Gaps and opportunities for further research

Sieg Snapp, SAS, CIMMYT

Opportunities

Changing World

Environment

Soil-Plant-Human Nutrition

Livelihoods

Global Challenges

Wicked problems and how to solve them

Participatory Research for Sustainable Intensification

High

Value Conflict

Low

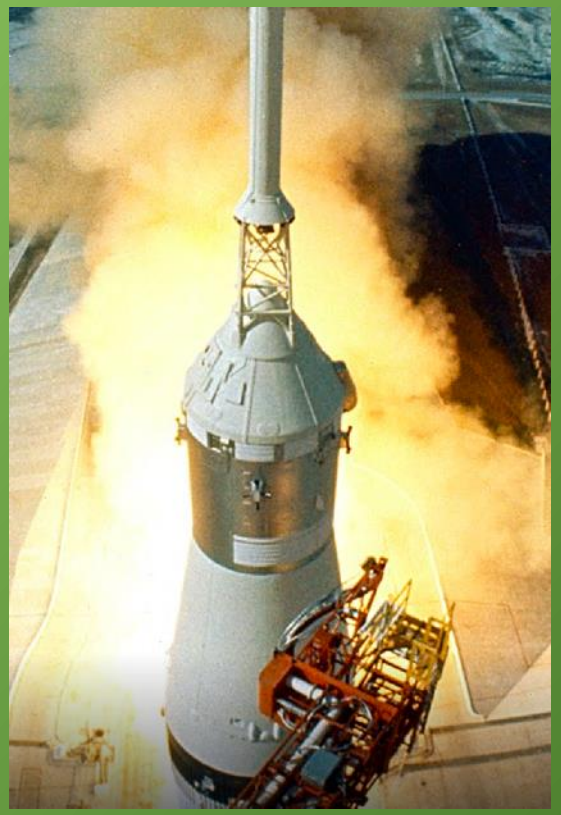
Wicked Problems
(Participatory Research)

Tame Problems
(Conventional component research)

Low

Uncertainty

High



Wicked problems: Agricultural systems are complex, with high uncertainty and value conflict, **not suited to reductionist component science**

Participatory research:

- **Relevance - Local priorities and context**
- **Engagement -** Who defines goals, approaches and indicators of success, co-learning cycles
- **New Knowledge and Adaptation -** Technologies, capacity and **knowledge**

Relevance

Research stations differ from farms

- Soil type, management, & management history
- **Seek to understand** on-farm variation and farmer goals rather than attempting to control all variables

Co-ID of problems: Degraded soil, poor nutrition

Plan: Plausible options identified

Act: Test options, exchange ideas, co-learn

Observe: monitor jointly

Reflect: Dialogue, synthesis, re-fine options

Iterative cycle: Novel options, New knowledge

Snapp et al., 2022 Frontiers in Ecology & the Environment

Semi-perennial

High Food Security

Low Food Security

Pigeonpea
(*Cajan cajanus*)

