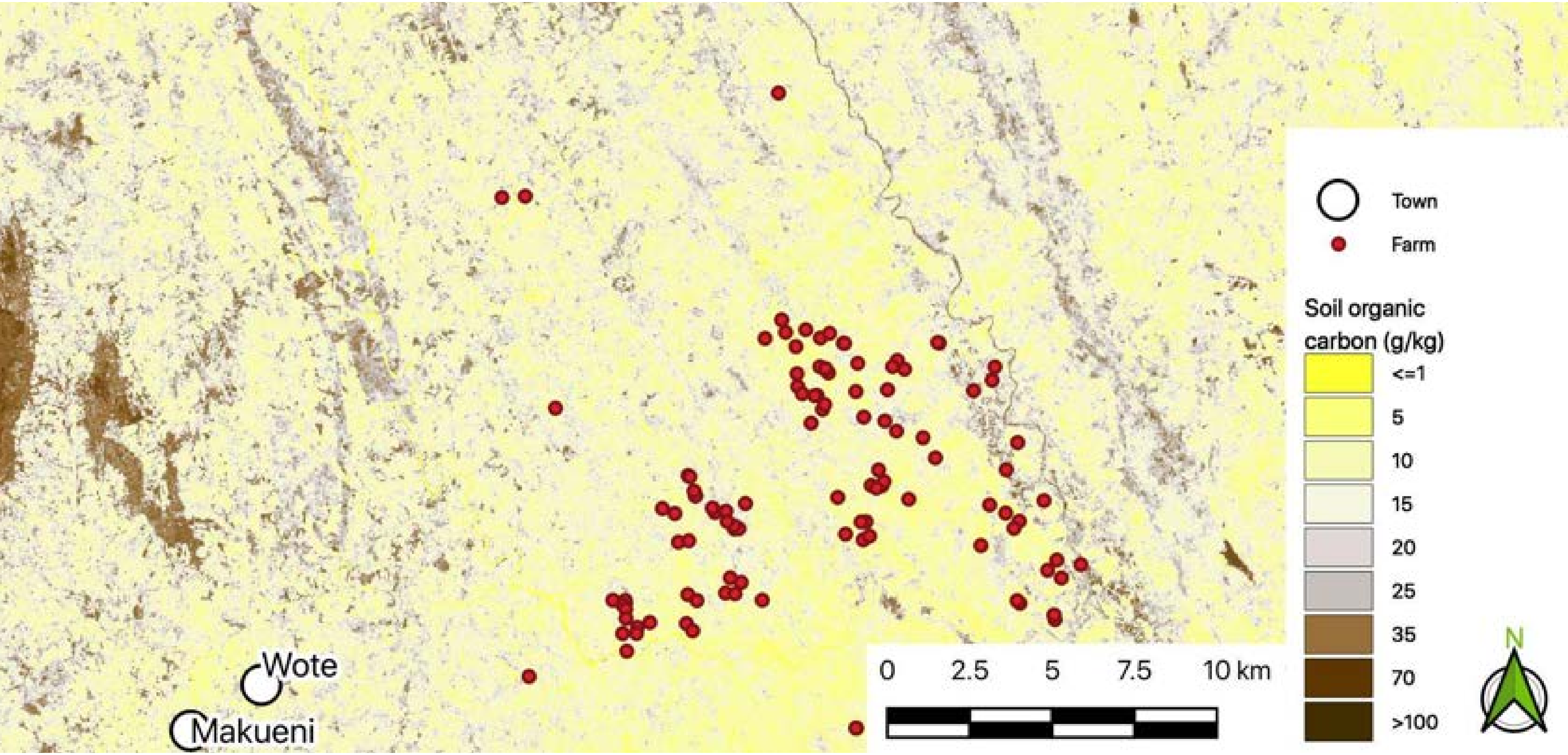
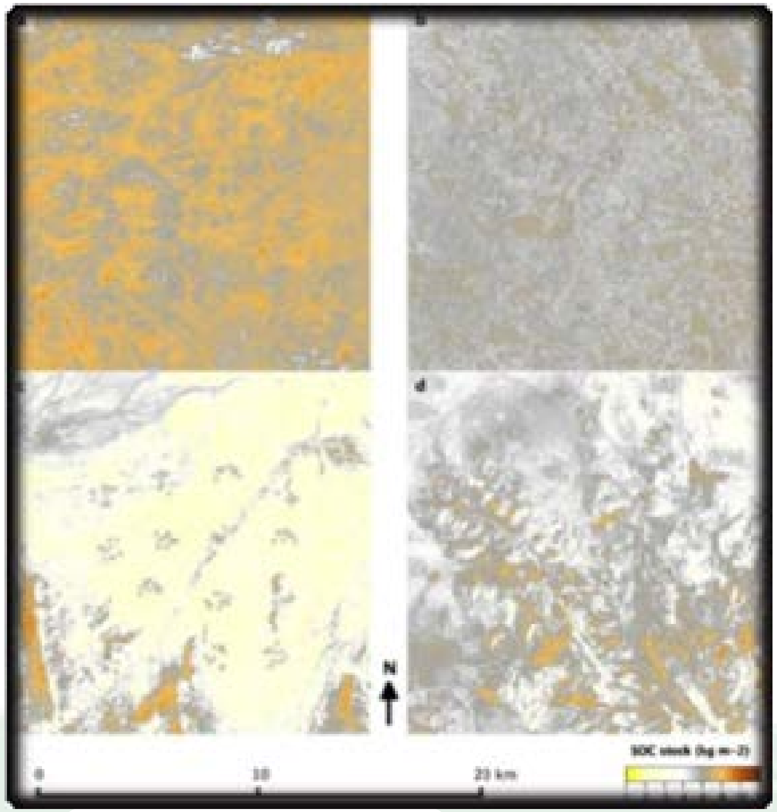
Farm-level assessments at 30 meter resolution to track what is happening at the farm/household level – impact of restoration/ management options on soil erosion



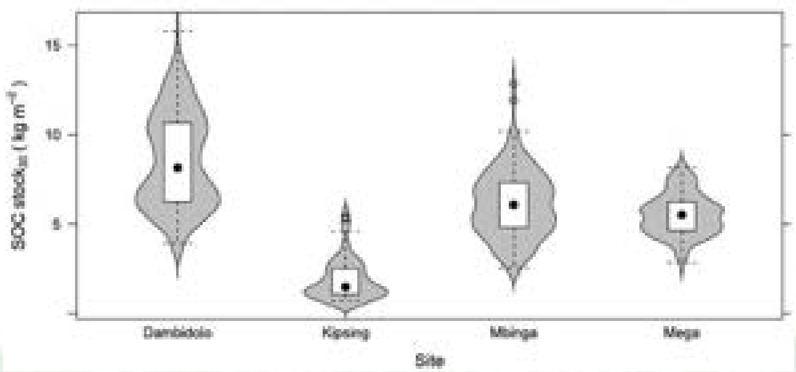
Important to assess multiple biophysical indicators at the same time to capture complexity: Example of soil organic carbon a key indicator of soil health



Example Output: Assessing Soil Carbon Storage as Potential Climate Change Mitigation Strategy



- Contrasting sites in Tanzania, Ethiopia and Kenya to demonstrate utility of method: SOC stocks to 30 cm
- To understand landscape patterns of SOC stocks
- SOC stocks are lower by 0.9 kg m^2 ($p < 0{:}01$) on average in eroded versus non-eroded areas.



