



International Center for Tropical Agriculture
Since 1967 *Science to cultivate change*

**Tropical
Forages**



RESEARCH
PROGRAM ON
Livestock

The role of science in developing low emitting livestock systems

Regional Awareness-Raising Workshop on Low
Emissions Livestock: Supporting Policy Through
Science in Southern Africa
24th July 2019 Pretoria, SA

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The importance of livestock



For PEOPLE

- Employment, income
- Economy
- Food and nutrition
- Cultural value
- Resilience and risk management



And the PLANET



- Biggest land user
- Natural resources:
 - Manure, carbon in the soil, energy...
 - GHGe, water use/pollution, degradation,...

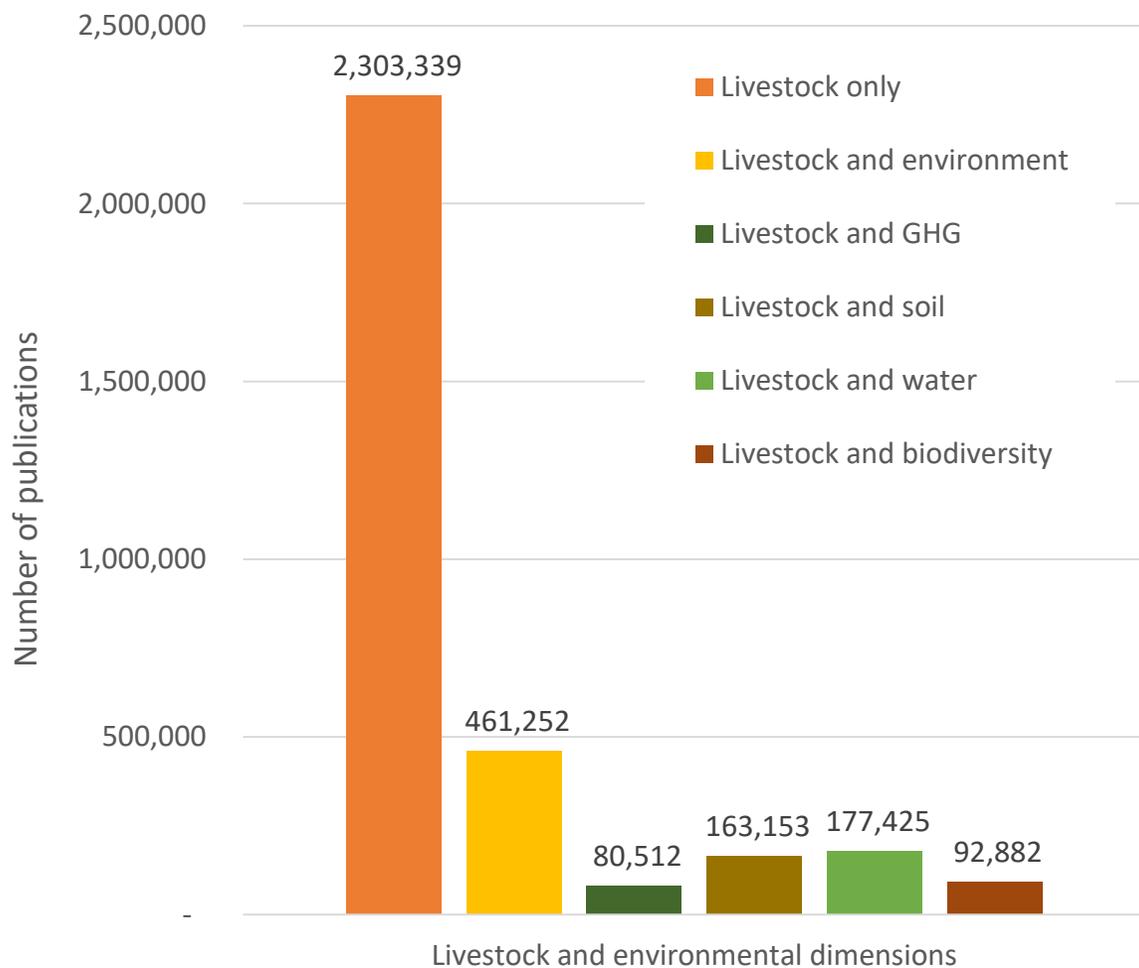
OECD narratives mostly negative

Not much evidence from Low-Middle Income Countries

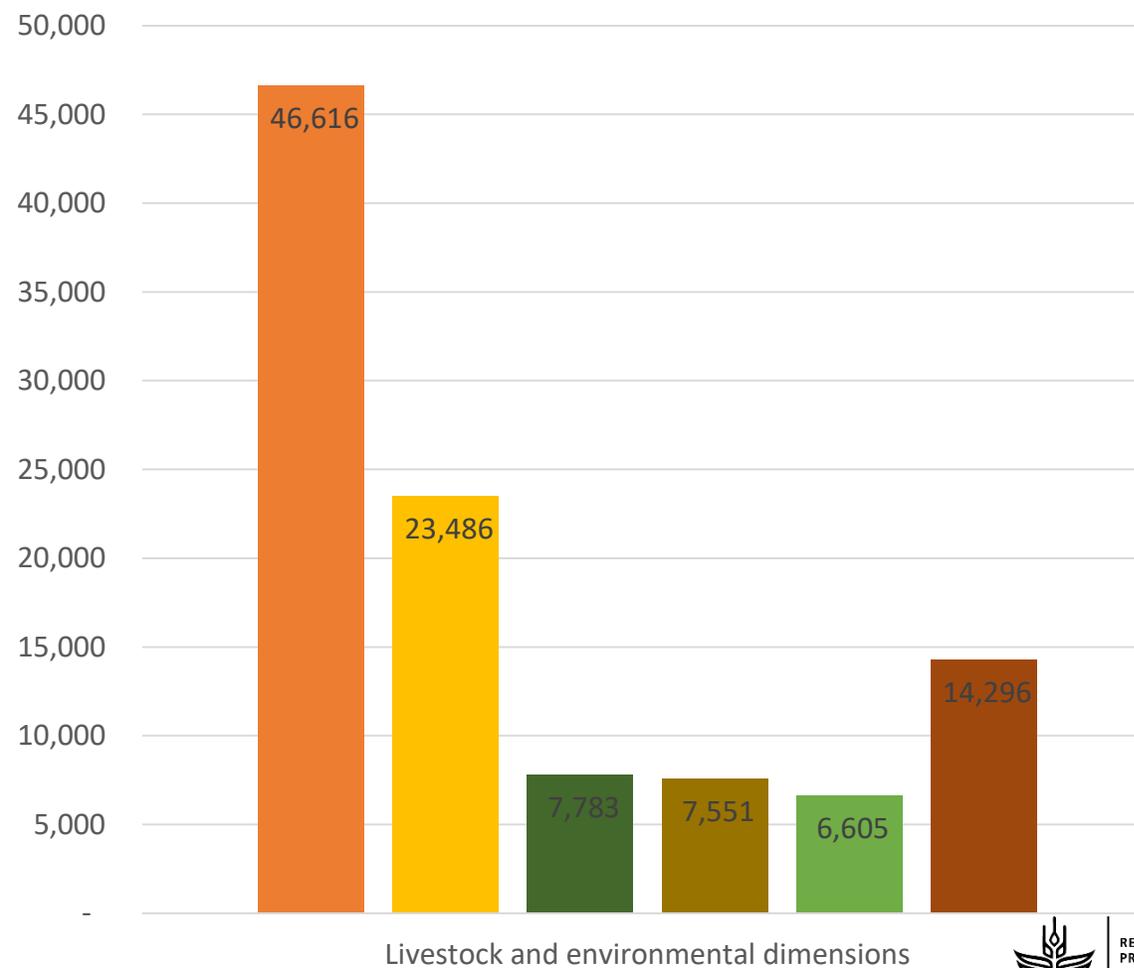
Sustainability is a big issue and needs to be managed

Current livestock and environment research

Global publication record



African publication record



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The aim of R&D at the livestock-environment nexus

Optimize the environmental footprint

i.e.
↑ “Goods” & “Bads” ↓

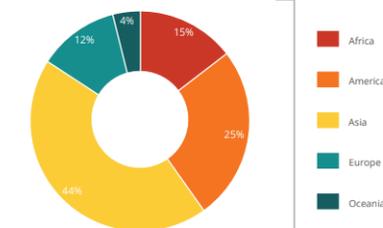


Zooming in on GHG emissions



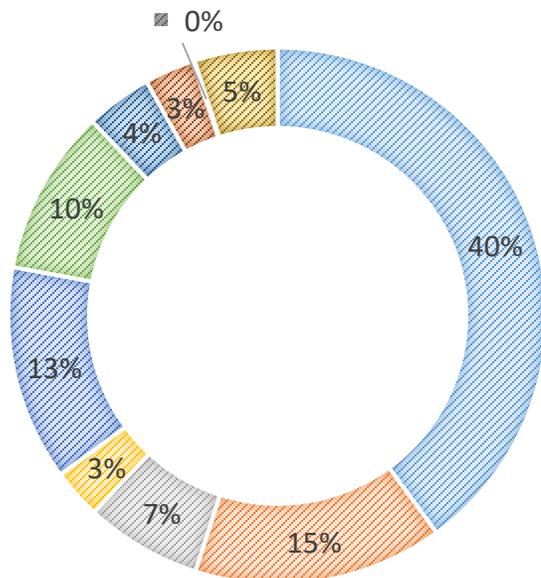
Investing in LIVESTOCK offers big potential gains
(for people and the planet)

Agricultural GHG emissions



GLOBAL GHG EMISSIONS BY SOURCE

- Enteric fermentation
- Manure left on pasture
- Manure management
- Manure applied to soils
- Synthetic fertilizer
- Rice cultivation
- Crop residues
- Cultivation org. soils
- Burning - crop res.
- Burning - savanna



FAO, Tubiello et al. 2014

Current knowledge (Tier 1):

- Agriculture: 30% of anthropogenic GHG emissions in SSA
- about 70% of agricultural GHGs from livestock
- 25% of emissions in livestock sector are from manure

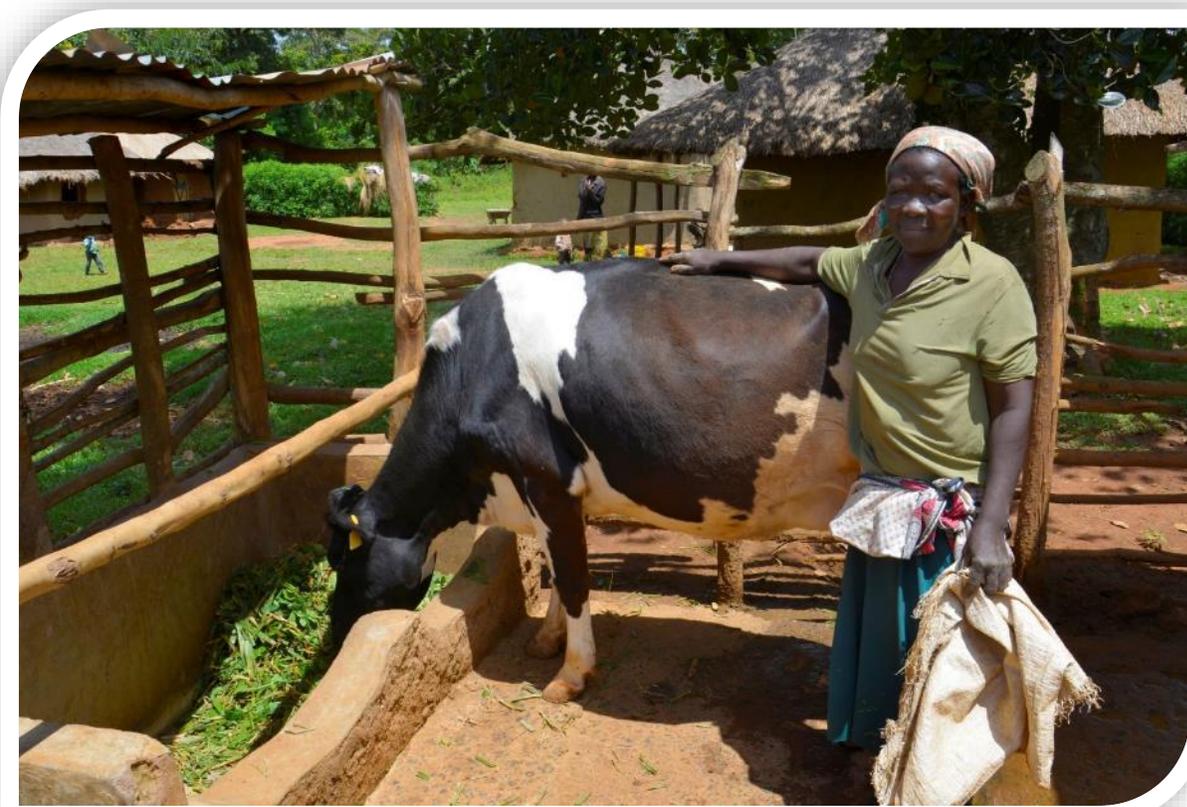
Paris Climate Agreement

- (Nationally Determined Contributions - NDCs)
- Tier 2 data: locally derived evidence
- Interventions to mitigate GHG emissions