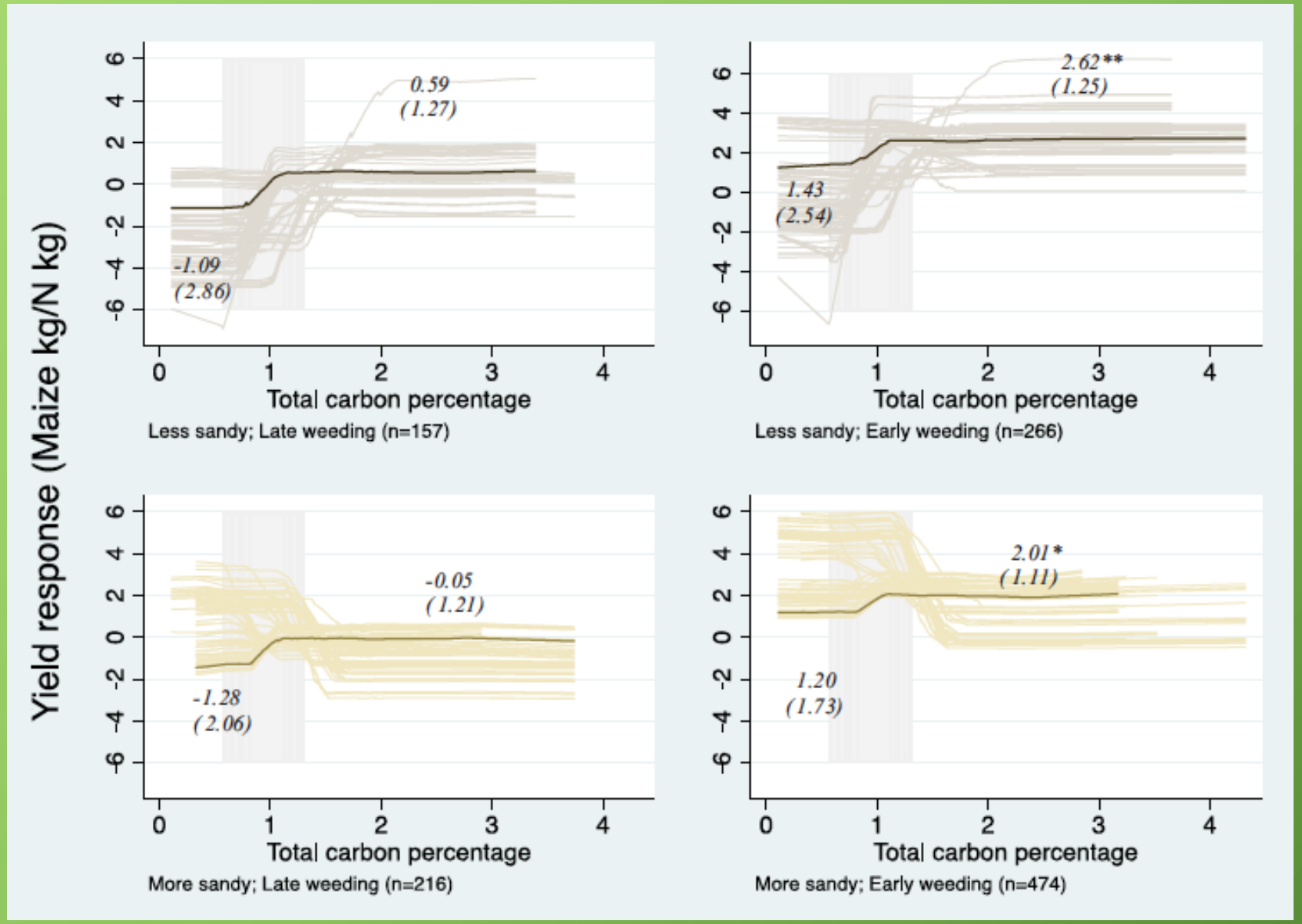
Low Soil Health

High Soil Health

Adaptation and New Knowledge: *Agroecology principles tested and refined through participatory research*

- **Crop diversification to** promote functional diversity
- **Multipurpose crop systems** = shrubby or viney food crops grown in mixtures with annual food crops
  - **Environmental services** (soils, energy) PLUS **provisioning services (food) to meet farmer needs, mitigate value conflict**
- **Extension guides: soil C > 0.9% threshold = fertilizer placement**

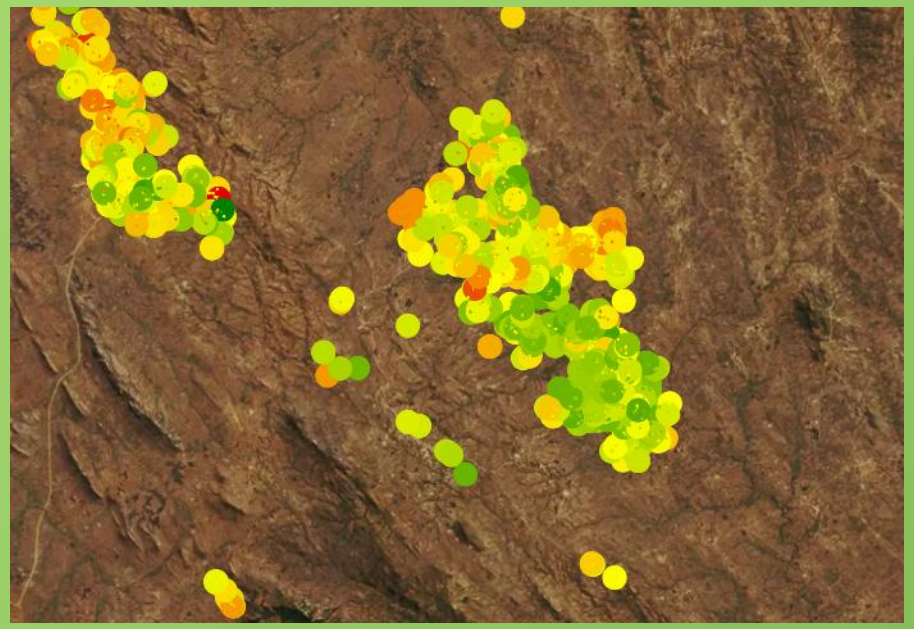
Soil organic C threshold 0.9% C

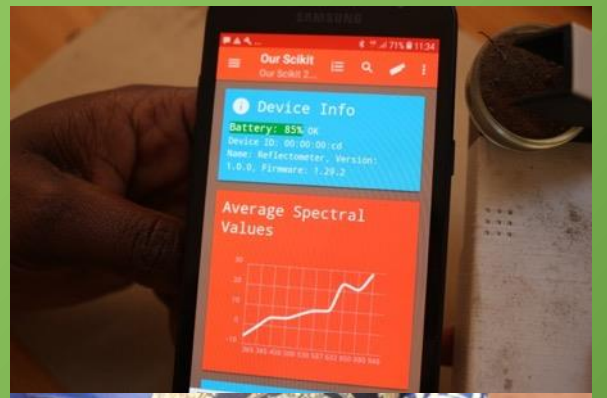


Burke et al., Agric. Economics 2020; Burke et al., World Dvlp in press

Extension guides based on soil carbon data:

Teaming up with Malawi extension to provide management advice based on handheld sensors





Malawi extension staff were trained in handheld soil C sensor, visited 595 farms, three fields per farm.

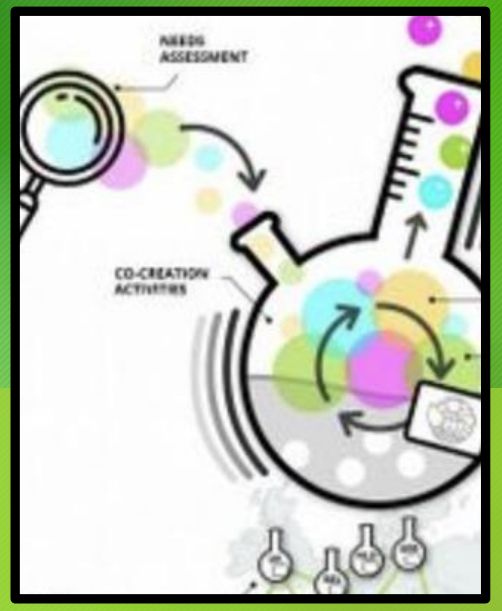
Farmers learned soil C status and options on where and how to rehabilitate soils, where to apply fertilizer.