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1.Vågen, T-G and Winowiecki, L. 2013. Mapping of soil organic carbon stocks for spatially explicit assessments of climate change mitigation potential. Environmental Research Letters. 8. http://dx.doi.org/10.1088/1748-9326/8/1/015011

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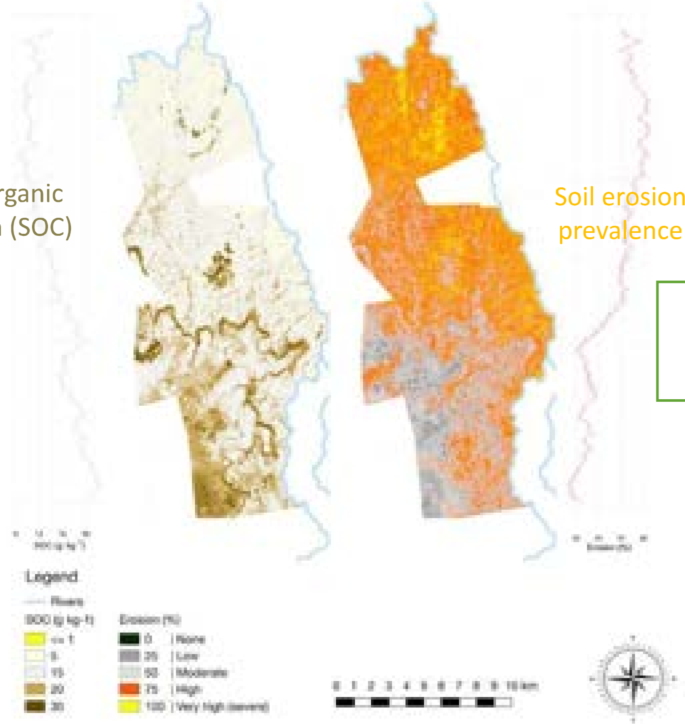
Spatially explicit assessment of priority areas for restoration: SOC and Erosion in Laikipia County, Kenya

Soil organic carbon (SOC)



Soil erosion prevalence

Restoration priority areas

https://theconversation.com/lessons-from-kenya-on-how-to-restore-degraded-land-98178

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Winowiecki, LA., Vågen, T-G., Kinnaird, MF, TG. O'Brien. 2018. Application of systematic monitoring and mapping techniques: Assessing land restoration potential in semi-arid lands of Kenya. Geoderma. https://www.sciencedirect.com/science/article/pii/S001670611830510X

Soil Organic Carbon Assessments

Spatial assessment of Soil Organic Carbon (SOC) at 30 meter resolution for Rwanda

Winowiecki, L. A., Bargués-Tobella, A., Mukuralinda, A., Mujawamariya, P., Ntawuhiganayo, E. B., Mugayi, A. B., Chomba, S., and Vågen, T.-G. 2021. Assessing soil and land health across two landscapes in eastern Rwanda to inform restoration activities, SOIL, 7, 767–783, https://doi.org/10.5194/soil-7-767-2021

Citizen science data collection using the Regreening App

https://play.google.com/store/apps/details?id=com.icraf.gsl.regreeningafrica&hl=en

Used by (among others):

- Implementing partners
- Scientists
- Extension agents
- Lead farmers
- Nursery managers

Modules:

- Tree planting
- FMNR
- Nurseries
- Training

Google Play

Translating Science into action to accelerate impact on the ground: Stories of Transformation

Mongabay Series: Global Agroforestry

Farmers regreen Kenya's drylands with agroforestry and an app

by David Njagi on 26 August 2021

- *In Kenya, less than 20% of farmland is suitable for crops due to inadequate rains and degraded soils, and many farmers have seen their land produce less to the point of needing food aid.*
- *Dried-out soils create a hard pan that rains and roots can't penetrate, but in Kenya, more than 35,000 farmers have joined the Drylands Development Programme to regreen their lands with agroforestry, joining peers in Burkina Faso, Ethiopia, Mali and Niger.*
- *By planting annual crops among useful trees like mango, orange and neem, vegetables and animal forage crops receive enough cooling shade and moisture for them to take hold out of the scorching sun.*
- *As each farmer learns what combination of crops and trees works for them, the results are rapidly shared with researchers and fellow farmers through an app, speeding the rate at which all the program participants can benefit from the knowledge.*

https://news.mongabay.com/2021/08/farmers-regreen-kenyas-drylands-with-agroforestry-and-an-app/

https://www.cifor-icraf.org/restoration-for-resilience/dryland/

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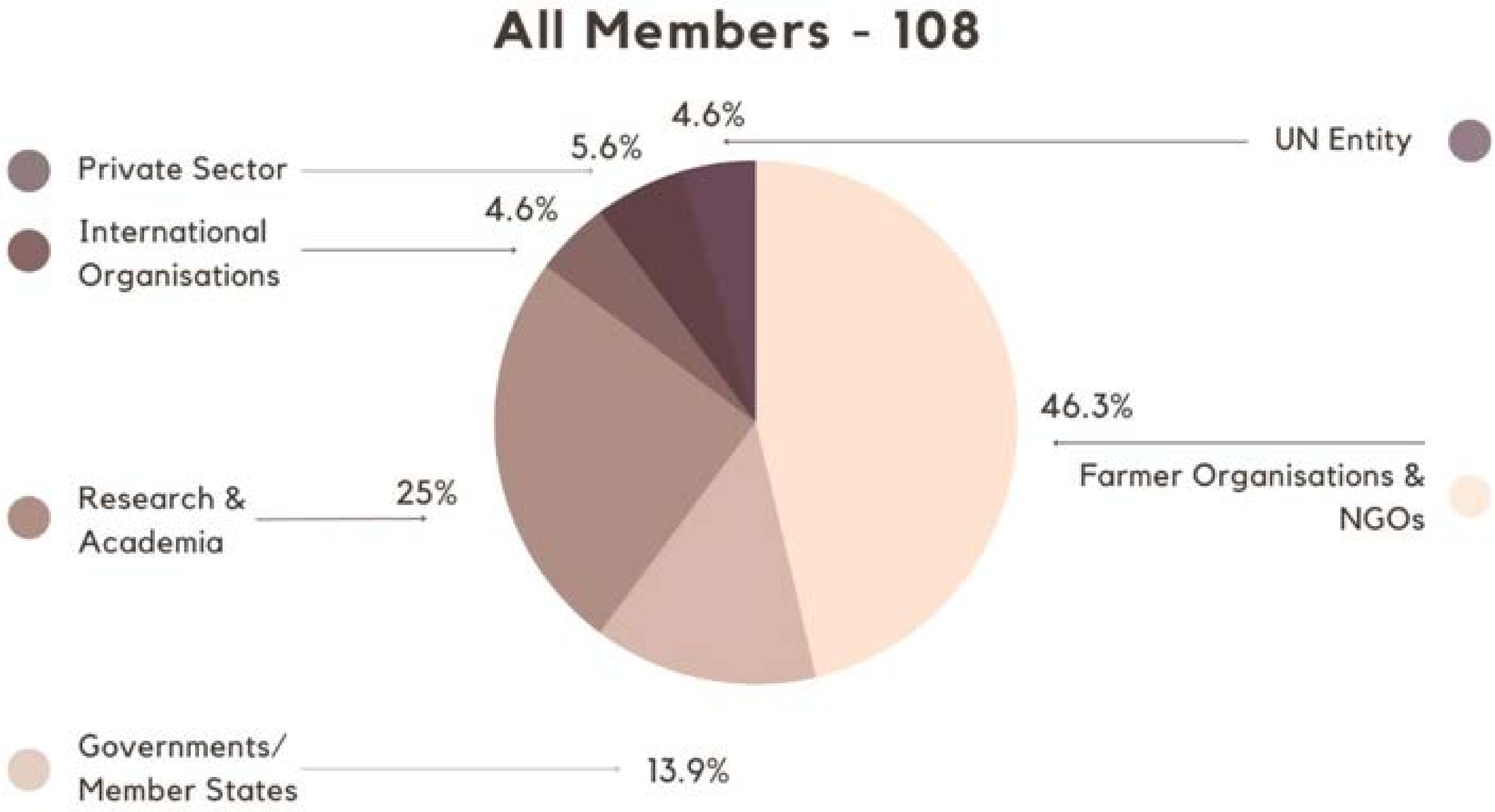
CA4SH Update