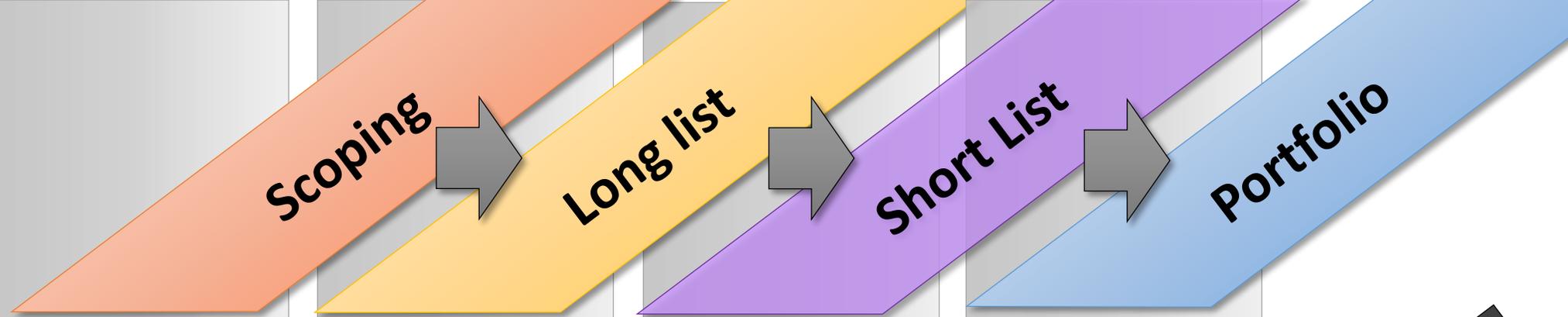
Low emissions livestock

- The global livestock sector contributes a significant share to anthropogenic GHG emissions.
- But it can also deliver a significant share of the necessary mitigation effort.
- **Low emissions livestock development offers countries an opportunity to achieve economic gains at the same time as responding to climate change.**
- Sustainable production to be complemented by Adaptation measures and Sustainable Consumption patterns.



SCIENCE

CSA Priority Setting



Climate Smartness

Suitably Increase Productivity
Increase Resilience and Adapt to Climate Change
Climate Mitigation and Low-Carbon Development

What

Outcome Indicators

Impact on GDP, Employment
Contribution to SDGs, INDCs, LDN, CBD, among others

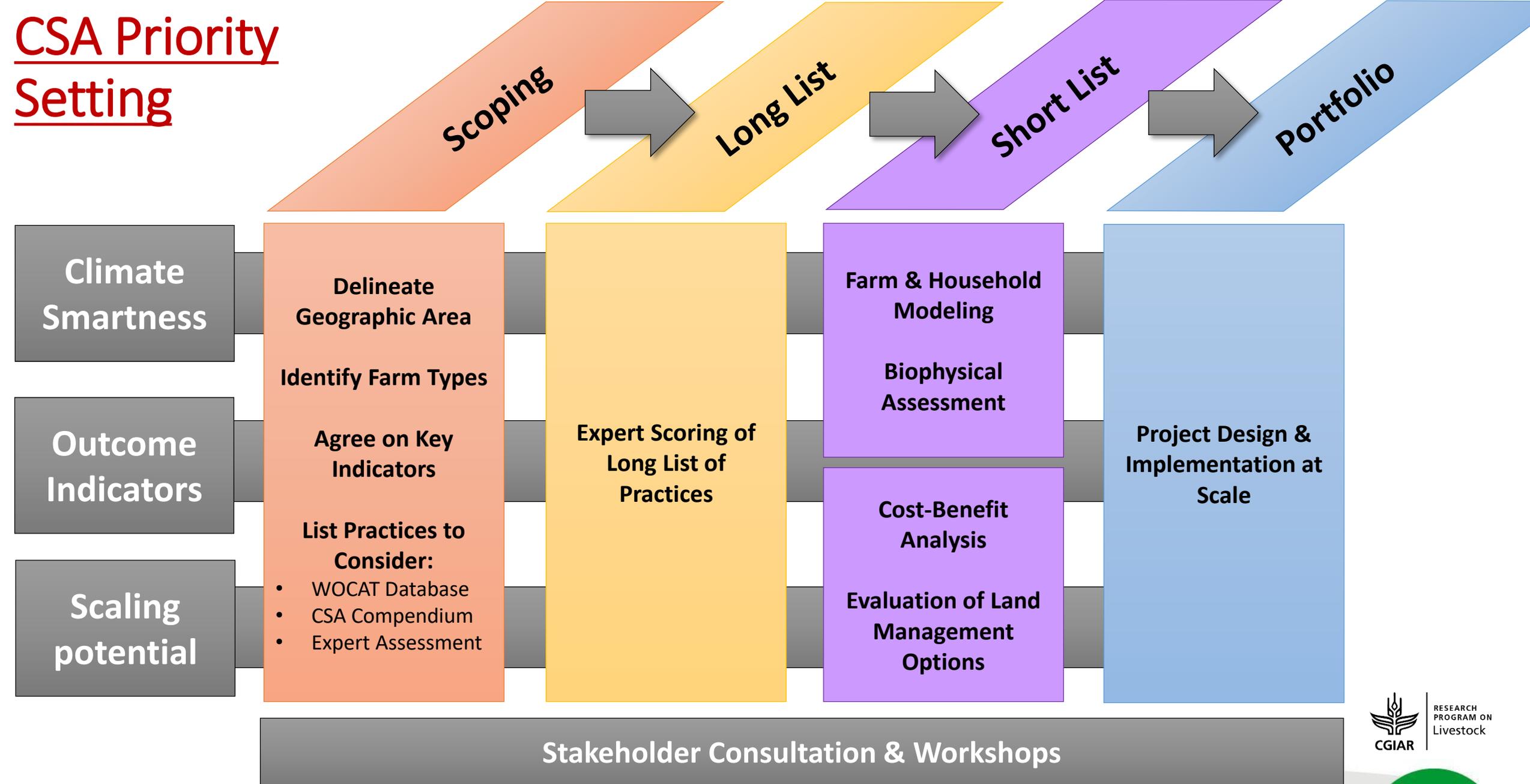
Why

Scaling potential

Adoption – Behavior and Economics
Delivery – Extension, Markets, ICTs, etc.
Sustainability – Maintenance of TIMP adoption & delivery

How

CSA Priority Setting



Research for evidence-based decision making - at farm and policy level

1. Function – support:

- ✓ Program and policy design
- ✓ Implementation
- ✓ Monitoring and Learning

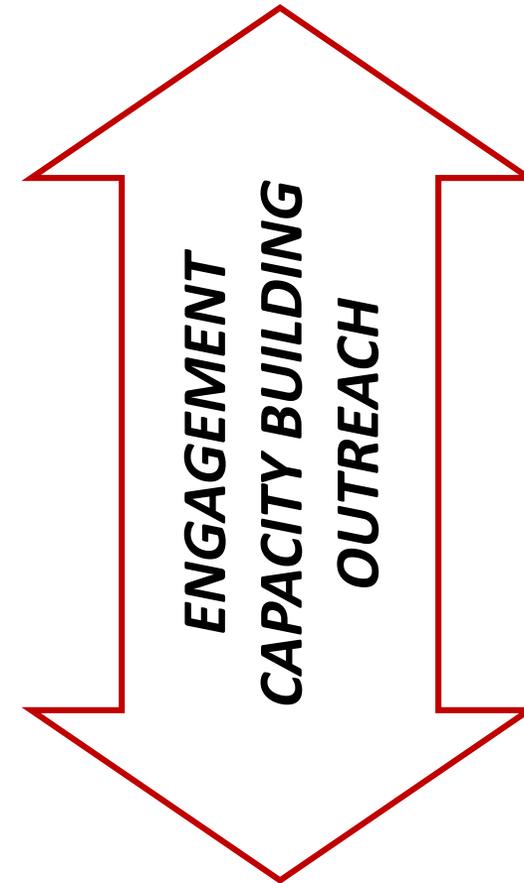
2. Challenges

- ✗ Lack of reliable data: animal numbers, breeds, feed resources, management practices, context-specific emission factors...
- ✗ Low adoption and uptake: awareness, buy-in; relevant, timely and actionable information; human and financial capacity
- ✗ Long-term investment



Research for evidence-based decision making - at farm and policy level

1. Improved *foresight and assessments*
 - a) 2-way CC-livestock interactions
 - b) based on site-specific data
2. Identify *solutions* and provide stakeholders with knowledge and incentives to implement solutions
3. Foster an *enabling* policy and institutional environment



== Targeting & prioritising, supporting & monitoring ==



Pillar 1: Assessments

Impacts of CC on Livestock

Hazards/stresses:

- Δ CO₂, temperature, precipitation
- Variability and extreme events

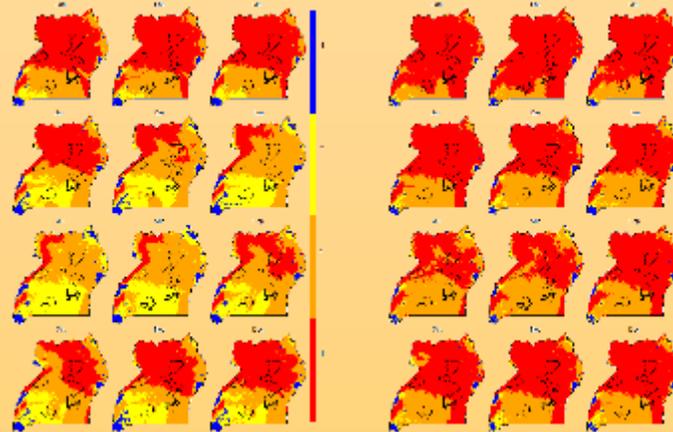
Direct impact

- Heat stress

Indirect impact

- Water
- Diseases
- Biodiversity, Soil
- Feed and forages
- Livelihoods and systems

Heat stress change – 2010-2035:



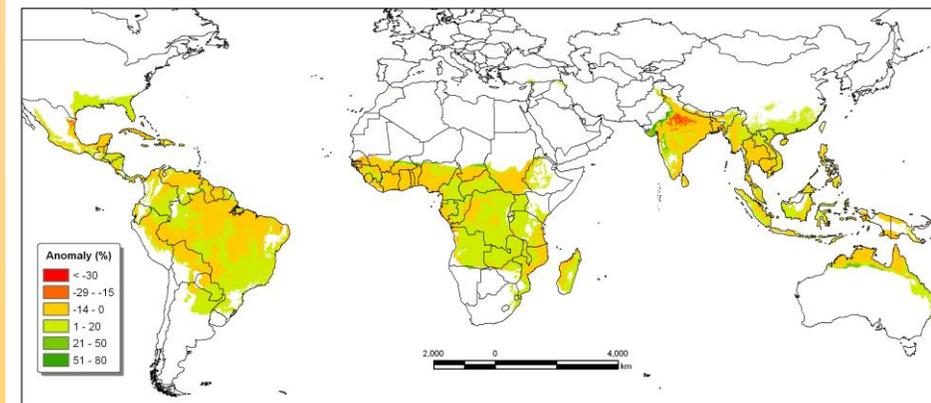
Heat stress is to likely increase in the future, with negative impacts (livelihoods and economy)

→ Quantification? Incl. knock-on effect on GHGe

→ How to adapt?