Ewing et al., SSSA 2021

Gaps and opportunities

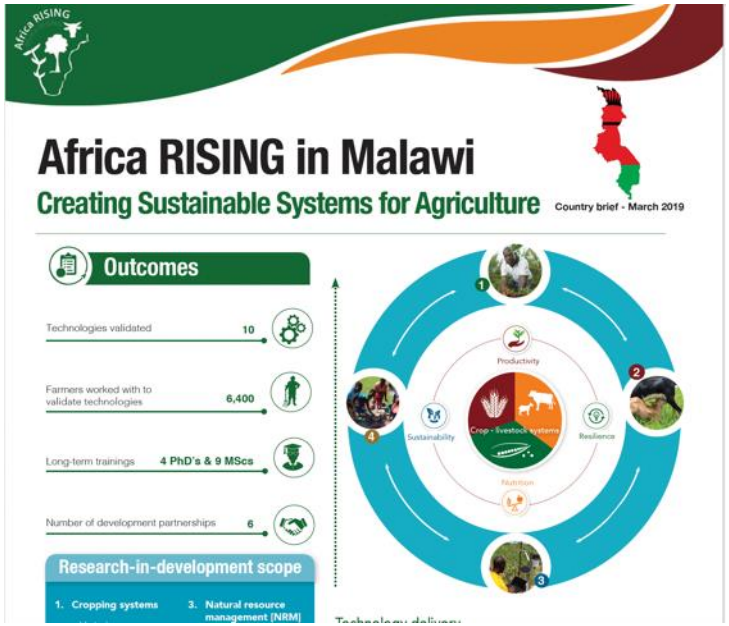
Handover of technologies

Service providers/ pathways for SI e.g., mech.



Innovation generation

Climate proofing



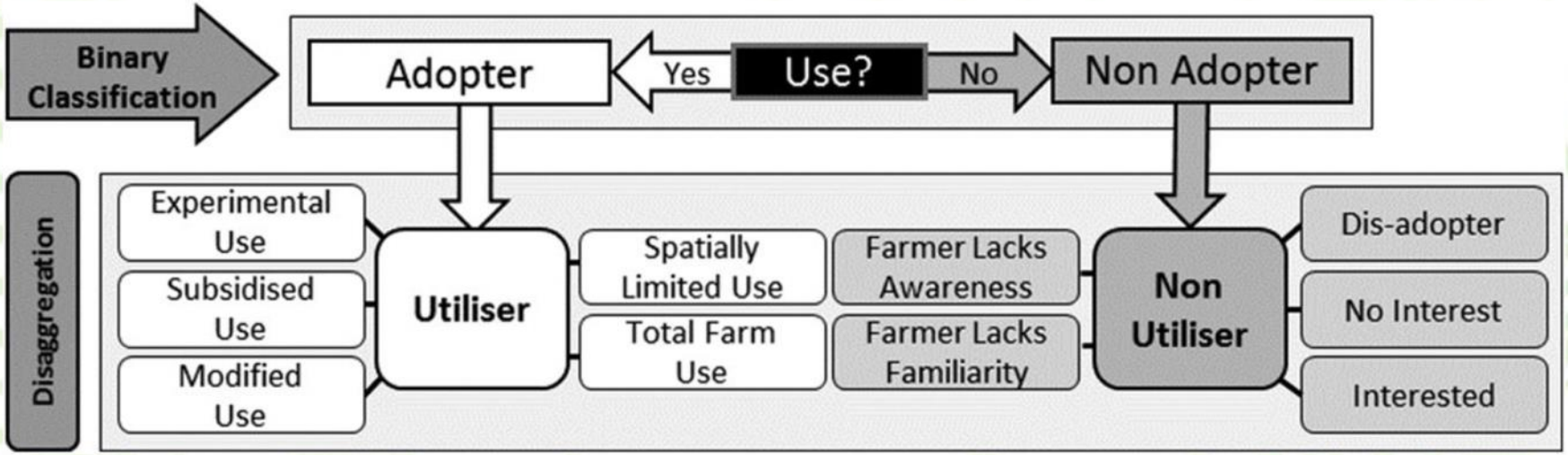
Handover of technologies

The many meanings of adoption…

- Why do farmers adapt?
- Adopt?
- Dis-adopt?
- Unpacking the handover process..