June 2022


CA4SH
COALITION OF ACTION 4 SOIL HEALTH
The main objective of the Coalition of Action 4 Soil Health (CA4SH) is to improve soil health globally by addressing critical implementation, monitoring, policy, and investment barriers that constrain farmers from adopting and scaling healthy soil practices
The goals of the Coalition include:
Integrate soil health considerations in policy across the development, environment, and climate change domains, and along value chains.
Expand on research in development into soil health practices, monitoring and evaluation, and financial tools and mechanisms.
Significantly increase the number of hectares of land under improved practices for soil health.
Significantly increase investments in soil health, by a margin of 5-10 fold above current financing commitments.

CA4SH MEMBERS - JUNE 2022



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WHAT DOES SUCCESS LOOK LIKE BY 2025

2022

1

MAINSTREAMING OF SOIL HEALTH

Inclusion of soil health in major declarations, including UNCCCD, UNFCCC, UNFCCC, UNEA, CFS as well as national strategies (NDCs, Agricultural policies, etc

2

ACTING LOCALLY

Identify champions in each region - as policy focal points, implementation and co-learning focal points.

3

FARMERS AT THE CENTER

An inclusive system. Highlighting flagship (lighthouse) projects/farms that represent the principles of CA4SH. Doubling the reach of soil health on the ground.

4

FINANCIAL INVESTMENTS

Increasing the financial investment in soil health by 5-10 fold.

5

SOCIAL LEARNING & NETWORKING

Building on existing knowledge and learning from other initiatives. Putting together information on projects/initiatives that are taking place to inspire each other.

6

SOIL HEALTH INDICATORS

Agreeing on a common set of soil health indicators.

7

BETTER DATA

Translating science into action through improved monitoring of soil health. Creating accessible data and information on the benefits of investing in soil health.

8

SECURED FUNDING

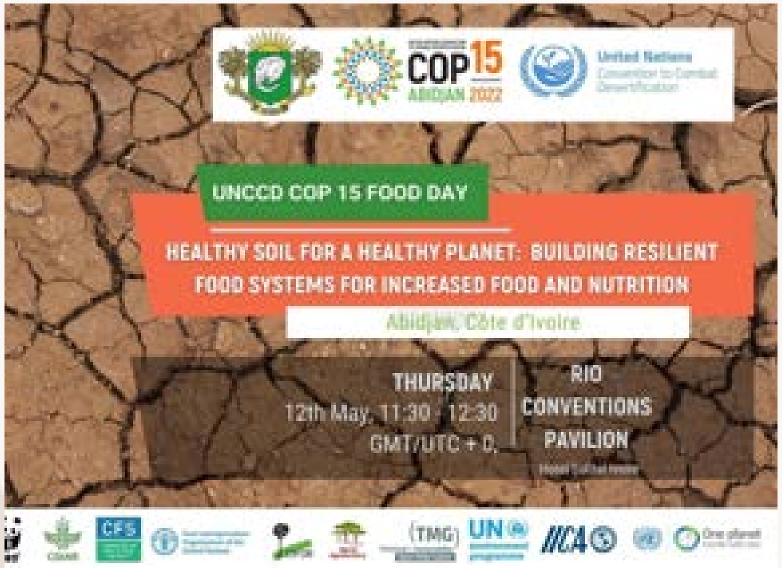
Joint funding proposals with partners to mobilise resources for CA4SH.

2025

CA4SH AT UNCCD COP 15

CA4SH organised **two** events at UNCCD COP15:

- Food Day Session - **Healthy Soil for a Healthy Planet: Building Resilient Food Systems for Increased Food and Nutrition**, 12th May, Rio Pavilion
- **Multi-stakeholder action for scaling Soil Health globally through evidence-based public and private investment**, 13th May



CA4SH Website, Newsletter, Social Media @ca4sh_global

Website launched: coalitionforsoilhealth.org

Monthly Newsletters

SOIL HEALTH RESOLUTION @ COP 27

- CA4SH with partners have drafted the Soil Health Resolution
- The Soil Health Resolution will be taken forward at the UNFCCC COP 27
- CA4SH has reached out to members states, as well as NGOs and research institutions
- Read the Resolution here: https://www.coalitionforsoilhealth.org/resource-library/soil-health-resolution-of-soil-champions-at-cop27
- Reach out to countries, contacts, member states!
- coalition4soilhealth@gmail.com

COP27
SHARM EL-SHEIKH
EGYPT 2022

Key messages

- Through stewardship, we can improve soil health.
- Scaling investments in soil health are urgently needed
- Public-private sector engagement is needed to bring equitable financial incentives to the famer to overcome economic barriers
    - Coalition of Action 4 Soil Health (CA4SH) may be able to fill key gaps but extended partnerships and action on the ground is needed
- Encouraging farmer innovation – to tailor the healthy soil practices to meet their needs is critical for scaling and for accelerating impact on the ground.
- We have the tools and methods to measure and track soil health at scales relevant to multiple stakeholders and at the cost and accuracy
- We can translate science into action to inform policy and decisions

Thank you!

Leigh Ann Winowiecki L.A.Winowiecki@cgiar.org
Tor-Gunnar Vågen T.Vagen@cgiar.org

Check out CIFOR-ICRAF Soil and Land Health Webpage for videos, brochures, and more:
https://worldagroforestry.org/landhealth
Video: Scaling ecosystem restoration in agricultural landscapes:
https://youtu.be/qvf0drWdTq4
AlJaZeera Earthrise special: http://youtu.be/vFMSEHV7Ap4

cifor.org | worldagroforestry.org

foreststreesagroforestry.org | globallandscapesforum.org | resilientlandscapes.org

The Center for International Forestry Research (CIFOR) and World Agroforestry (ICRAF) envision a more equitable world where forestry and landscapes enhance the environment and well-being for all. CIFOR-ICRAF are CGIAR Research Centers.