Suitability change – 2000-2020 (A2):

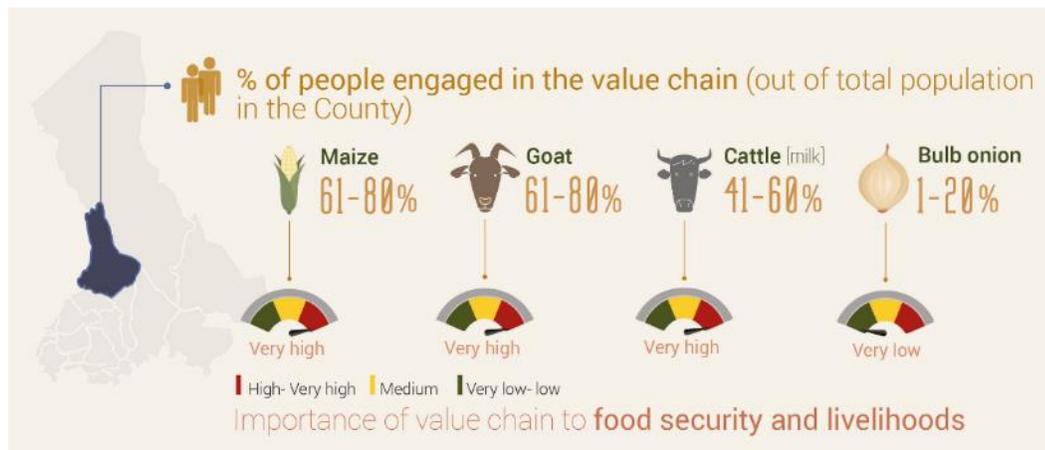
Brachiaria brizantha (Signal grass)



- “no-regret” forage choices
- Breeding for future conditions

County Climate Risk Profiles:

- Four Key Value Chains in each County
- Key Risks and Adaptation Options Identified



Kenya County Climate Risk Profile Series

Climate Risk Profile West Pokot County

Highlights

- The agricultural and livestock sector is the most important segment of West Pokot's economy. On average, 65% of the entire farm produce is sold, and 83% of households derive at least part of their income from on-farm activities. In 2012, income from the main crops totaled KSh 3.2 billion, with maize and beans alone accounting for 96% of the value. In comparison, the livestock sector contributed KSh 29.6 million, 93% of which was from trade in cattle, goats, sheep and camels.
- One of the most apparent effects of climate change observed by farmers is the occurrence of floods that wash out fertilizers and contribute to soil erosion. West Pokot is especially vulnerable since its soils are sandy and generally have low fertility. Climate models predict increasing variability in the onset and duration of rains with significant increases in the risk of floods.
- The late onset of rains and unpredictable rainfall lead to more frequent and extreme droughts that greatly impact productivity of rain-fed crop systems as well as quantity and quality of pastures. Increased drought stress and heat are projected to continue between 2020 and 2060.
- Water harvesting and irrigation have proven successful in improving productivity of certain crops and have transformed the transition zone between highlands and lowlands in Otum. Within ten years of the introduction of irrigation, West Pokot has become a major producer of onions nationally; there are plans to increase water harvesting and irrigation on individual farms in the coming years.
- The county government's efforts to vaccinate livestock have quickly and successfully combated the spread of diseases in West Pokot. Vaccination is important in the county, in view of the high rates of animal migration from neighbouring Turhana and Baringo counties and Uganda.
- Agricultural extension services in the county have limited reach; county government extension officers, while well trained and experienced, are too few to effectively cater to the needs of producers in the county. In addition, county budget allocation for new hiring and support for field activities remains low. In the face of this challenge, there has been notable collaboration between public, private, and non-governmental bodies, ranging from direct financial support towards field expenses of extension officers to secondment of fully-remunerated technicians at publicly-funded facilities.
- The county government is finalising a policy document on coordination, harmonisation, and funding of programmes. The document is targeting the agricultural sector, with major focus on activities that address key aspects of climate change adaptation and preparedness. The county should work with stakeholders in both public and private sectors and donors to improve services.



Value Chain	Provision of inputs	On-farm production	Harvesting storage and processing	Product marketing	Risk Level	Adaptation Options			
Goat	<p>Risks: Low pasture access (floods of pasture grazing fields), loss of vegetation cover, structure destruction (nets/access routes), inaccessibility to inputs (water/supplies/medicines)</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Use of locally available materials to construct goat sheds; local sourcing of goat breeding stock; use of alternative feed (harvested crop residues), use of improved goat breeds</p> <p>Other potential options to increase farmers' adaptive capacity: Construction of flood resistant/control structures; improved access to extension services agents and agropets in rural/inaccessible areas</p>	<p>Risks: Increased demand for veterinary services (high pest and disease incidence), high mortality rates; reduction of goat population</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Tree planting to supplement pastures; migration from flood-prone areas; use of traditional belts to treat diseased goats; reliance on indigenous practices; chemical control of pest and diseases; culling and vaccination of sick animals; livestock diversification (cattle/poultry)</p> <p>Other potential options to increase farmers' adaptive capacity: Re-afforestation and restocking of pastures; flood control and water capture measures (dykes, canals, ponds); targeted management (pasture planning)</p>	<p>Risks: Reduction in harvested milk and meat (goat) quantities; increased incidence of milk and meat products spoilage (due to lack of refrigeration facilities); destruction of storage infrastructure</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Use of traditional methods of meat preservation (smoking); use of refrigeration facilities; value addition of stored milk products (fermentation)</p> <p>Other potential options to increase farmers' adaptive capacity: Adoption of modern methods of meat preservation (canning, refrigeration); farmer training on post-harvest handling of goat products (meat, milk, skin); reclamation and rehabilitation of flooded areas</p>	<p>Risks: Low products supply on the market; low market activity (loss of incomes for traders); job opportunities; high market prices</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Reliance on traditional weather forecasts to sell and buy new breeding stock; community efforts to improve damaged infrastructure to facilitate market access; farm gate sales (due to low household incomes)</p> <p>Other potential options to increase farmers' adaptive capacity: Farmer groups/cooperatives to bargain better market prices; improved weather forecast to predict viable times for goat sales; County fund to cushion farmers from market losses</p>	<p>Risks: Poor pasture/feeds quality and quantity; inadequate water supply; high demand for extension services (diseases, feeds); high demand for drugs (from agropets)</p> <p>Magnitude of impact: Moderate</p> <p>Farmers' current strategies to cope with the risks: Alternative feed resources (ignised maize stovers); artificial insemination (for improved breeding); use of locally sourced improved bulls</p> <p>Other potential options to increase farmers' adaptive capacity: Introduction of feed supplements (pastures/mineral supplements); capacity building for pasture preparation and use of alternative diseases/pest control techniques; beef/leather conservation technologies (hay, silage)</p>	<p>Risks: Malnutrition; poor animal vigor; increased disease incidence; high production costs; increased animal mortality</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Use of vaccination for disease control; controlled feeding regimes (goats/locks); increased awareness of animal husbandry practices (hygiene, milking, feeding); supplementation and improved feeding</p> <p>Other potential options to increase farmers' adaptive capacity: Use of modern certified vaccines for disease and pest control; incorporation of dairy process (feed chopping, cleaning)</p>	<p>Risks: Reduced milk production; high milk spoilage; poor milk quality; low household income</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Construction of milking sheds and pastures; milk cooling and bottling; milk storage in traditional vessels; milk fermentation; milk distribution (milk bars, hawkers)</p> <p>Other potential options to increase farmers' adaptive capacity: Promotion of cooling structures in rural areas using solar energy; establishment of county-based processors (pasteurization and packaging); value addition to cultured milk products (milk, yogurt, cheese)</p>	<p>Risks: Increased market price (milk scarcity)</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Use of local markets for selling dairy products</p> <p>Other potential options to increase farmers' adaptive capacity: Linkage with consumer organizations for profitable milk sales; enterprise diversification (poultry, crop farming)</p>	
Cattle (milk)	<p>Risks: Inaccessibility to inputs (fertilizers, seed); lack of credit facilities; low use of mineral fertilizers</p> <p>Magnitude of impact: Major</p> <p>Farmers' current strategies to cope with the risks: Use of certified hybrid seeds; mixture-based varieties; reliance on informal seed systems (community); non-use of organic/inorganic fertilizers; use of open-pollinated maize varieties</p> <p>Other potential options to increase farmers' adaptive capacity: Promotion of moisture-tolerant varieties (genotypical niches); upscale use of open-pollinated varieties; County support for provision of inputs</p>	<p>Risks: Soil erosion; formation of gullies; water logging; poor stand establishment; stunted and weak plants; high pest and disease incidence; difficulties in field agronomic activities (preparation, sowing)</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Early/late planting; staggered cropping; use of FYM and compost manure; intercropping; agroforestry; establishment of water harvesting structures; enterprise diversification (business, horticulture production)</p> <p>Other potential options to increase farmers' adaptive capacity: Upscale of conservation agriculture; development of drainage structures</p>	<p>Risks: Poor quality and quantity of harvested produce; increased seed spoilage (both silos/containers); poor household food security; increased transportation (farm to storage) and harvest labor costs</p> <p>Magnitude of impact: Moderate</p> <p>Farmers' current strategies to cope with the risks: Repairation of damaged stores and silos; construction of new storage facilities; farm gate sales (to avoid transportation and storage costs); crop residues fed to livestock; low supply of processing materials by millers</p> <p>Other potential options to increase farmers' adaptive capacity: Land reclamation from floods; County support for shared storage facilities (in crop/animal)</p>	<p>Risks: Market inaccessibility; scarcity of animal feed byproducts</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: Small-scale milling; sale of produce (at farm/gate locally); low market activity and loss of job opportunities by traders</p> <p>Other potential options to increase farmers' adaptive capacity: Improved roads linking farmers to markets; online marketing</p>	<p>Risks: High temperatures</p> <p>Magnitude of impact: Major</p> <p>Farmers' current strategies to cope with the risks: Alternative feed resources (ignised maize stovers); artificial insemination (for improved breeding); use of locally sourced improved bulls</p> <p>Other potential options to increase farmers' adaptive capacity: Introduction of feed supplements (pastures/mineral supplements); capacity building for pasture preparation and use of alternative diseases/pest control techniques; beef/leather conservation technologies (hay, silage)</p>	<p>Risks: Poor pasture/feeds quality and quantity; inadequate water supply; 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enterprise diversification (poultry, crop farming)</p>
Maize	<p>Risks: Inaccessibility to farms and input dealers (damaged roads); low input sales (seeds, fertilizers, chemicals)</p> <p>Magnitude of impact: Severe-Major</p> <p>Farmers' current strategies to cope with the risks: Farmer (community) initiatives to maintain feeder road (less access to farms/inputs); support credit access for inputs purchase; use of certified seed; use of fertilizers (organic and inorganic)</p> <p>Other potential options to increase farmers' adaptive capacity: Roads improvements (with proper drainage systems); diversification of input dealers; improved credit access</p>	<p>Risks: Distortion of planting durations; poor productivity; increased incidence of pest and disease</p> <p>Magnitude of impact: Severe-Major</p> <p>Farmers' current strategies to cope with the risks: Staggered planting; construction of soil and water structures (weirs/banks); tree planting (shading levels); agroforestry and crop rotation regimes; enterprise diversification (pastures/seed crop)</p> <p>Other potential options to increase farmers' adaptive capacity: Promotion of conservation agriculture; Capacity building/awareness raising on soil and land management; agroforestry systems; viable tree species</p>	<p>Risks: High transport costs (necessity to roads); high post-harvest losses; high storage costs</p> <p>Magnitude of impact: Severe-Major</p> <p>Farmers' current strategies to cope with the risks: Timely harvesting; sorting and grading; use of above-ground storage facilities; use of efficient farm transportation means (trucks/vehicles instead of bullocks); engagement in farmer cooperatives to facilitate bulk storage</p> <p>Other potential options to increase farmers' adaptive capacity: Capacity building/awareness raising on improved storage facilities; access to alternative materials/methods for bulk storage; improved access to early warning systems</p>	<p>Risks: High costs of products (low supply); income losses (poor quality and perishability); reduced market activity (loss of job and income opportunities)</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: High sale (farm-gate and local markets)</p> <p>Other potential options to increase farmers' adaptive capacity: Development and promotion of crop insurance products to cover production losses; expansion of existing stores (within community/markets); County support in seeking external markets and marketing opportunities</p>	<p>Risks: Increased demand for drought tolerant seeds; high costs of mechanized equipment for production</p> <p>Magnitude of impact: Major</p> <p>Farmers' current strategies to cope with the risks: Use of certified hybrid seeds; drought tolerant varieties; use of open-pollinated maize varieties</p> <p>Other potential options to increase farmers' adaptive capacity: Promotion of certified drought tolerant varieties; use of compost and farm manure; use of open-pollinated varieties</p>	<p>Risks: Increased incidence of crop failure and pests and diseases; low crop productivity</p> <p>Magnitude of impact: Severe-Moderate</p> <p>Farmers' current strategies to cope with the risks: Staggered cropping; use of soil scale conservation agriculture; irrigation</p> <p>Other potential options to increase farmers' adaptive capacity: Upscale of conservation agriculture (zero tillage); drip irrigation (drip); water harvesting technologies (sand, troughs, pans)</p>	<p>Risks: High incidence of rodent and storage pests; increase in produce theft, due to scarcity</p> <p>Magnitude of impact: Moderate</p> <p>Farmers' current strategies to cope with the risks: Storage facilities (farm owned); small scale milling; storage pest control (chemicals/local resources)</p> <p>Other potential options to increase farmers' adaptive capacity: Upscaling of modern silos and plant clinics; use of IPM practices</p>	<p>Risks: Increased maize price; abrogation of contractual agreements (due to profitable market prices)</p> <p>Magnitude of impact: Moderate</p> <p>Farmers' current strategies to cope with the risks: Stabilization of maize prices (through credit maize reserves); farm farmer associations/unions to aid produce bargains</p> <p>Other potential options to increase farmers' adaptive capacity: Grain reserves for dry season milling and processors; associations to link farmers to markets and to improve their wheat accessibility; online marketing/trading platforms</p>	
Bulb onion	<p>Risks: Inaccessibility to farms and input dealers (damaged roads); low input sales (seeds, fertilizers, chemicals)</p> <p>Magnitude of impact: Severe-Major</p> <p>Farmers' current strategies to cope with the risks: Farmer (community) initiatives to maintain feeder road (less access to farms/inputs); support credit access for inputs purchase; use of certified seed; use of fertilizers (organic and inorganic)</p> <p>Other potential options to increase farmers' adaptive capacity: Roads improvements (with proper drainage systems); diversification of input dealers; improved credit access</p>	<p>Risks: Distortion of planting durations; poor productivity; increased incidence of pest and disease</p> <p>Magnitude of impact: Severe-Major</p> <p>Farmers' current strategies to cope with the risks: Staggered planting; construction of soil and water structures (weirs/banks); tree planting (shading levels); agroforestry and crop rotation regimes; enterprise diversification (pastures/seed crop)</p> <p>Other potential options to increase farmers' adaptive capacity: Promotion of conservation agriculture; Capacity building/awareness raising on soil and land management; agroforestry systems; viable tree species</p>	<p>Risks: High transport costs (necessity to roads); high post-harvest losses; high storage costs</p> <p>Magnitude of impact: Severe-Major</p> <p>Farmers' current strategies to cope with the risks: Timely harvesting; sorting and grading; use of above-ground storage facilities; use of efficient farm transportation means (trucks/vehicles instead of bullocks); engagement in farmer cooperatives to facilitate bulk storage</p> <p>Other potential options to increase farmers' adaptive capacity: Capacity building/awareness raising on improved storage facilities; access to alternative materials/methods for bulk storage; improved access to early warning systems</p>	<p>Risks: High costs of products (low supply); income losses (poor quality and perishability); reduced market activity (loss of job and income opportunities)</p> <p>Magnitude of impact: Major-Moderate</p> <p>Farmers' current strategies to cope with the risks: High sale (farm-gate and local markets)</p> <p>Other potential options to increase farmers' adaptive capacity: Development and promotion of crop insurance products to cover production losses; expansion of existing stores (within community/markets); County support in seeking external markets and marketing opportunities</p>	<p>Risks: Increased demand for drought tolerant seeds; high costs of mechanized equipment for production</p> <p>Magnitude of impact: Major</p> <p>Farmers' current strategies to cope with the risks: Use of certified hybrid seeds; drought tolerant varieties; use of open-pollinated maize varieties</p> <p>Other potential options to increase farmers' adaptive capacity: Promotion of certified drought tolerant varieties; use of compost and farm manure; use of open-pollinated varieties</p>	<p>Risks: Increased incidence of crop failure and pests and diseases; low crop productivity</p> <p>Magnitude of impact: Severe-Moderate</p> <p>Farmers' current strategies to cope with the risks: Staggered cropping; use of soil scale conservation agriculture; irrigation</p> <p>Other potential options to increase farmers' adaptive capacity: Upscale of conservation agriculture (zero tillage); drip irrigation (drip); water harvesting technologies (sand, troughs, pans)</p>	<p>Risks: High incidence of rodent and storage pests; increase in produce theft, due to scarcity</p> <p>Magnitude of impact: Moderate</p> <p>Farmers' current strategies to cope with the risks: Storage facilities (farm owned); small scale milling; storage pest control (chemicals/local resources)</p> <p>Other potential options to increase farmers' adaptive capacity: Upscaling of modern silos and plant clinics; use of IPM practices</p>	<p>Risks: Increased maize price; abrogation of contractual agreements (due to profitable market prices)</p> <p>Magnitude of impact: Moderate</p> <p>Farmers' current strategies to cope with the risks: Stabilization of maize prices (through credit maize reserves); farm farmer associations/unions to aid produce bargains</p> <p>Other potential options to increase farmers' adaptive capacity: Grain reserves for dry season milling and processors; associations to link farmers to markets and to improve their wheat accessibility; online marketing/trading platforms</p>	