Handover of technologies – understanding adoption

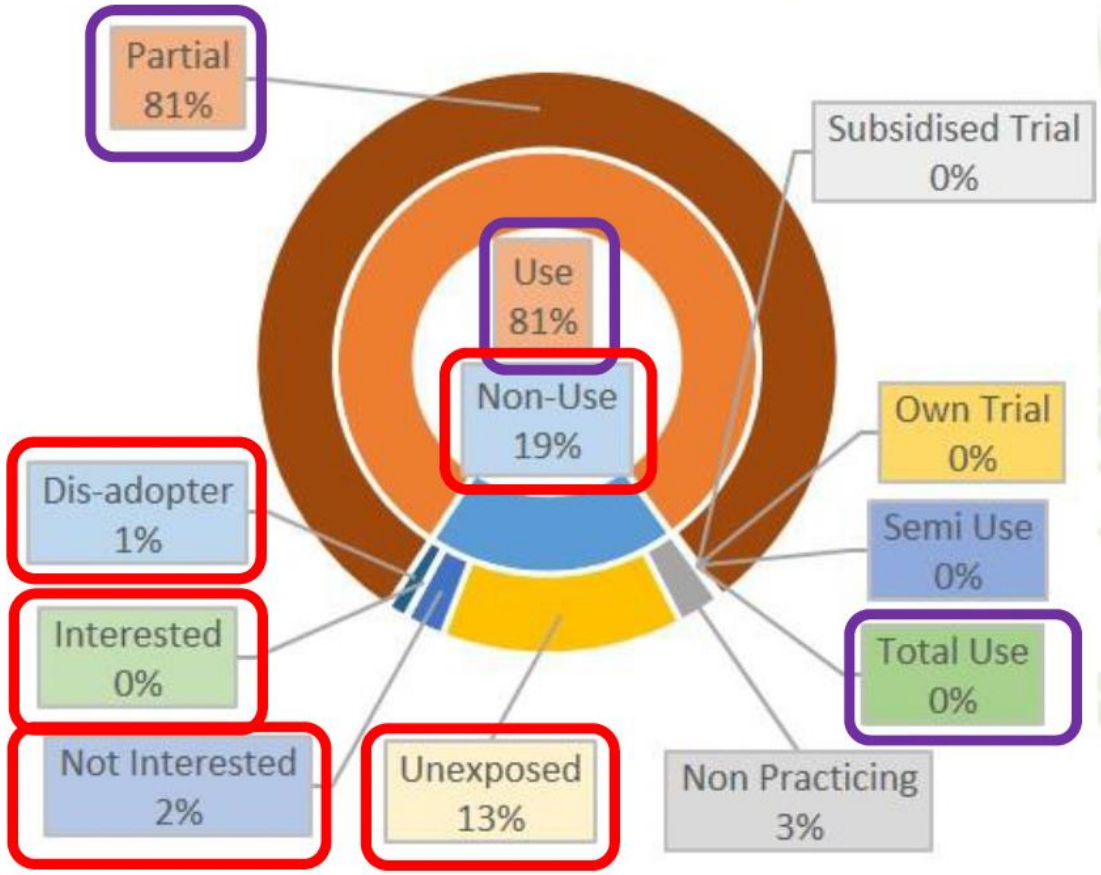
Disaggregated 'adoption'



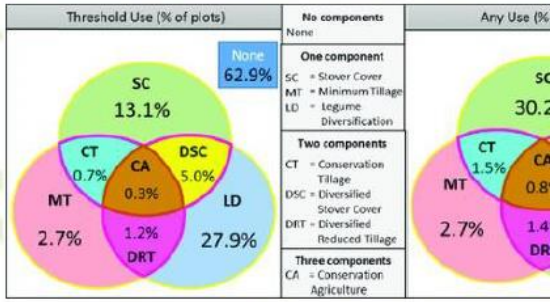
Brown, B., Nuberg, I., Llewellyn, R. (2017) Stepwise frameworks for understanding the utilisation of conservation agriculture in Africa. *Agricultural Systems* 153 (11-22) https://doi.org/10.1016/j.agsy.2017.01.012

B. Brown et al., 2017

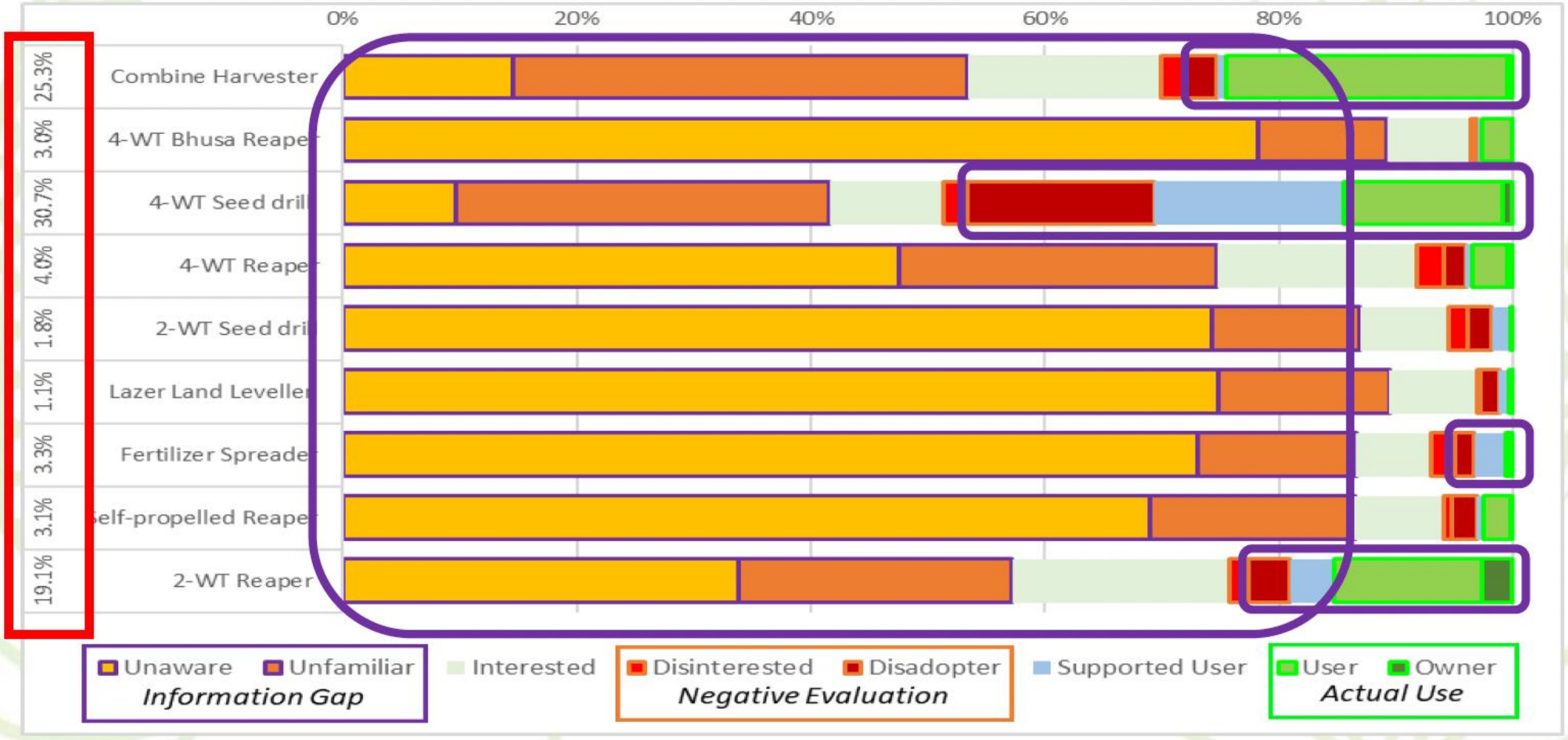
Conservation Agriculture in Eastern and Southern Africa