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Global Landscapes Forum Resilient Landscapes

Research for the development of healthy soil for farmers to realize food security

Satoshi Nakamura
Japan International Research Center for Agricultural Sciences

JIRCAS
国際農研

Contents

1. Introduction of JIRCAS

2. Our consideration for RA for Africa

3. Potential technologies which can contribute to soil health from our activities

4. Toward soil health enhancement in Africa

Japan International Research Center for Agricultural Sciences

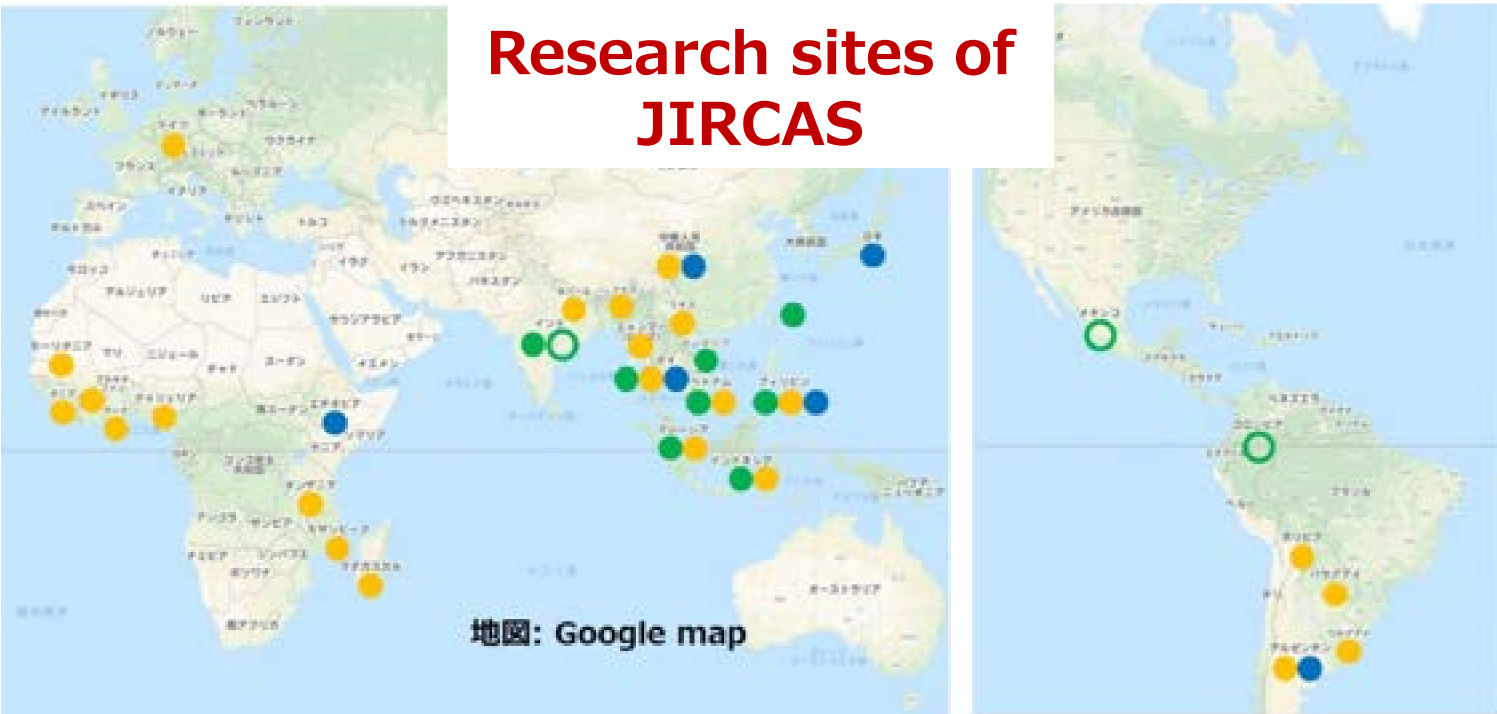
plays a key role in international collaboration in the field of agriculture, forestry and fisheries research, with the aim of providing solutions to global environmental problems, food insecurity, and extreme poverty.

Vision

- **Solving global food and environmental issues**
- **Functioning as a core center**

1970	Establishment of the Tropical Agriculture Research Center (TARC) by the Ministry of Agriculture and Forestry
1993	Reorganized as the Japan International Research Center for Agricultural Sciences under the umbrella of the Ministry of Agriculture, Forestry and Fisheries (MAFF)
2015	Restructured as a National Research and Development Agency
2016	Beginning of Fourth Medium to Long-Term Plan
2020	**50th anniversary**
2021	Beginning of Fifth Medium to Long-Term Plan

Research sites of JIRCAS



Research programs

- **Environment**
- **Food**
- **Information**

Common challenges and directions of expected change in African savanna food systems

- Low productivity due to low soil fertility
- Unstable production due to unstable seasonal rainfall
- Few options of crops and agricultural techniques
- Shortage of human resources for research and dissemination

- Soil health enhancement against further degradation/ erosion
- Establishment of resilient agriculture
- Tech. development dealing with increasing demand and changing food needs
- Capacity buildings for new research and dissemination procedure

Technologies for contributing to soil health enhancement in Africa

1) Technology should be practicable by farmers

Fallow Band System (FBS)

2) Technology should be beneficial for farmers

Farmers applicable CA options

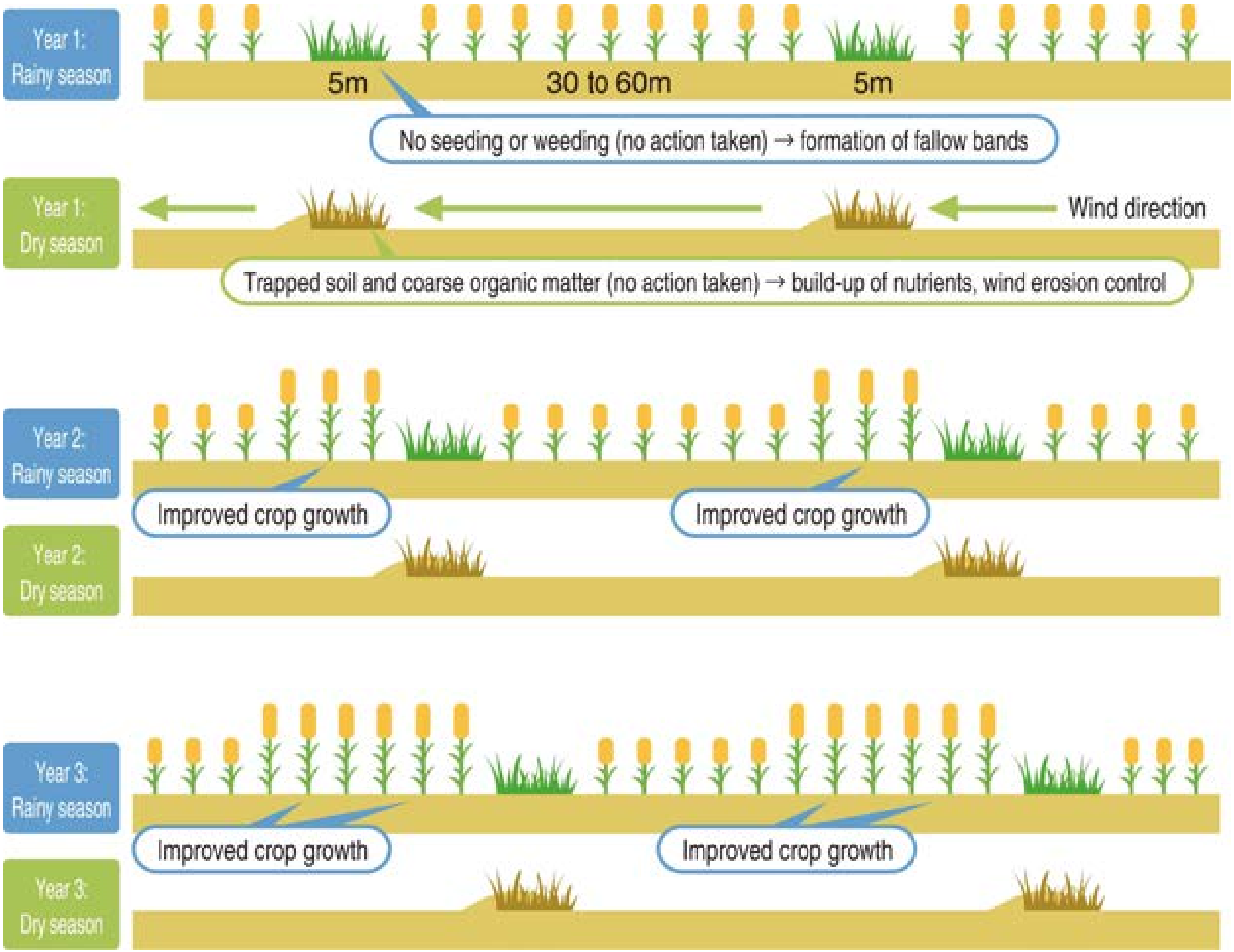
3) Technology should utilize local materials for farmers