Impacts of Livestock on CC / GHG emissions

SSA-specific emission factors

- Tier 2 estimates of ruminant Emission Factors
- Difference due to assumptions about energy intake
 - Feed shortage/seasonal LW loss
 - Caution: only one location
- Countries in stronger position for climate finance

Report	Region	Males	Females	Calves
		kg CH ₄ yr ⁻¹		
IPCC	Africa	49	41	17.3
Goopy et al. (2017)	Nyando, Kenya	34.4	24.6	16

IPCC approach

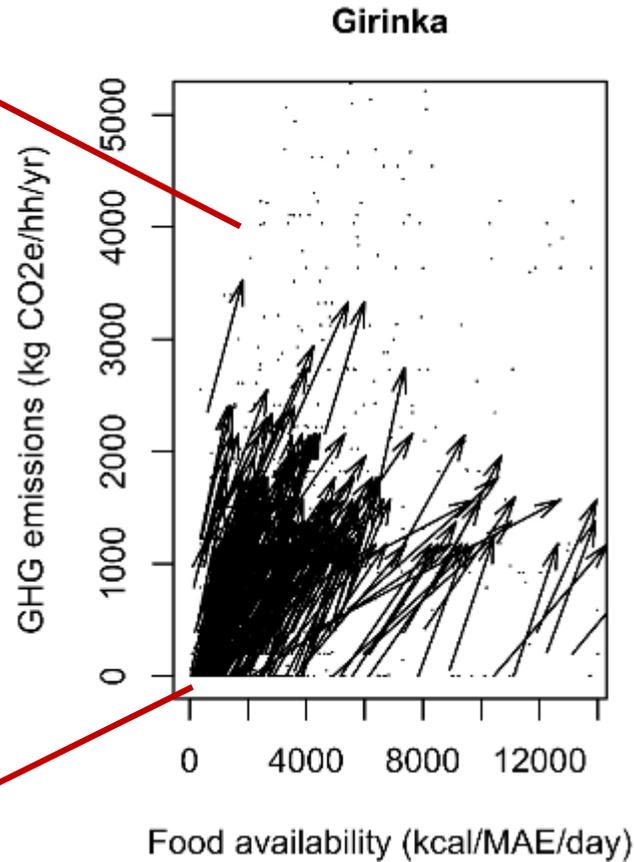
CH₄ = Energy intake * Y_m ("methane conversion factor")



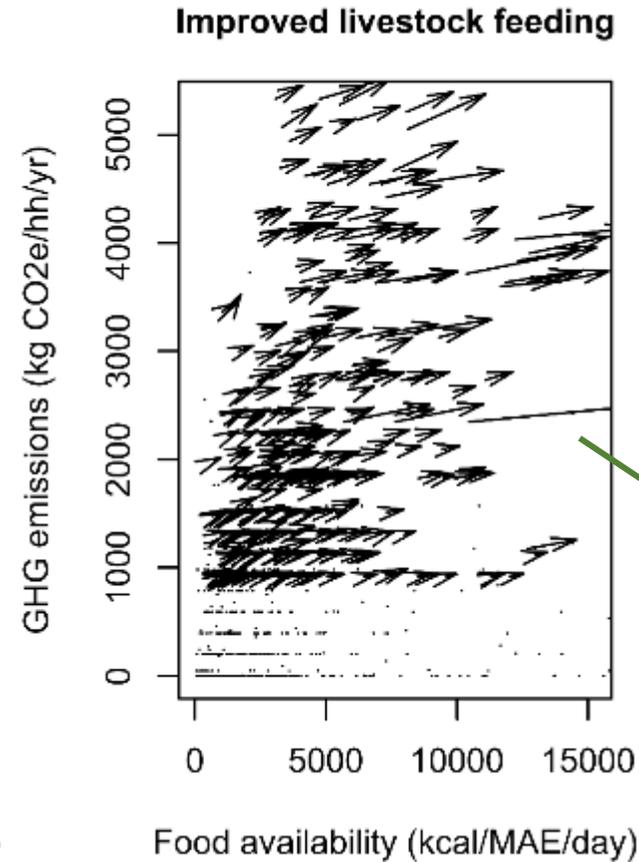
Potential impacts of livestock policies in Rwanda

GHG vs. food security trade-offs

GHGe
increase



Pro-poor



Only small
GHG increase

Impact of livestock on CC: *Ex-ante* environmental assessments (CLEANED)

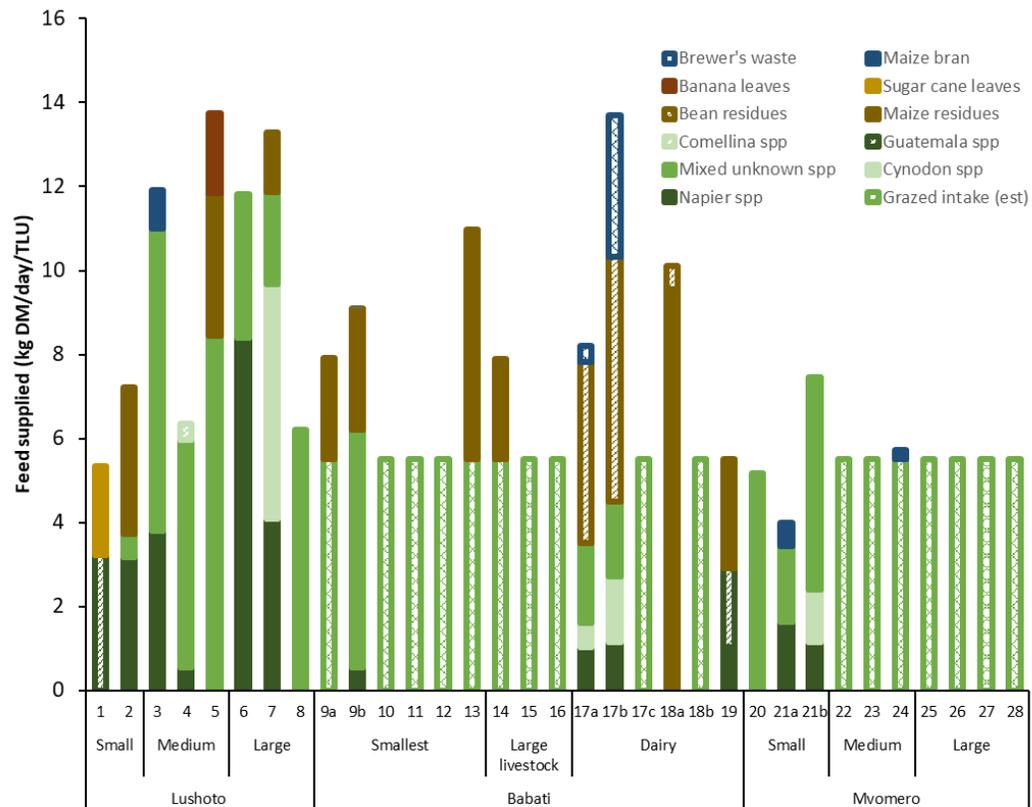
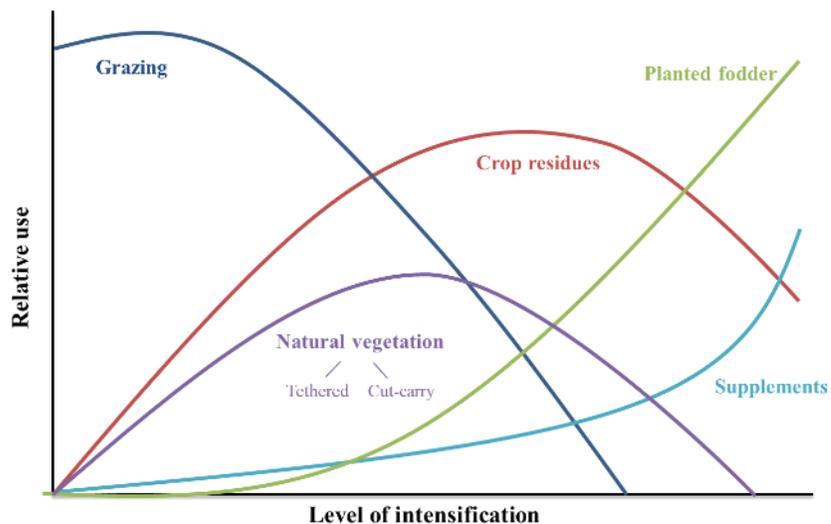
-> Potential impact of intervention packages in different livestock production systems in the dairy VC of Tanga, Tanzania