Is just reporting "81%" that helpful?



Status of Agricultural Mechanization in Nepal



wn, B., Prasad, G., Krupnik, K. (2021) Visualising adoption processes through a stepwise framework: A case study of mechanisation on the Nepal Terai. Agricultural Systems (volume 192) https://doi.org/10.1016/j.agsy.2021.103200

Gaps and opportunities

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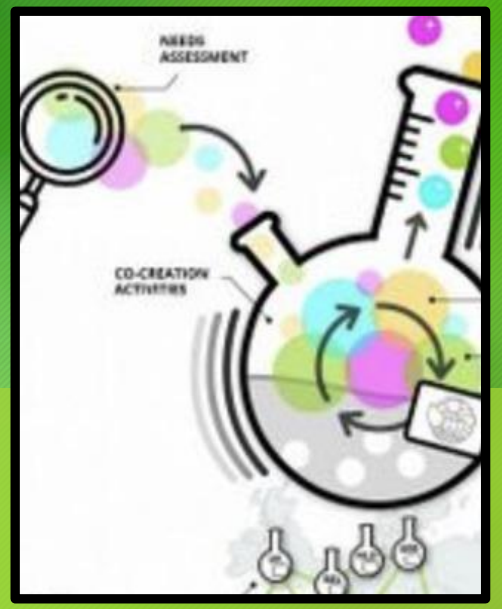
Service providers/ pathways for SI e.g., mech.



Innovation generation

Climate proofing

Service providers: Which models work where?

Digital apps

So many apps… Which work where?

Which business models?

Machinery

Linking demand and supply

Size, specialization, incentivization

Agrodealers/VBAAs

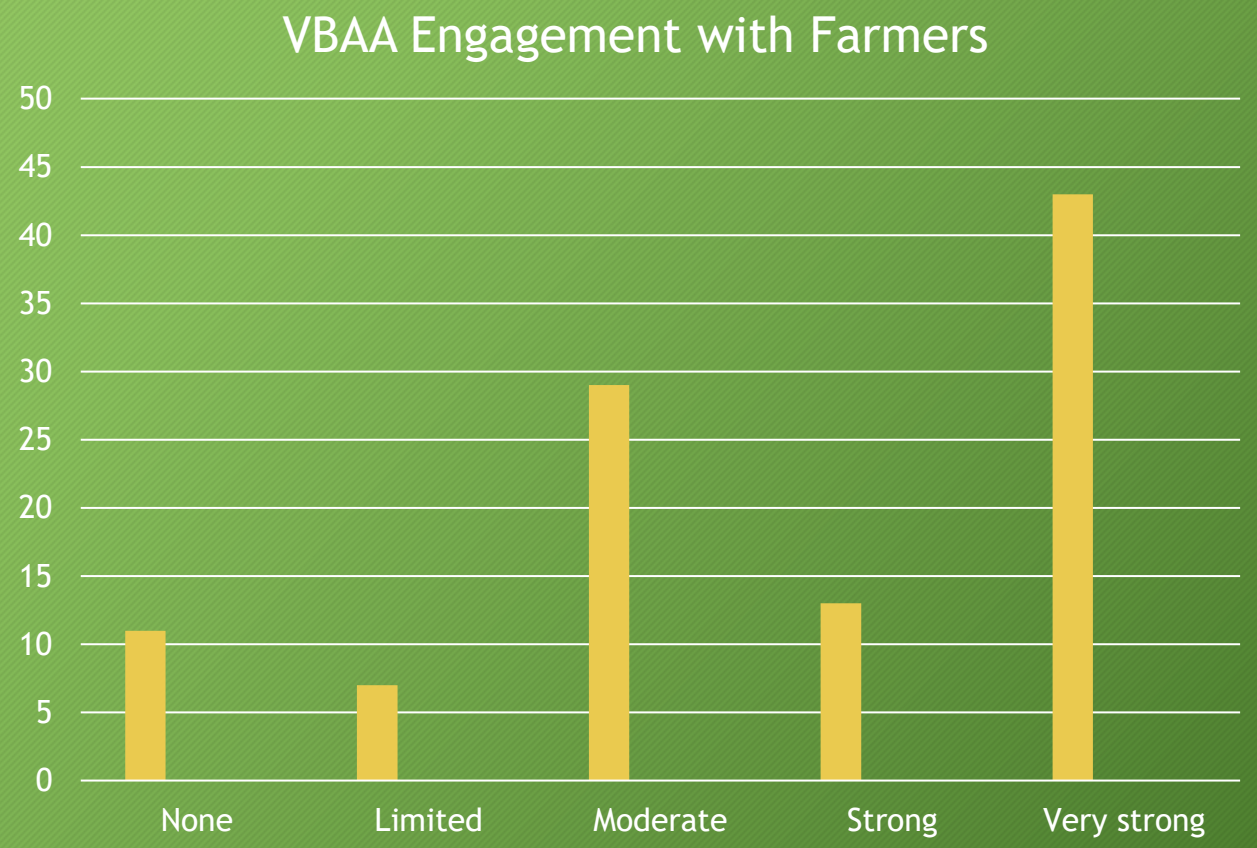
Models for linking finance, advice, farmer bidirectional learning..