African local phosphate rock utilization

Fallow Band System (FBS)

- Initially developed to control soil erosion by wind and increase crop production
- Simple and does not require additional costs or labor from local farmers
  (Ikazaki et al. 2011; Ikazaki 2017)
- Selected as a promising countermeasure
  by FAO Global Soil Partnership

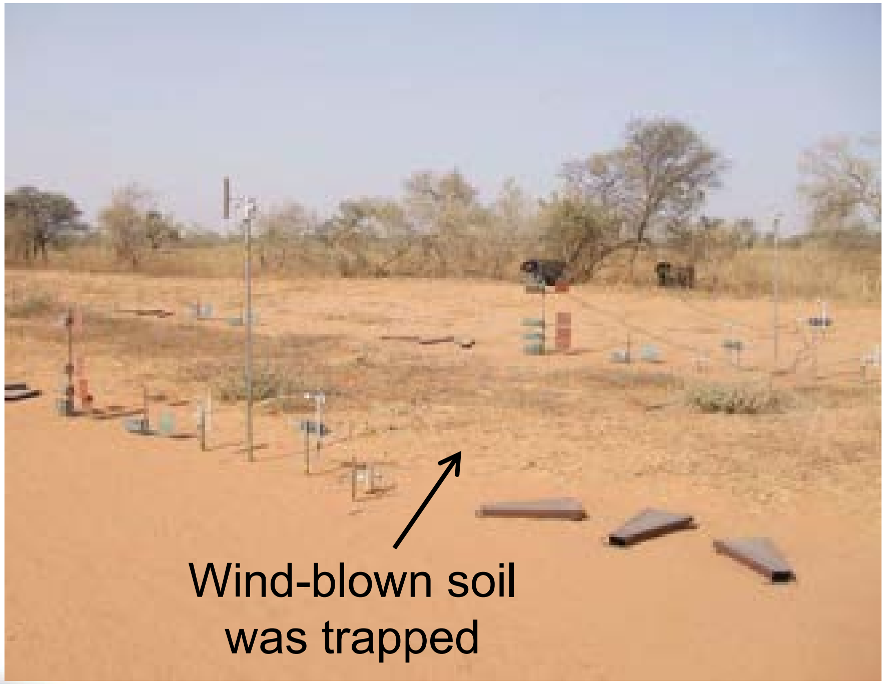
Fallow Band System (FBS)



Fallow Band System (FBS)

- Four-year on-station and on-farm trials showed that
  - FBS controlled wind erosion by > 70%
  - FBS increased crop production by 36–81%

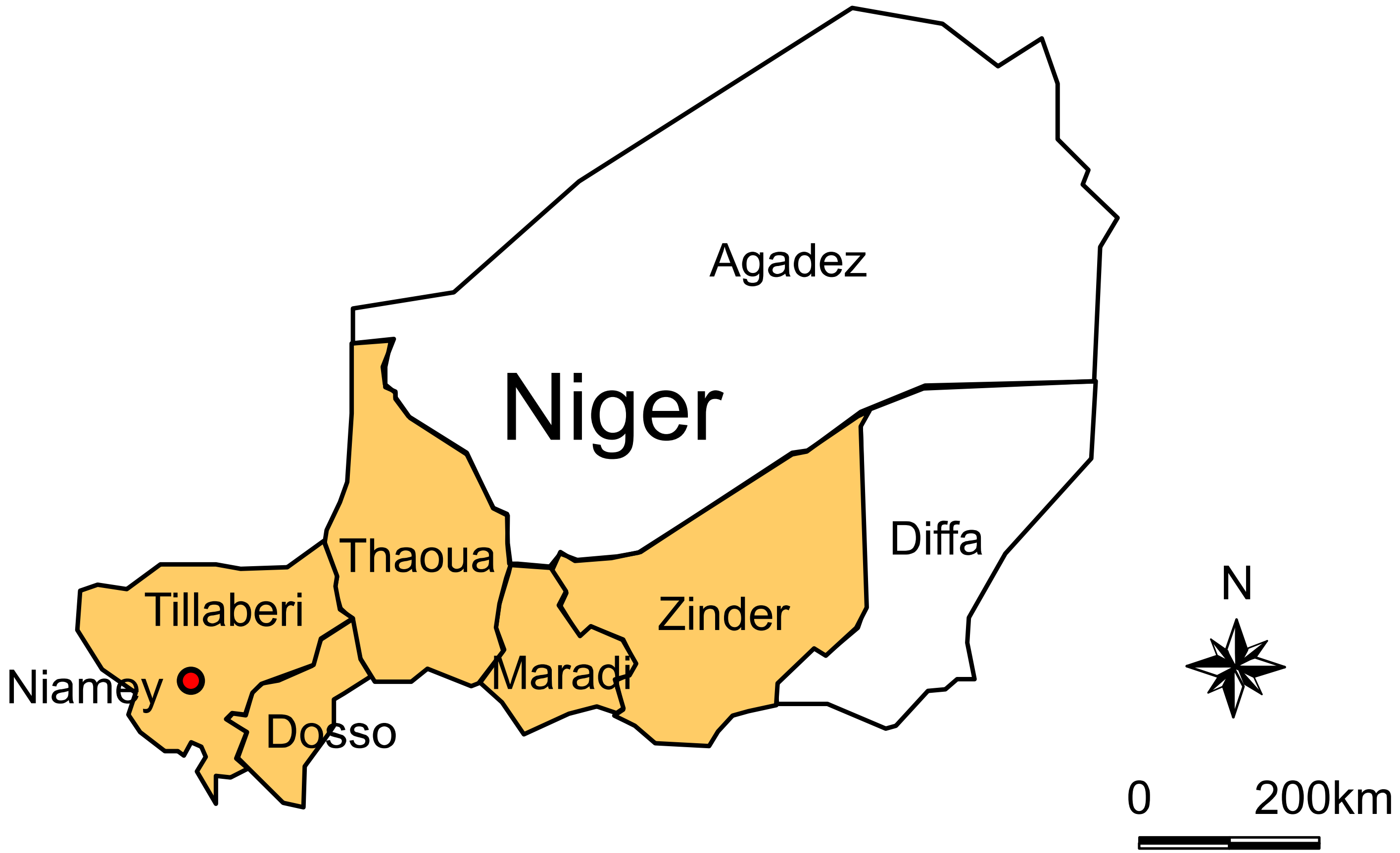
- Effects on water erosion control and crop production are being evaluated in Burkina Faso