	Productivity		Land requirements		Water use			GHG emissions			
	Total supply (FPCM)	Productivity (FPCM/ha)	Land used (ha)	Land used per product (ha/MT FPCM)	Total water use (m3)	Water use per area (m3/ha)	Water use per product (m3/MT FPCM)	Total emissions (kg CO2-eq)	Emissions per area (kg CO2-eq/ha)	Emissions per product (kg CO2-eq/MT FPCM)	
Mixed crop-livestock enterprise	Baseline	1,157	525	2.2	1.9	1,234	560	1.1	2,647	1,202	3.7
	Genetics		-	-	-	-		-	-		-
	Feed	+++	+	---	+	---		+	---	-	++
	Health	+++	+	---	+	---		+	---		+
	Combined	+++	++	---	++	---		++	---	-	++
Agro-pastoral enterprise	Baseline	10,862	195	55.7	5.1	28,570	513	2.6	36,271	652	7.7
	Genetics	++	+++	++	++	++		++	+	-	++
	Feed	++	+++	++	+++	++	-	+++	---	---	+++
	Health	++	+++	++	+++	++	-	+++	---	---	+++
	Combined	+++	+++	-	++	-		++	---	-	+++
Tanga VC	Baseline	135,372,101	235	576,462	4.3	299,119,461	519	2.2	413,748,868	718	6.6
	Genetics		+		+			+			+
	Feed	++	+++	++	++	+		++		---	++
	Health	+++	+++	++	+++	+	-	+++	---	---	++
	Combined	+++	+++	+	+++		-	++	---	---	++

---: negative change of more than 50%, --: negative change of 20-50%, -: negative change of 5-20%, +: positive change of 5-20%, ++: positive change of 20-50%, +++: positive change of more than 50%

CLEANED X: minimum-data environmental ex-ante assessment tool

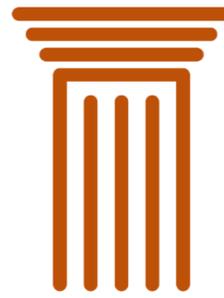
Core of the model: feed basket descriptions (dry and wet season)



Triangulation between PGIS info, survey data and expert opinion

→ Large uncertainty!

Therefore: more detailed feed baskets being measured



Pillar 2: Technologies

Different options

Technical interventions

- Genetic improvement (productivity, heat-tolerance, disease-resistance, ...)
- Animal health
- Feeds and forages:
 - Improved forages, conservation, fodder banks, supplementation, land restoration, re-seeding of pastures

Changes at system or landscape level

- Diversification
- Shifts in species and/or production systems
- Landuse planning and sustainable land mngt. (biodiversity, water, soils, ...)
- Protection of ecosystems services (incl. carbon sequestration!)

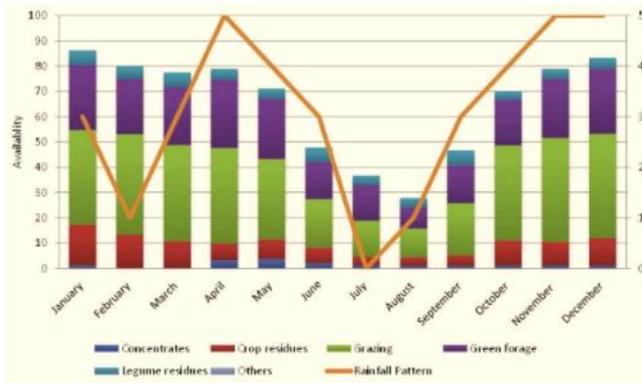
Institutional and policy options

- Markets and Trade
- Early warning, contingency planning, insurance, ...
- Climate finance mechanisms, PES, ...



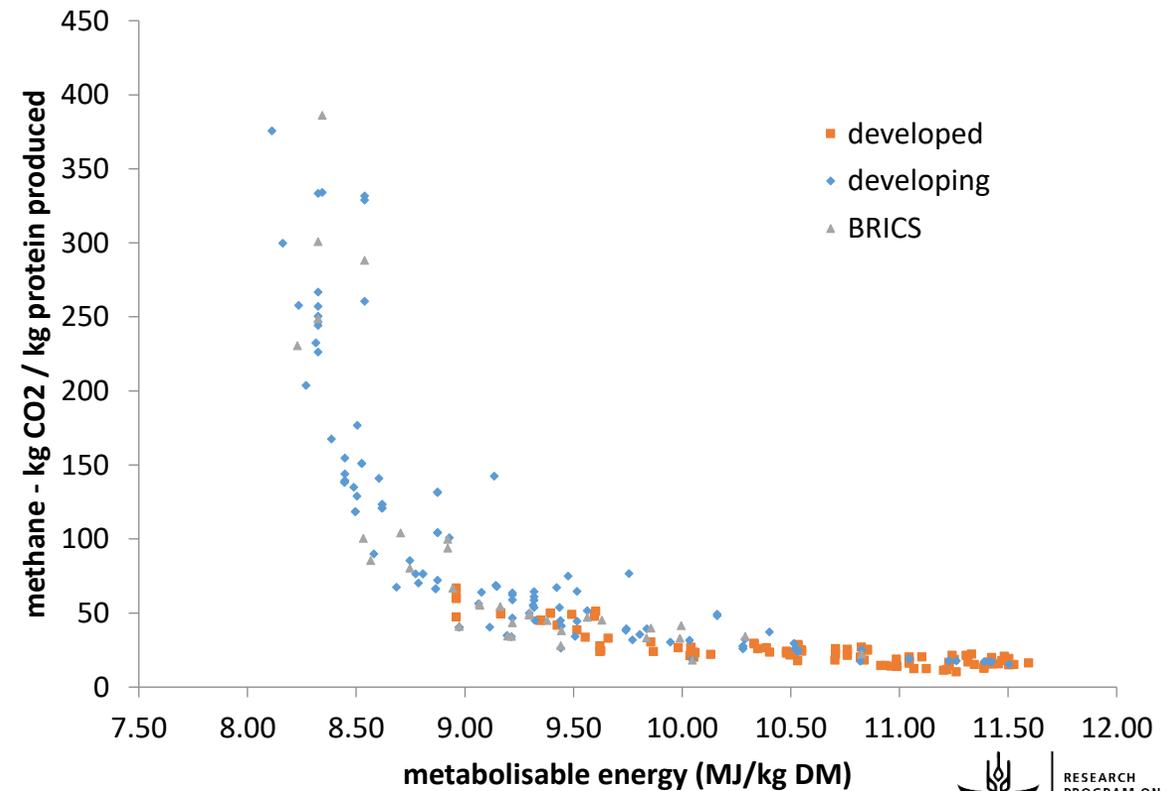
The example of feeds and forages – a true triple win

- **Current potential** of mixed crop-livestock systems in e.g. SSA remains largely **underexploited**



Main production constraint: sufficient quantity and quality of feeds all year round (*Maass et al, 2013*)

- Improved feeding offers the potential to **improve productivity & reduce GHG emissions**



Herrero et al, 2012



Program level (all countries, includes research cost)													
NPV Scenario Heatmap (USD \$,000), Total Surplus basis													
		Increase in productivity											
		5%	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%
Adoption rate	5%	-3,169	4,837	12,848	20,864	28,885	36,911	44,942	52,979	61,021	69,067	77,119	85,177
	10%	4,837	20,864	36,911	52,979	69,067	85,177	101,306	117,457	133,628	149,820	166,032	182,265
	15%	12,848	36,911	61,021	85,177	109,379	133,628	157,923	182,265	206,653	231,088	255,569	280,096
	20%	20,864	52,979	85,177	117,457	149,820	182,265	214,793	247,403	280,096	312,871	345,729	378,669
	25%	28,885	69,067	109,379	149,820	190,389	231,088	271,915	312,871	353,956	395,170	436,513	477,985
	30%	36,911	85,177	133,628	182,265	231,088	280,096	329,290	378,669	428,234	477,985	527,922	578,044
	35%	44,942	101,306	157,923	214,793	271,915	329,290	386,917	444,797	502,930	561,316	619,954	678,845
	40%	52,979	117,457	182,265	247,403	312,871	378,669	444,797	511,255	578,044	645,162	712,610	780,388
	45%	61,021	133,628	206,653	280,096	353,956	428,234	502,930	578,044	653,575	729,523	805,890	882,674
	50%	69,067	149,820	231,088	312,871	395,170	477,985	561,316	645,162	729,523	814,401	899,794	985,702
	55%	77,119	166,032	255,569	345,729	436,513	527,922	619,954	712,610	805,890	899,794	994,322	1,089,474
	60%	85,177	182,265	280,096	378,669	477,985	578,044	678,845	780,388	882,674	985,702	1,089,474	1,193,987
70%	93,239	198,519	304,670	411,692	519,586	628,351	737,988	848,496	959,876	1,072,127	1,185,249	1,299,243	
75%	101,306	214,793	329,290	444,797	561,316	678,845	797,384	916,934	1,037,495	1,159,067	1,281,649	1,405,242	
80%	109,379	231,088	353,956	477,985	603,174	729,523	857,033	985,702	1,115,532	1,246,522	1,378,672	1,511,983	
85%	117,457	247,403	378,669	511,255	645,162	780,388	916,934	1,054,801	1,193,987	1,334,493	1,476,320	1,619,466	
90%	125,540	263,739	403,429	544,608	687,278	831,438	977,088	1,124,229	1,272,859	1,422,980	1,574,591	1,727,693	
95%	133,628	280,096	428,234	578,044	729,523	882,674	1,037,495	1,193,987	1,352,150	1,511,983	1,673,487	1,836,661	
99%	141,721	296,473	453,087	611,561	771,898	934,095	1,098,155	1,264,075	1,431,857	1,601,501	1,773,006	1,946,373	
100%	149,820	312,871	477,985	645,162	814,401	985,702	1,159,067	1,334,493	1,511,983	1,691,535	1,873,149	2,056,826	