Comparisons with OneAcre model?

Do VBAAs become agrodealers?

Village Based Ag Advisors Model - Tanzania

- VBAAs provided seed, seed treatments, inputs
- VBAAs set up demos, engaged with farmers, extension
- VBAAs provided consistent extension messages on bean spacing, seed treatments
- Few VBAAs ‘graduated’ to Agrodealers



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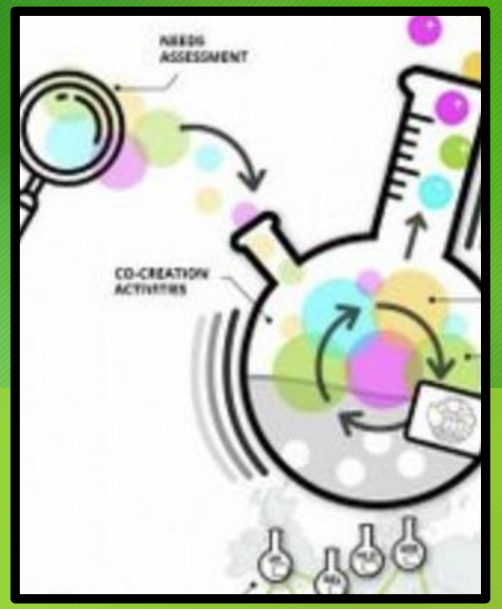


Innovation generation

Climate proofing

Research innovation approach: Breeders

<u>1. Participatory genetic gain</u>: rapid throughput on-farm that samples a broad range of ag environments, with participatory feedback on product profiles

Network sampling

Implement appropriately scaled on-farm testing with expanded/improved digital tools

Data analytics

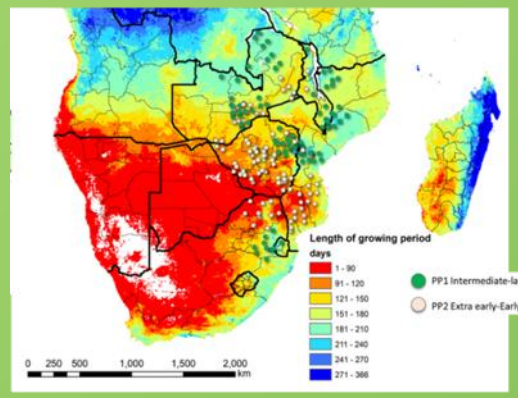
Maximize the insights from on-farm trials and use the data to inform modelling on options/innovations relevance (and subsequent redesign) and scaling decisions

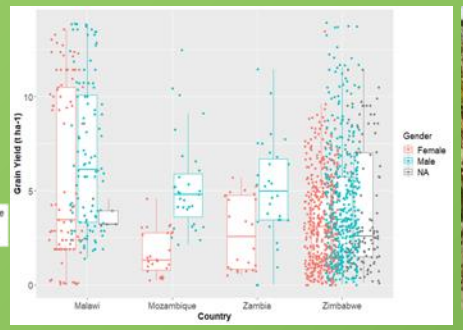
Farmer's perspectives

Narrow the gap between new/improved options and farmer preferences

Market segment

Conduct market research to refine product profiles





Do we need a new type of infrastructure?

Build out to test and generate innovations:

1. Simple tryouts by thousands of farmers chosen using a stratified-random selection process to be representative of agroecologies and household typologies, provide farmers access to genetics, agronomy, post harvest
2. E-surveys to monitor farmer practice and adaptations
3. Systematic evaluation of performance: farmer preference, crop yield, profit, sustainability indicators

Innovations by Context = Performance

Linking researcher and farmer knowledge

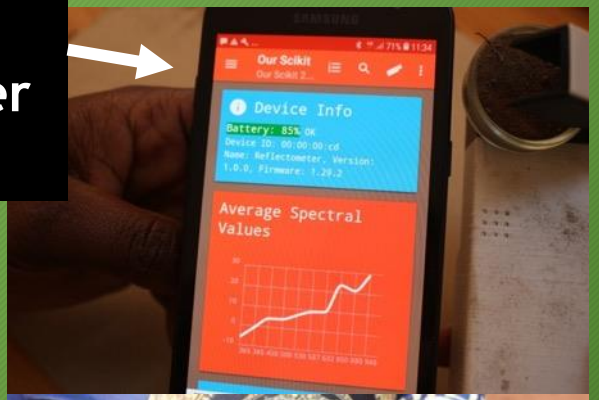
- **Researcher innovations**
- **Farmer innovations**
- ***Both are key to adaptation***