JIRCAS 国際農研

Fallow Band System (FBS)

- adopted by farmers in 89 villages, 23 districts, and 5 regions in 2010-2012
- 74% of the farmers continued FBS in 2016



Conservation Agriculture (CA) research in West Africa (2011-2015)

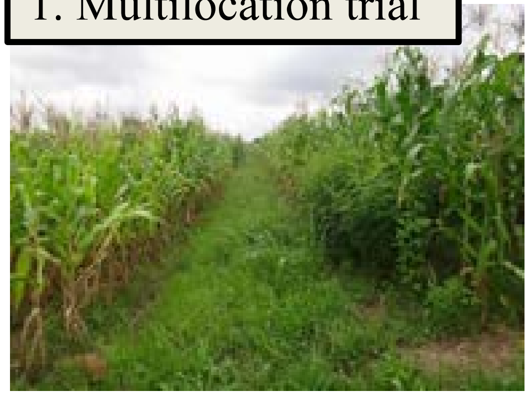
CA: Three principles

Minimum tillage by ripper

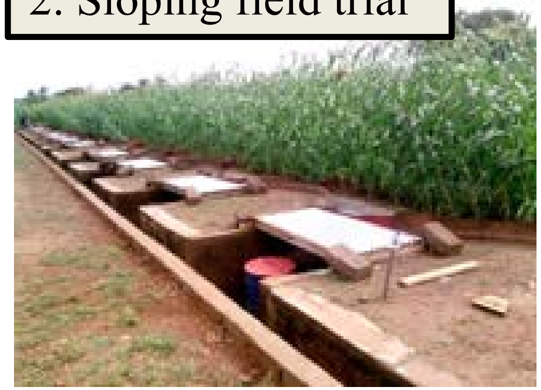
Residue Mulch

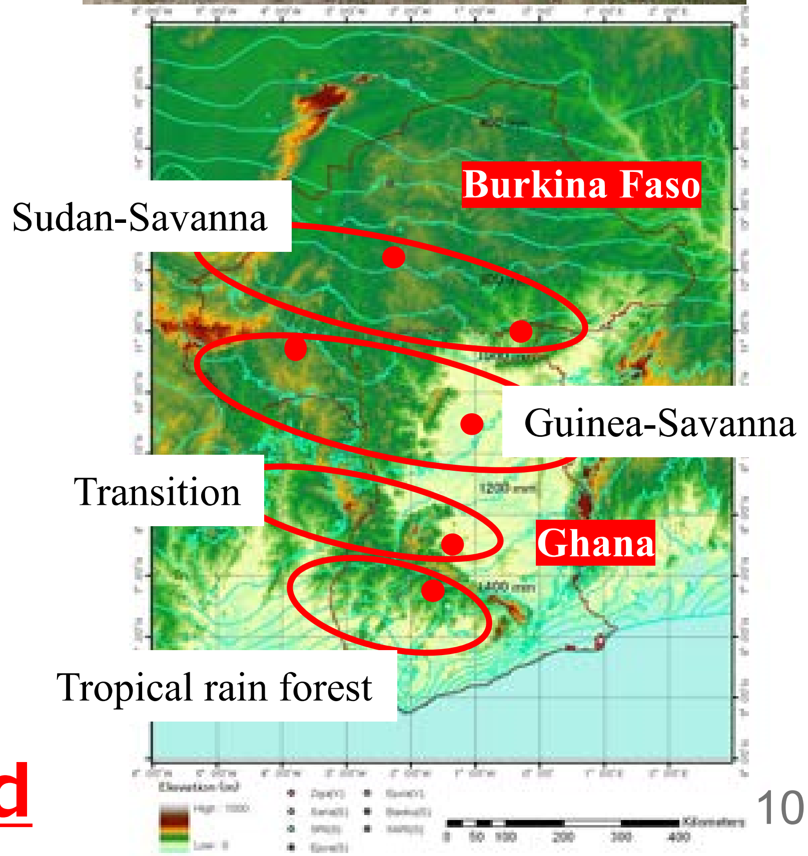
Pigeon pea intercrop (alley)