Gonzalez et al, 2016



Brachiaria example – improved livestock productivity

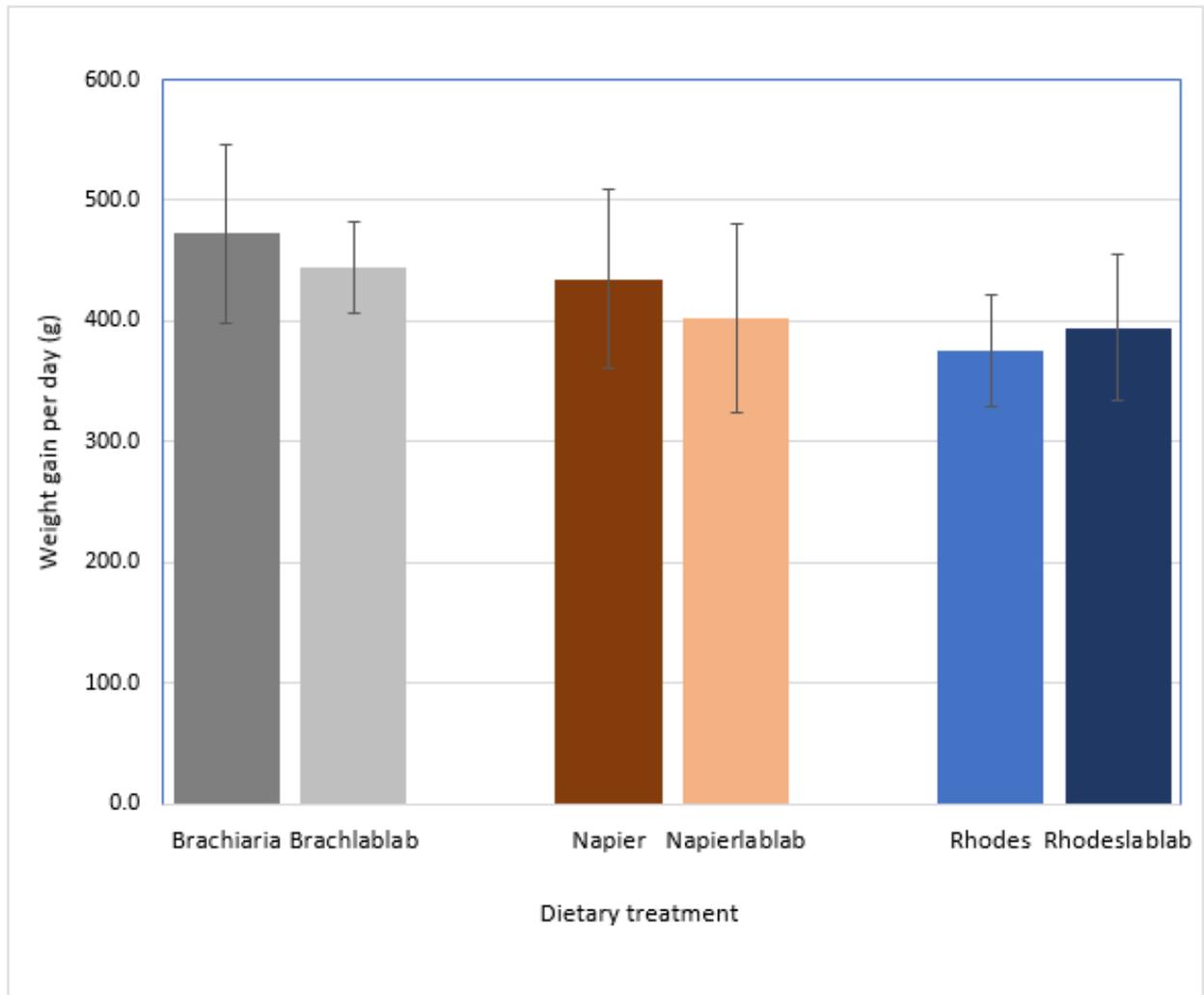
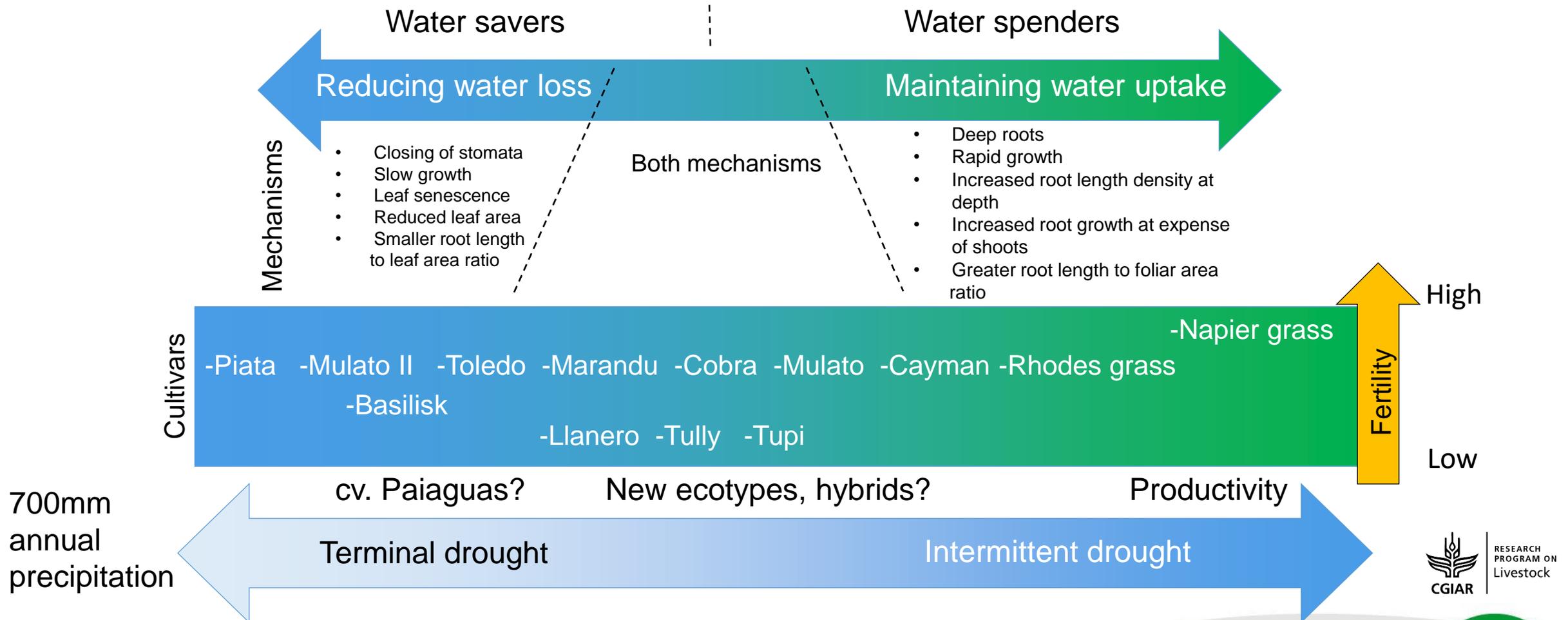


Figure 1: Average daily weight gain (g) of growing Boran steers fed on Brachiaria, Napier and Rhodes grass grown either alone or intercropped with *Dolichos lablab* over a 65-day feeding period.

Brachiaria grasses adapted to drought and low fertility

Targeting of *Brachiaria* grasses to areas with different patterns of drought

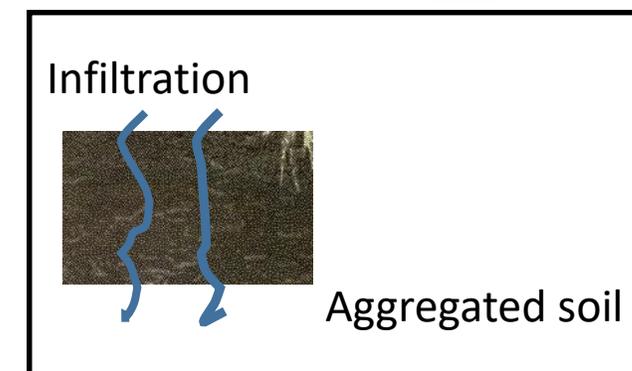
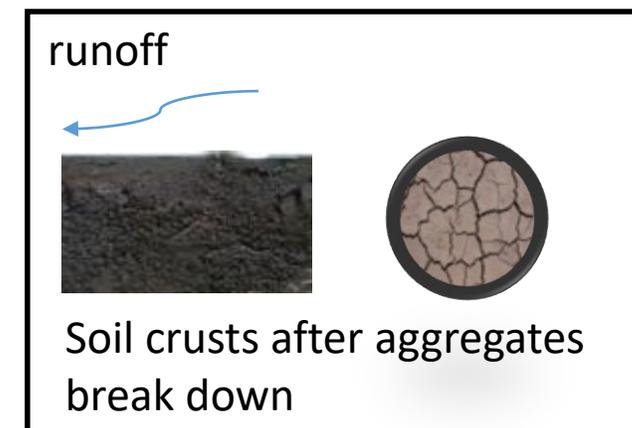


Contribution of *Brachiaria* grasses to soil quality improvement

Improving soil aggregation

- Soil aggregates are groups of soil particles that bind to each other more strongly than to adjacent particles.
- Aggregate stability refers to the ability of soil aggregates to resist disintegration when disruptive forces associated with tillage and water or wind erosion are applied.
- Aggregate stability (e.g., MWD) is an indicator of organic matter content, biological activity, and nutrient cycling in soil.
- Increase of mean aggregate size under *Brachiaria* grasses relative to bare soil (>2 years)

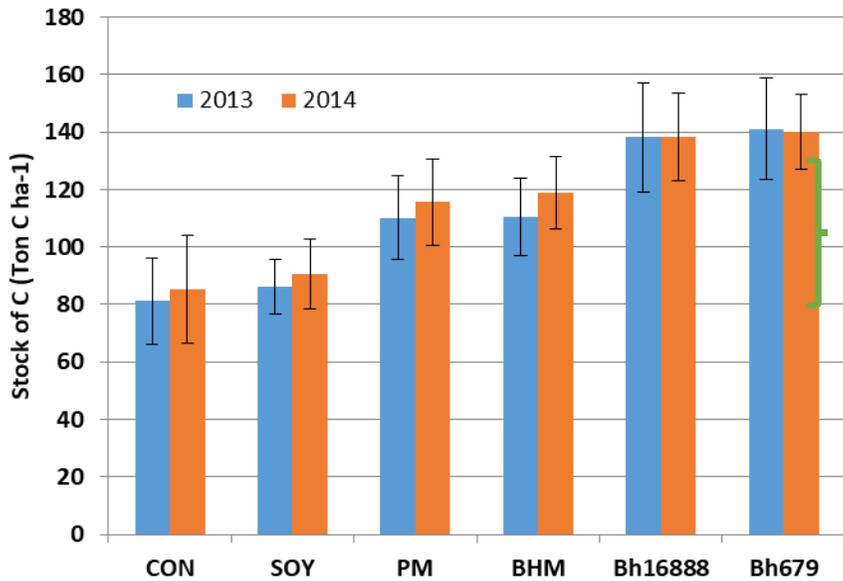
	Mean weight diameter (mm)	
	Greenhouse	Palmira
Bare soil	150	109
Napier	227	134
Rhodes	287	133
Brachiaria grasses		
Basilisk	316	128
Tully	354	125
Llanero	349	118
Tupi	378	127
Marandu	277	134
Toledo	279	138
Piata	260	136
Mulato	309	125
Mulato II	290	137
Caymán	319	131
Mean	304	131
LSD	20	15



Contribution of *Brachiaria* grasses to soil carbon accumulation

Soil carbon sequestration – LAC – 10 years old experiment

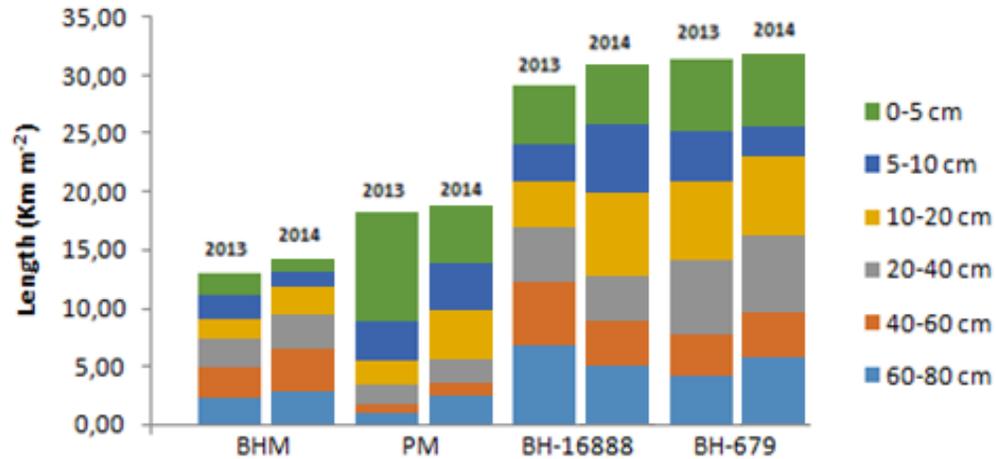
Soil carbon stocks



6 Ton C/ha/year

Root length

2013 - 2014



80cm depth

CON: Bare soil, PM: *P. maximum*, BHM: *Brachiaria* Mulato hybrid, BH:679: *B. humidicola* 679 and BH-16888: *B. humidicola* 16888