Scaling over space and time

- **How to improve knowledge at 10m-100m scale? Hand-held sensors, Apps, E-surveys**
- **How to build in feedback loops? Document farmer tryouts for fast/fail learning and input to research**
- ***How to accelerate learning over time?***

Innovation Lab:
Building on mother & baby trials, 1000farms

Document context
E-surveys, Sensors, LandPKS App,
Document farmer try outs



Rapid throughput at scale on-farm
Each black dot represents a Mother and baby trial cluster – usually 6-10 mothers at each location and over all > 4000 babies.
The red dots are on-station

Document CONTEXT

Socio-economic context

- RHoMIS and similar E-Surveys facilitates a standardized household survey method that includes questions about family labor, livelihood strategies and gender-aware documentation of agrifood practices, activities and control over income derived.
- Documentation of household composition, farming system, nutrition, other indicators, allows calculation of wealth index, sustainability indicators e.g., nutrient balance, greenhouse gas emission prediction.
- Abridged list of questions and indicators to reduce the length of the questionnaire to reduce respondent fatigue.

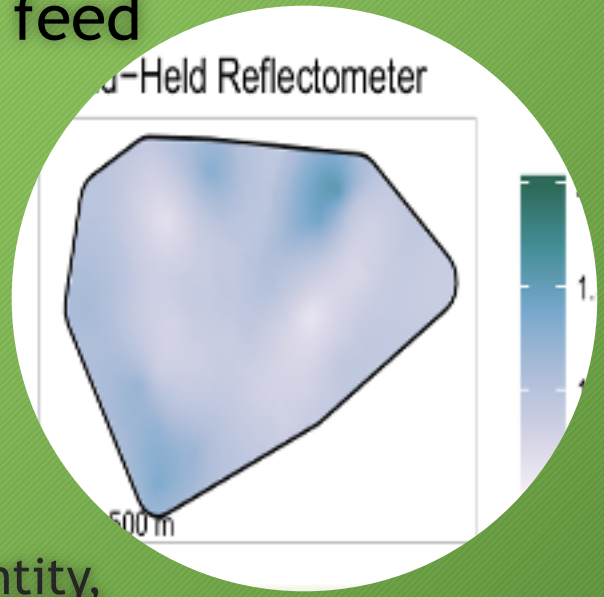
Environmental context

Site characterization: weather and soils for example, LandPKS and hand-held sensors (soil C reflectometer Our-Sci.net, soil pH, others)

Document PERFORMANCE

Performance assessment by farmers:

- Farmer assessment/ratings: labor requirements, nutrition, taste, yield, storage, livestock feed potential, other traits
- Adoption, adaptation and dis-adoption

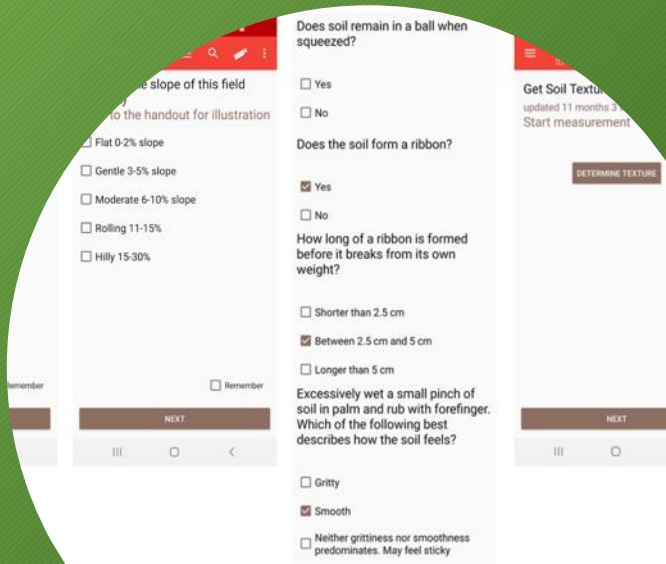


Data analytics:

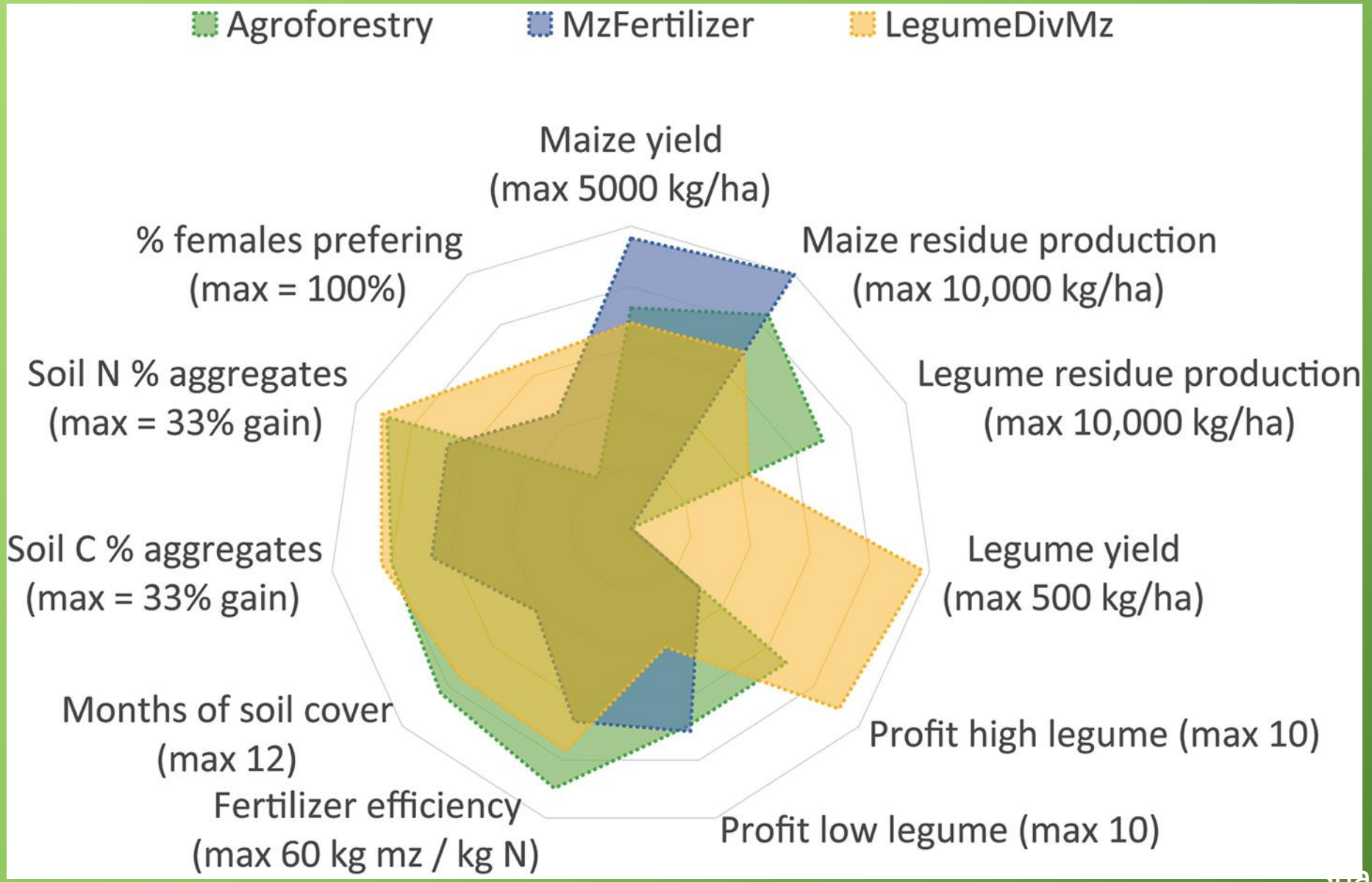
- *Modeling, Bayesian regression*

Performance assessment - biophysical

- Yield-cuts
  - Yield, variability of yield, stover quality & quantity,
  - Livestock weight gain
- Soil properties over time
- Household nutritional benefits, income (modeled)



Performance assessment



Snapp et al., 2022 FEE

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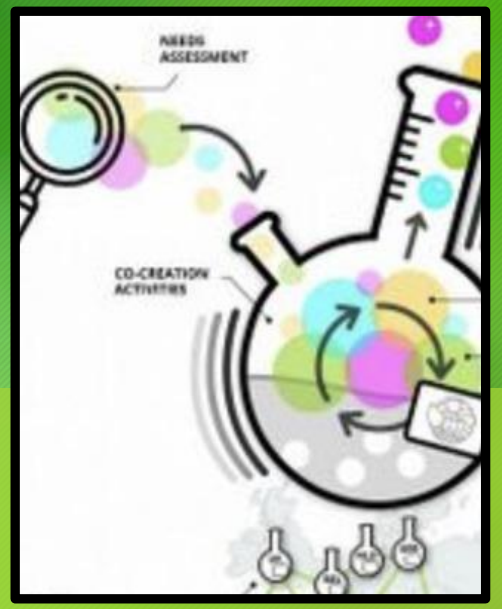

Innovation generation

Climate proofing

Use case: Climate proofing through generating dual-purpose crops and agrifood innovations *for climate resilient crop-livestock systems*

Climate Proofing: Systems analysis - options

Increasing demand:

- Livestock-auction systems
- Market information
- Education on livestock performance (tape to show gain)

Increasing supply:

- Integration of fodder species in CA systems
- Improved rangeland management and grazing systems, community innovations
- ***Dual-use crop generation***
- Fodder technologies - mechanization

Multi-purpose/dual purpose sorghum variety **Soubatimi**
Stay green - sweet and juicy stem
Released date: 2016 in ECOWAS seed catalog and available with NARS partners *early generation seed) and seed companies/farmers organizations (certified seed) in Mali, Burkina Faso and Niger

Outcomes from Climate-Proofing

Rapid generation of new varieties, phenotypes needed for niches, meeting farmer preferences:

- Dual purpose varieties for SI dairy
- Dual purpose varieties for marginal environments, soil health and community health
- Technologies for livestock gain for auctions
- Guidance for researcher priority setting and review committees

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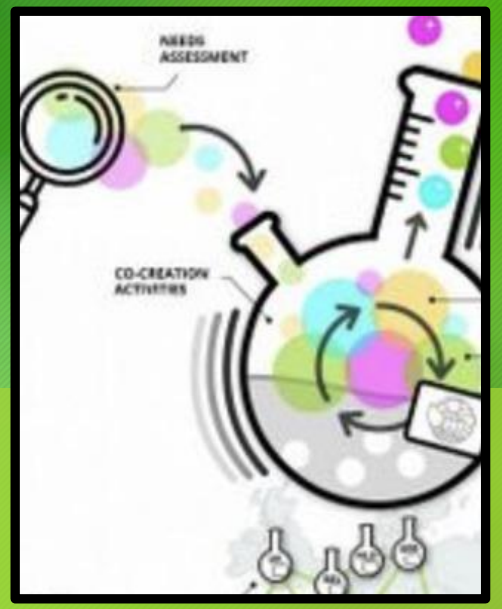

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