1. Multilocation trial



2. Sloping field trial

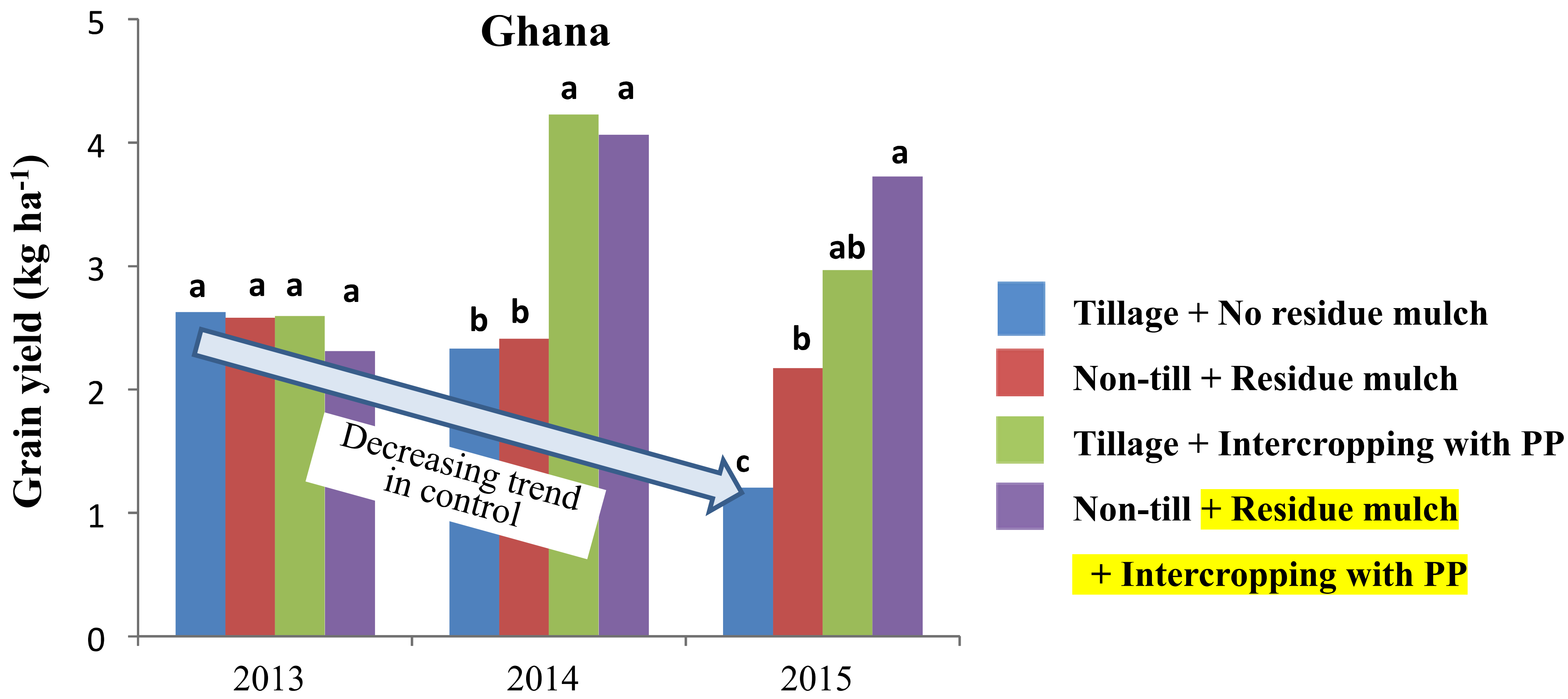




Effect on yield and on soil and water conservation was evaluated

Conservation Agriculture (CA) research in West Africa

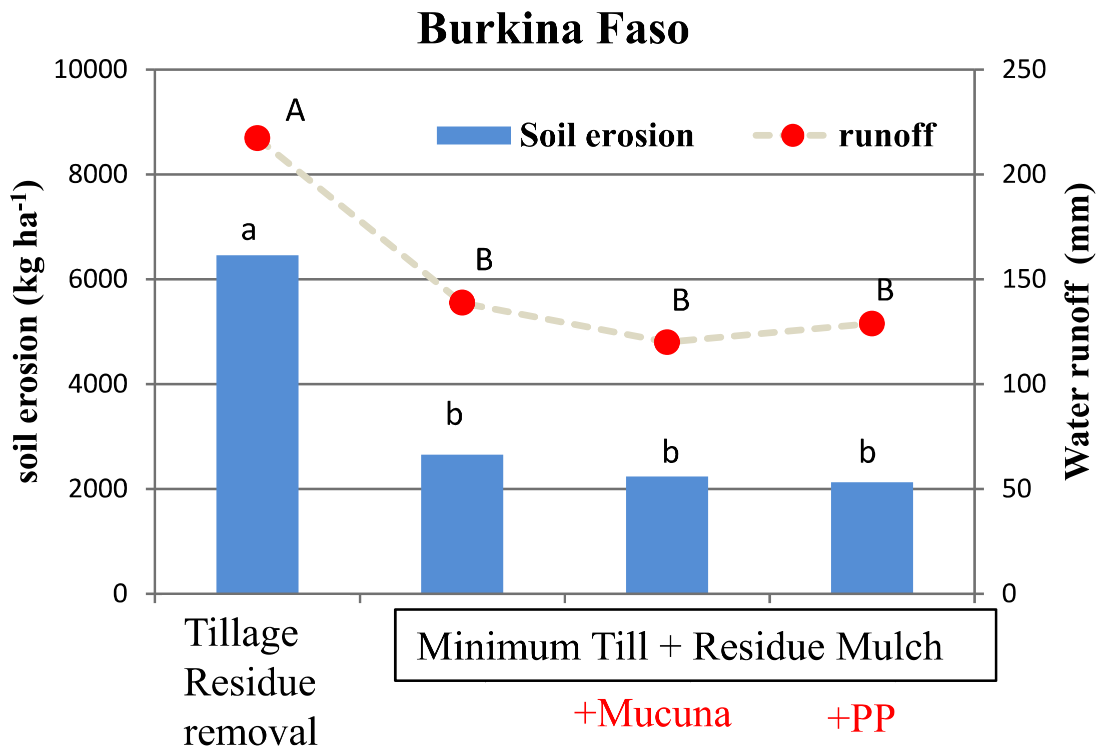
Effect of CA on the yield



- **Pigeon pea intercropping is highly effective** to increase the yield of maize and cowpea
- However, it requires more labor for pruning to avoid competition

Conservation Agriculture (CA) research in West Africa

Effect on soil and water conservation



*** To prevent soil erosion, minimum tillage + residue mulch is enough.**

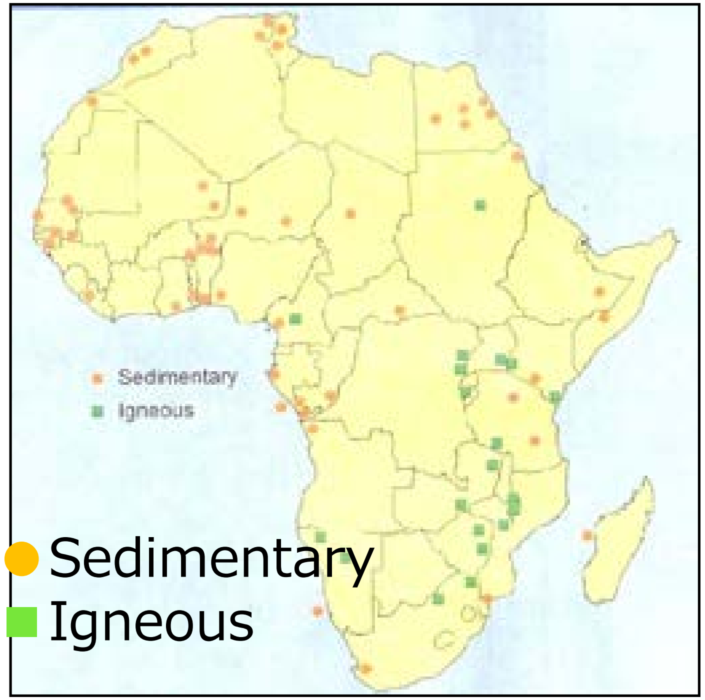
Ikazaki et al.(2018)

Measurement of soil erosion & water runoff

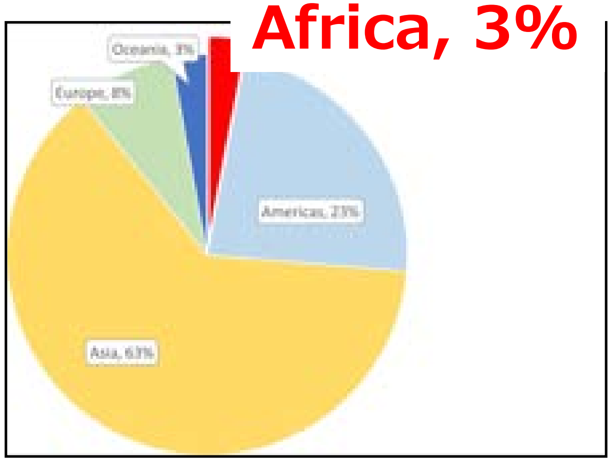
Conclusions

- **Perennial pigeon pea intercropping (alley) is one of the promising CA components in the south from Guinea-Savanna zones.**
- **Soil and water conservation can be achieved by the combination of Non (or minimum) tillage with residue mulch.**

Local phosphate rock utilization



PR deposits in Africa FAO(2004)



Percentages of P resource use in the world(FAOSTAT, 2015)

Abundant P resources in Africa

P resource reserve in the World and Africa

	PR reserve		Production in 2015 (Million ton)	
World	**69,546**		**221**	
Africa	**56,930**	**82%**	**46**	**21%**

USGS(2015)

82% of the world P reserve is allocated in Africa. But the rate of utilization is just 3% of the world.