Contribution of *Brachiaria* grasses to soil carbon accumulation

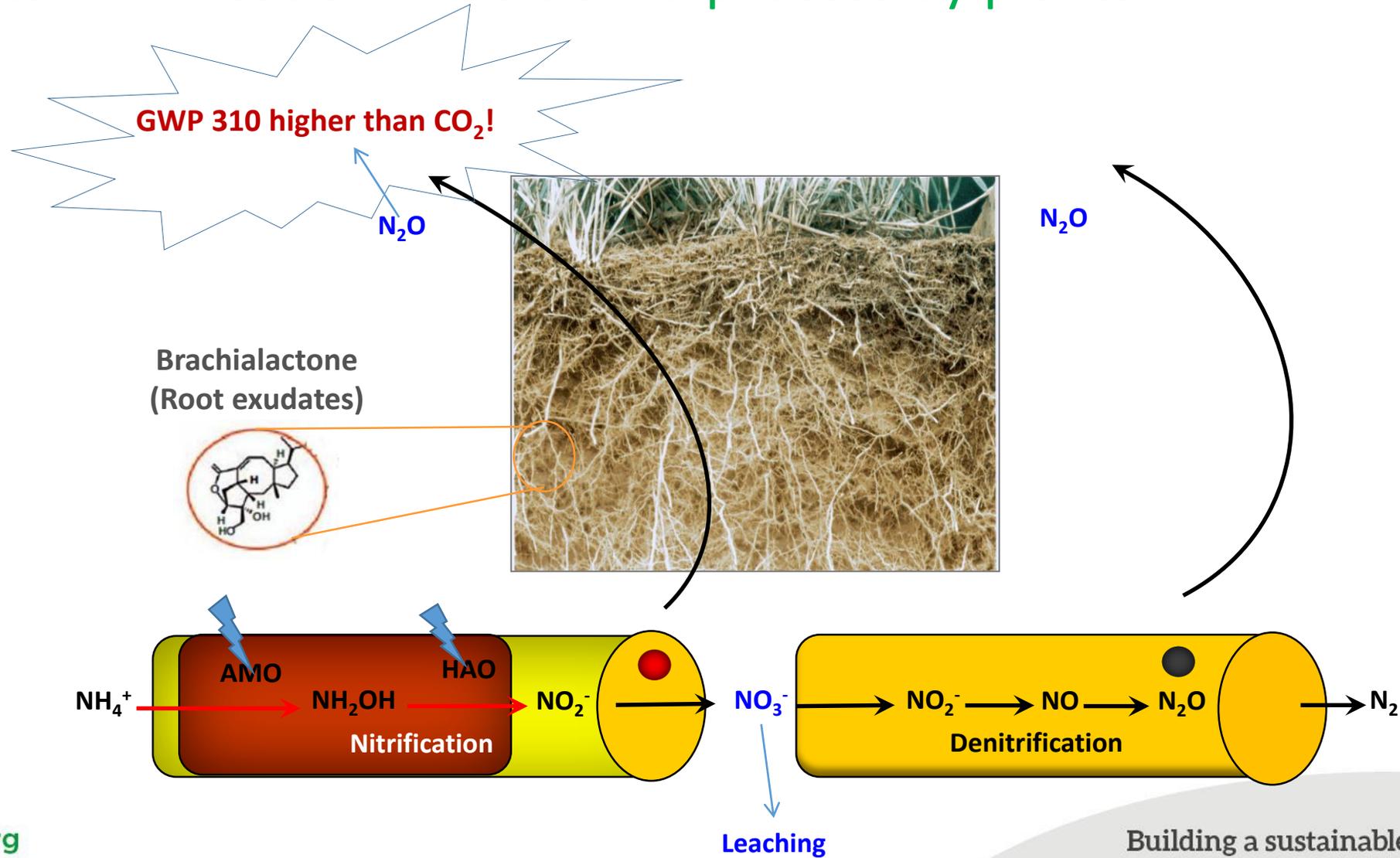
Soil organic carbon (SOC) – East Africa

SOC (g/kg)		Rwanda (2.5 year)		Kenya (1 year)		ILRI campus (2.5 years)	
	Greenhouse study (2.5years)	Santander de Quilichao	On farm	Katumani			
				+P	+N	No fertilizer	
Bare soil	20	29	24	26	28	24	22
Napier	21	30	23	27	29	26	22
Rhodes	22						
Basilisk	24	28	24	26	28	25	23
Tully	26	33		25	30	24	23
Llanero	26	34					
Tupi	26						
Marandu	23	28	23	28	28	26	24
Toledo	25	28	23	28	28	28	24
Piata	22	32	26	29	31	28	24
Mulato	24	28	23	27	28	26	
Mulato II	21	25	25	25	25	24	23
Caymán	25						
Mean	23	29	24	27	28	26	23

- Overall, a tendency for greater soil carbon accumulation from *Brachiaria* grasses
- Further statistical analysis is in progress

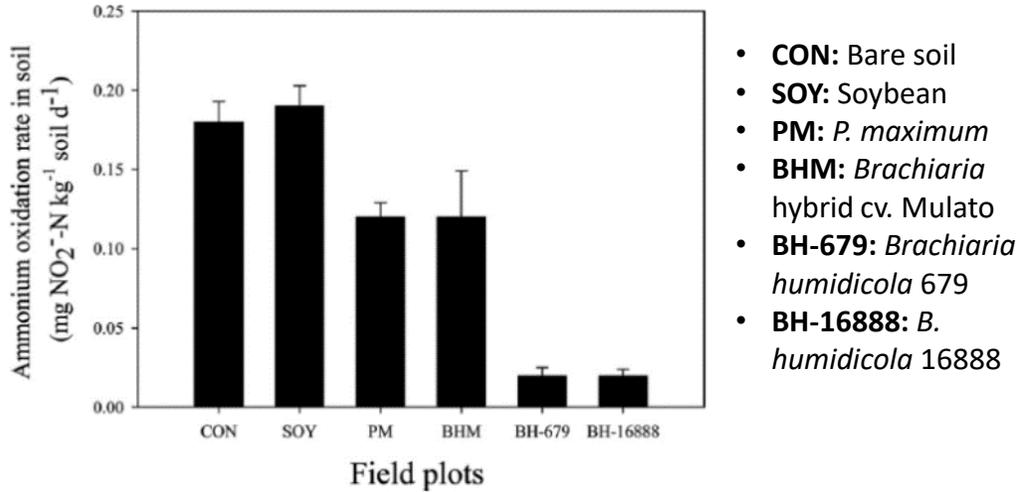
Contribution of *Brachiaria* grasses to GHG emission reduction

Biological Nitrification Inhibition: a process by plants

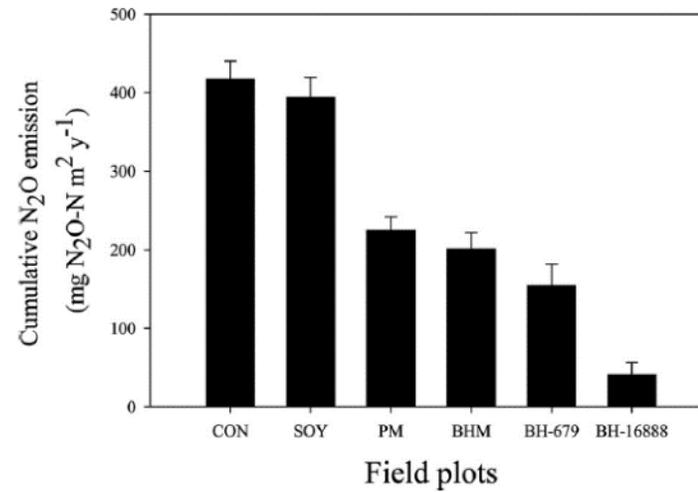


Evidence for Biological Nitrification Inhibition in *Brachiaria* pastures

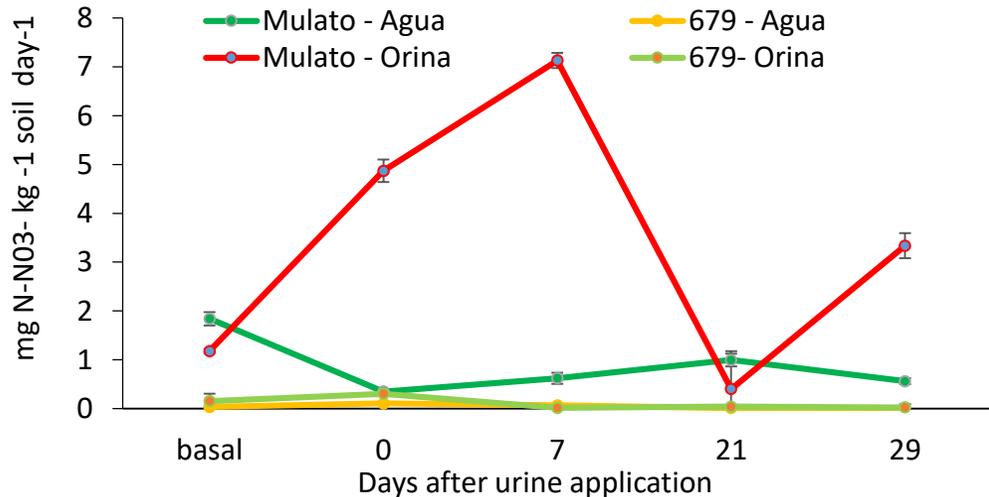
Soil ammonium oxidation rate



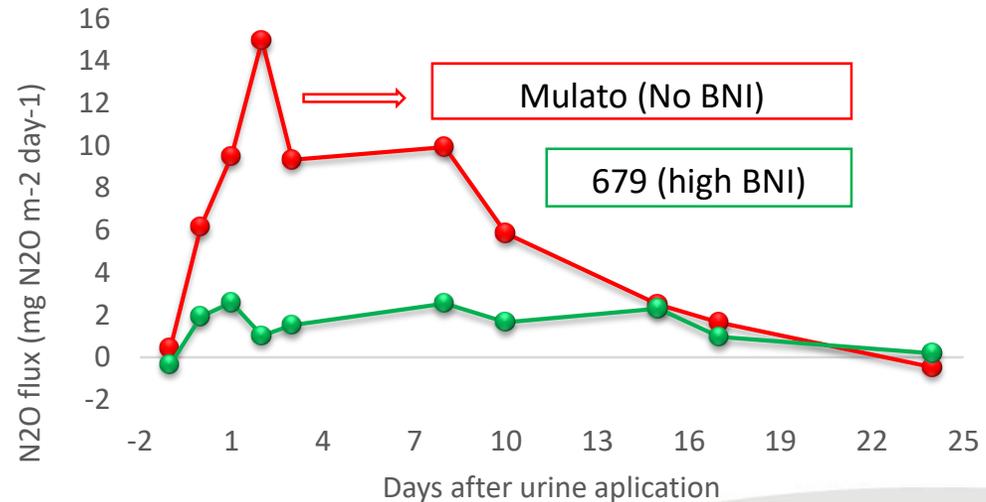
N₂O emissions



Nitrate production in soil



N₂O fluxes





Pillar 3: Institutions and Policies

Scaling of Tropical Forages

East Africa

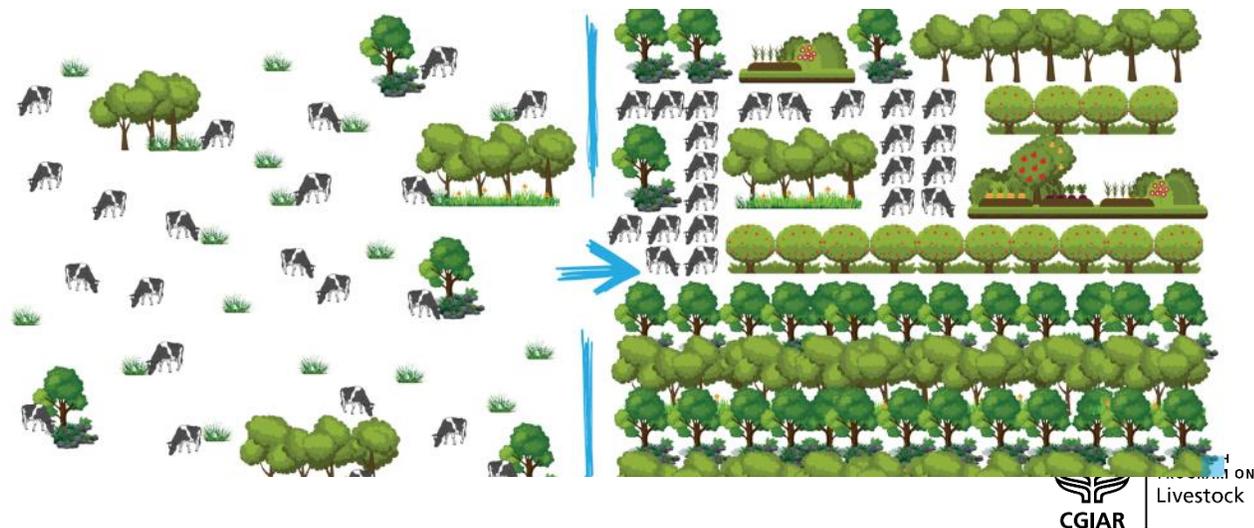
- Demo plots
- Field days
- 'Trade fairs'
- Fact sheets
- Close interaction with private sector e.g. seed suppliers and dairy cooperatives