- Further, huge low-grade PRs have been found in Africa

⇒**Unutilized**

Local phosphate rock utilization

Different P fertilizers from Burkina Phosphate Rock

Type	Appearance	Method of fabrication	Merit Demerit
Phosphate rock powder		Pulverize raw Phosphate rock	Very low-solubility -Cheap price
Partially acidulated Phosphate rock (PAPR)		React with sulfuric acid	Fast-acting -Sulfur supply -Risk of soil acidification -Risk of heavy metal contamination
Calcinated Phosphate rocks (CPRs) *New Method!*		Add Carbonate （K, Ca, Mg, etc.), then calcinate the mixture with high temperature	Slow-acting - K and Ca supply - No risk of soil acidification - Capable to remove heavy metals from PR

Local phosphate rock utilization

Yield Improvement by Direct Application of Low-Grade Phosphate Rocks in African Rainfed Rice

Outline

Direct application of low-grade phosphate rock (PR) to rainfed rice is effective in West Africa. Significant differences were observed among the different agroecological zones (AEZ) in the first year. In all AEZs, residual effects of PR applied in the previous year can be expected, and the optimal application pattern depends on the level of residual effect.

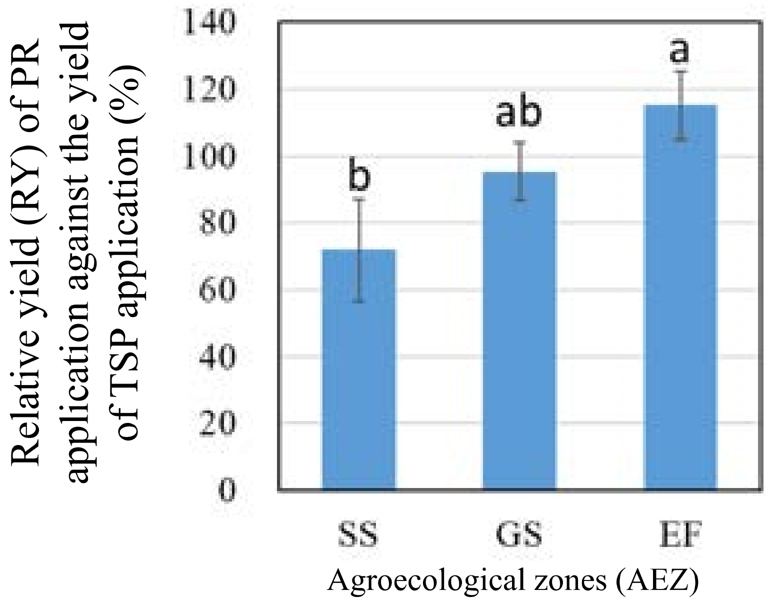


Fig 1 First-year application effect of PR under each agroecological zone

Even reducing the frequency,

SS, GS: Twice every three years
EF: Once every three years

PRDA can obtain similar yields to annual applications, thanks to the residual effect.

Local phosphate rock utilization

Fertilizer production using African local low-grade phosphate rock through calcination technology

Outline

African low-grade phosphate rocks (PRs) can be fertilized by calcination with alkali addition. The application effect of the P fertilizer obtained by calcination with the addition of potassium carbonate is equivalent to that of triple super phosphate (TSP), a commercially available fertilizer.

Fig. 1 Equipment for Fertilizer production installed on site

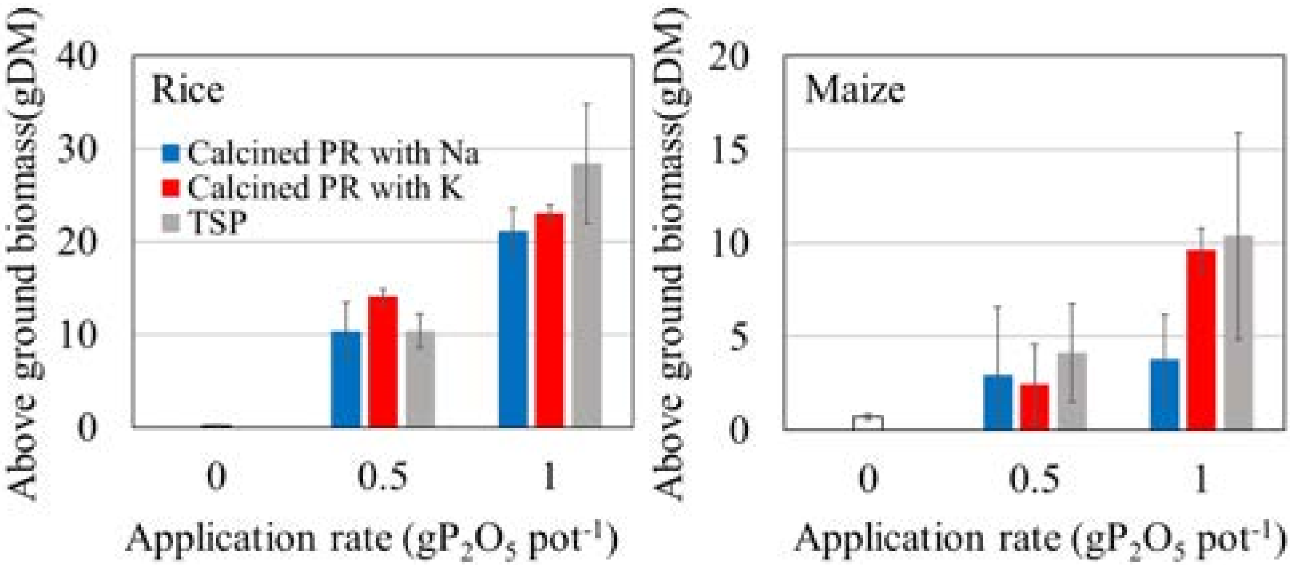


Fig. 2 . The application effect of calcined PRs on rice and maize

Technologies for contributing to soil health enhancement in Africa

1) Technology should be practicable for farmers

Despite a good technology, it is useless if it is not practicable for farmers; **we need to aim to develop practicable technologies like Fallow Band System（FBS）**．

2) Technology should be beneficial for farmers

Although technical packages have a positive effect on soil health strengthening, **it should contribute to the improvement of yield and/or farmer’s income**, to disseminate technology.

3) Technology should utilize local materials for farmers

Technology for soil health enhancement should utilize local materials, such as organic resources and local PRs, to reduce its cost and ensure applicability and accessibility.

Toward soil health enhancement in Africa

Need to strengthen sustainable productivity and restore soil health

Achieving truly sustainable food security in African savannas requires sustained productivity gains and restoration of soil health

No one size fits all

Need to consider technological development and extension methods for smallholders that take into account local edaphoclimatic and socioeconomic conditions.

Develop sustainable technologies and capacity buildings

Need to validate and develop practical sustainable technologies based on scientific findings in model countries in dry and wet savannas, and train human resources for their deployment.

A partnership among government, development, research, and extension sectors is essential in order to achieve social-scale impacts.

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