Colombia

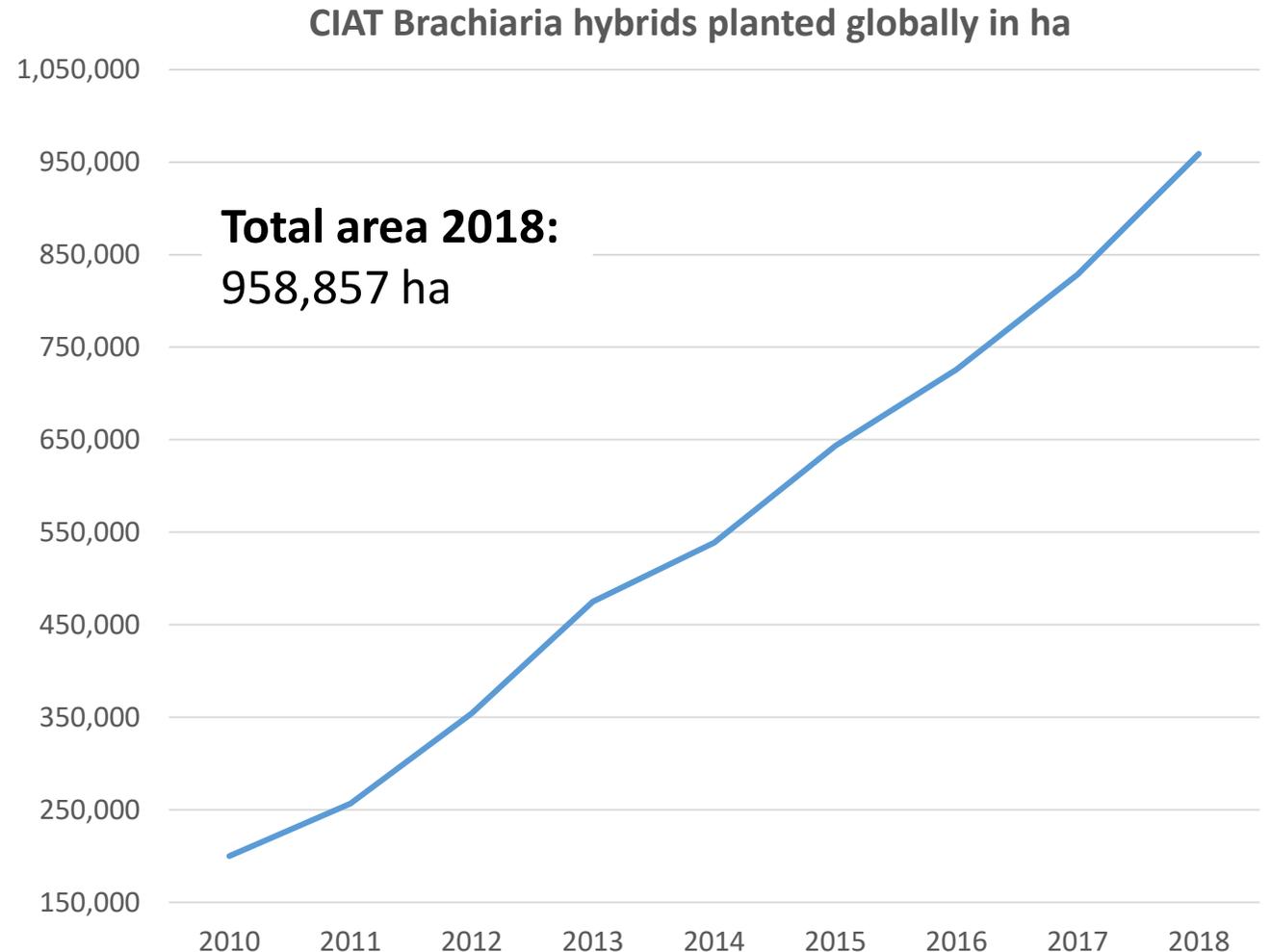
GANSO's farm level business model

- Support farms with extensive cattle operations to transition to an **intensified system** with improved pasture management boosting productivity and reducing land use
- a) Intensification of cattle operations; b) Diversification of production; c) Restoration and conservation



Collaboration with the private sector for boosting hybrid dissemination

- CIAT is collaborating with the private forage seed sector on *Brachiaria* hybrids since 2001
- Since 2001, CIAT's *Brachiaria* hybrids have been planted on over **950,000 hectares** in more than **30 countries** of the global tropics
- Since 2018 a **new agreement is in place** between CIAT and Papalotla, a Mexican forage seed company specialized on hybrids
- The main market is in Latin America but a **constant growth is being observed** for Africa and Southeast Asia



Colombian Roundtable for Sustainable Cattle and Dairy (MGS)



48 permanent members from the public and private sector in Colombia, including donors and scientific institutions.

The MGS works through 3 thematic commissions:



13 regional roundtables were created and cover all main cattle and dairy regions of Colombia. Principal tasks:

- Capacity building of primary producers
- Knowledge and information Exchange
- Development of innovations
- Influencers for regional policy making

ciat.cgiar.org

Idea: 2014

Formalization: 2015/16

Operational with annual work plan: since 2016

Main objectives of the MGS:

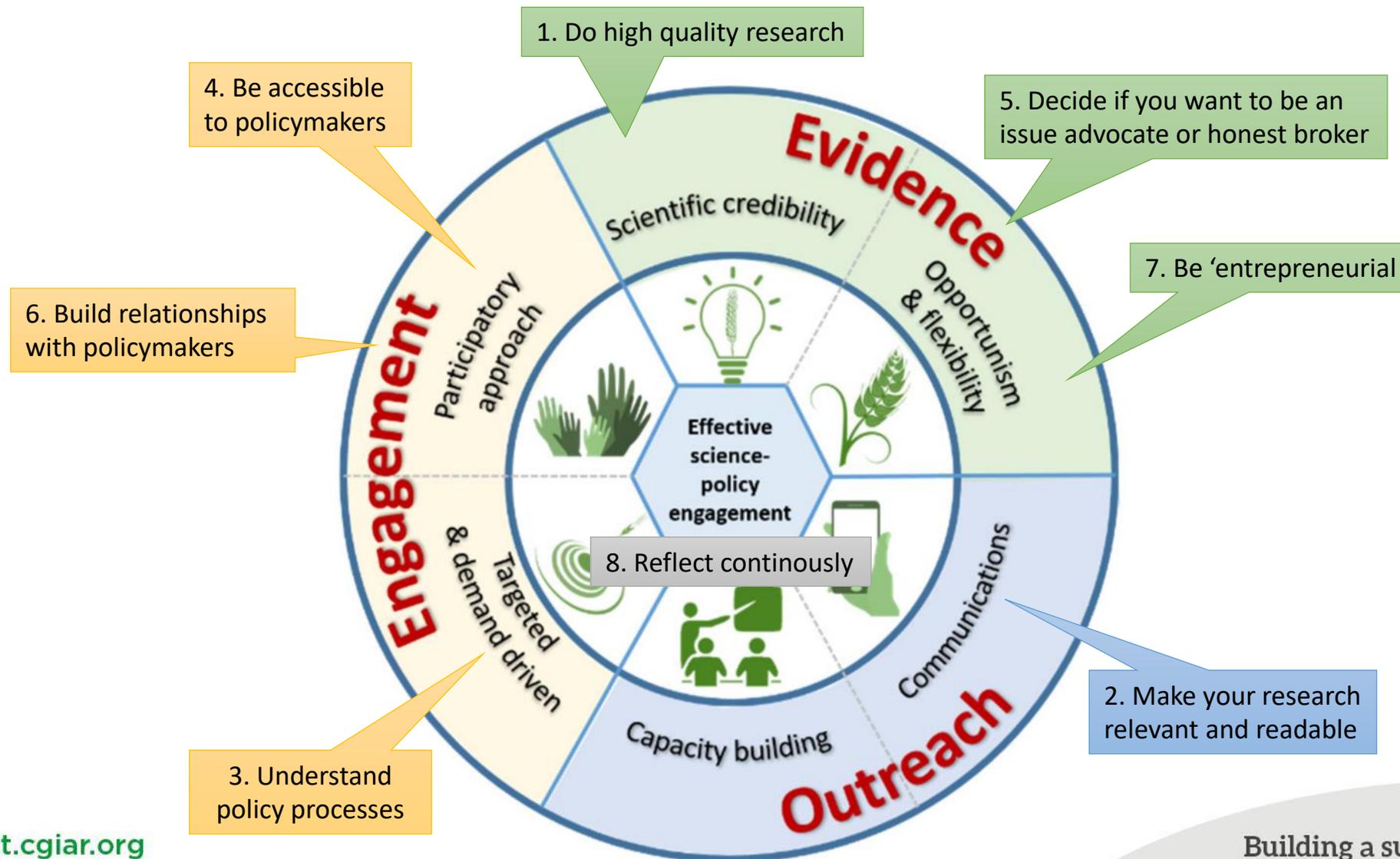
- 2018-20: Establish technical guidelines for a national level public sector policy on Sustainable Cattle/Dairy
- Constant knowledge exchange and dialogue among the members of the roundtable
- Fund raising for national level projects on Sustainable Cattle/Dairy
- Capacity building for primary producers and value chain actors both at regional and national level
- Integrating the MGS into the Global Roundtable for Sustainable Beef (GRSB) and exchange with other roundtables from Latin America (e.g. Brazil, Costa Rica, Mexico)

Building a sustainable future



The process of influencing decision-making

Engagement + Evidence + Outreach = Outcomes



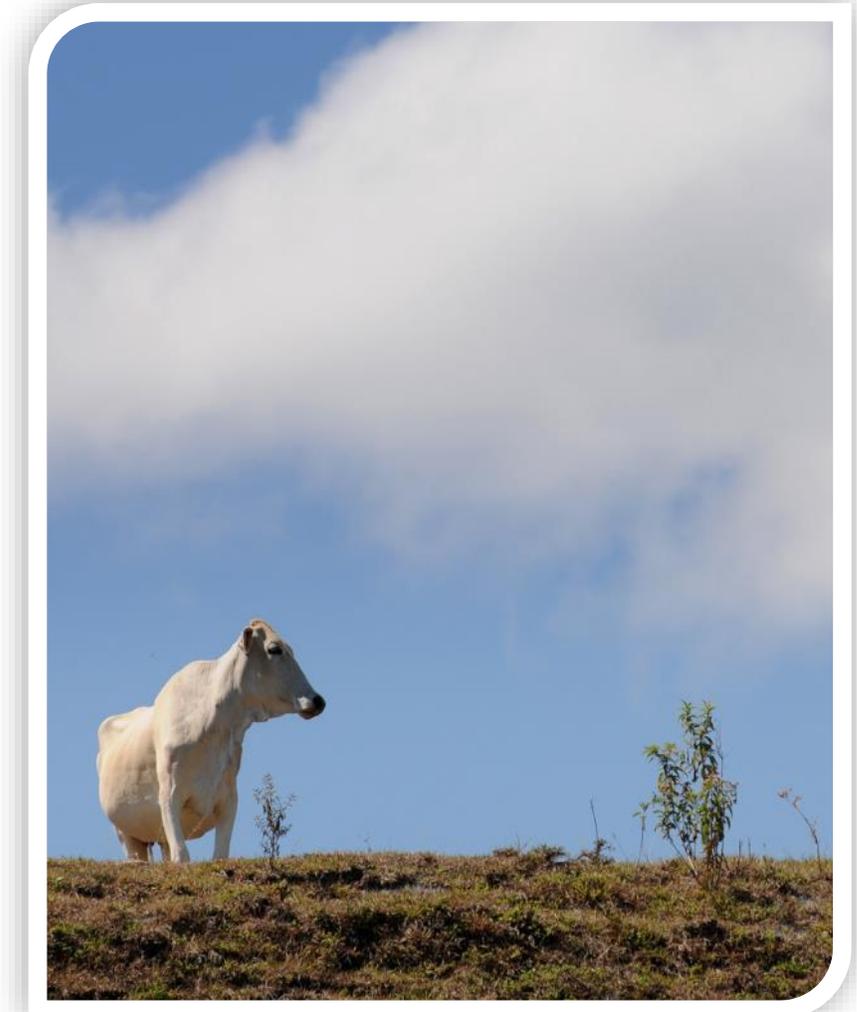
In conclusion

- Livestock is important for economies and livelihoods
- Livestock is affected by and contributes to CC
- Livestock productivity in SA is relatively low

- Real opportunities for triple wins
- Co-benefits and trade-offs need to be quantified

- Science has a role to play:
 - Development of solutions (technical and institutional)
 - Targeting and prioritization
 - Monitoring and Learning

- Research process is as important as results
 - Engagement, Evidence, Outreach



Thank you!



WE'RE PROUD TO
HAVE CELEBRATED 50 YEARS
OF AGRICULTURAL RESEARCH
FOR DEVELOPMENT

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GHG monitoring for program and policy support



- Rwanda's national strategy on Green Growth and Climate Resilience
- Rwanda's National Strategy for Climate Change and Low Carbon Development Strategy
- NDC for Rwanda -> improved quantitative reporting to IPCC
- Many organizations/investors interested in climate impact of their programs – including IFAD, Send a Cow
- Assist in arguing for increased investment from Green Climate Fund
- Carbon trading?



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CLEANED: minimum-data environmental ex-ante assessment tool

The quantification of

1. Production (absolute and per ha)
2. Land requirement for feed production (ha, ha/kg product)
3. GHG emissions (absolute, per ha, per kg product, per protein)
4. Soil health (Erosion, NUE, % area leached, % area mined)
5. Water use (absolute, per ha, per kg product, per protein)

+ simple Cost/Benefit calculations for intervention scenarios

In different livestock production systems; under different scenarios



Evaluating Land Management Options (ELMO)

Participatory tool for assessing farmers' land management (LM) decisions, preferences & trade-offs

- 1 Identify techniques & attributes to be discussed
- 2 Record respondent characteristics
- 3 Define LM techniques & baseline
- 4 Rank & Score LM costs & input requirements
- 5 Rank & Score LM benefits & desired outcomes
- 6 Rank LM advantages & positive attributes
- 7 Rank LM disadvantages & negative attributes
- 8 Rank and weight LM alternatives overall

Individual discussions with farmers

