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Climate smart approaches for reducing GHG emission from livestock in developing countries

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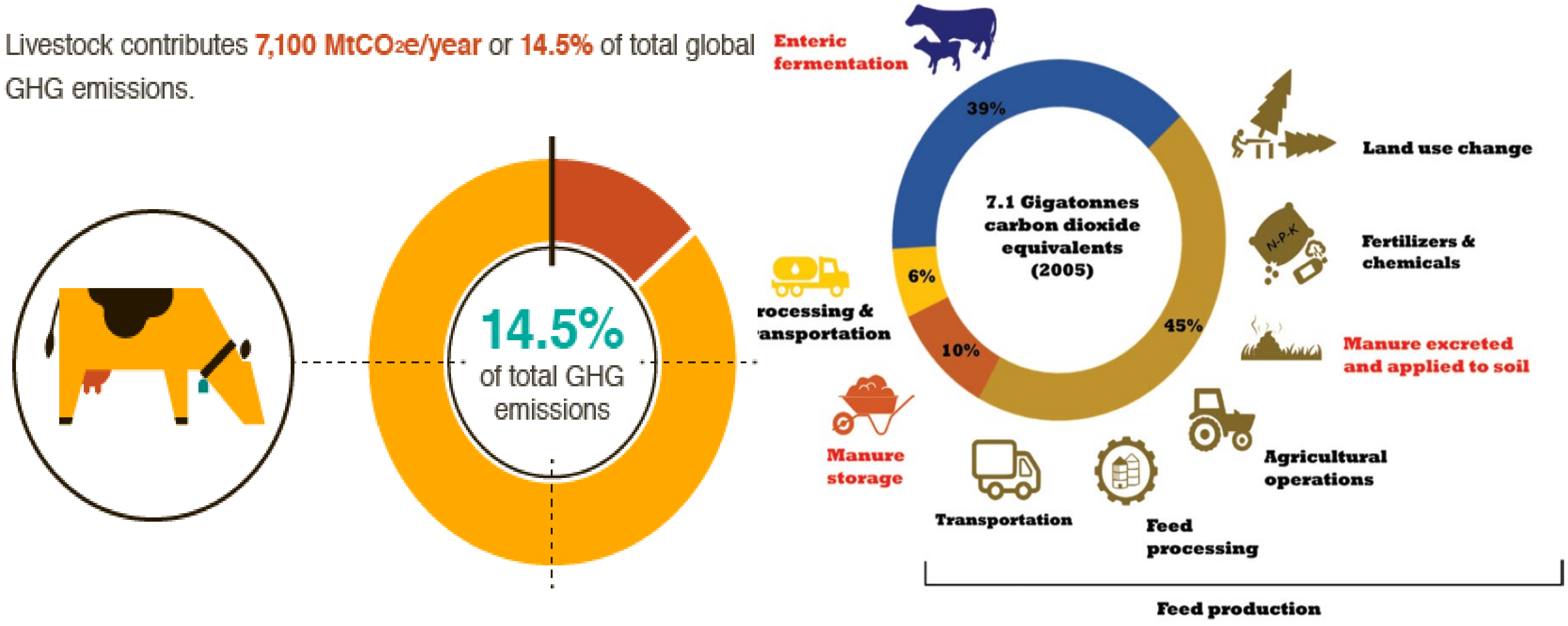
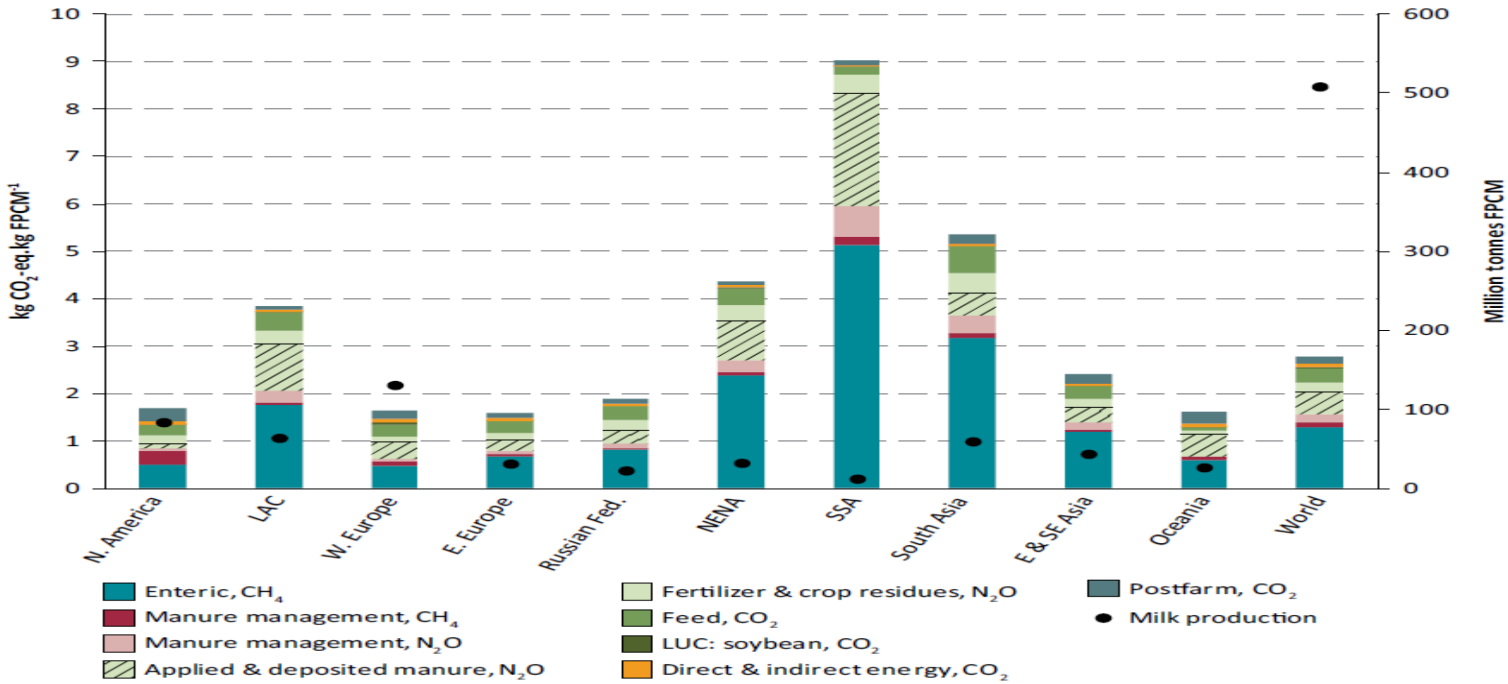
Livestock's contribution to GHG



Emissions by source (Gerber et al., 2013)

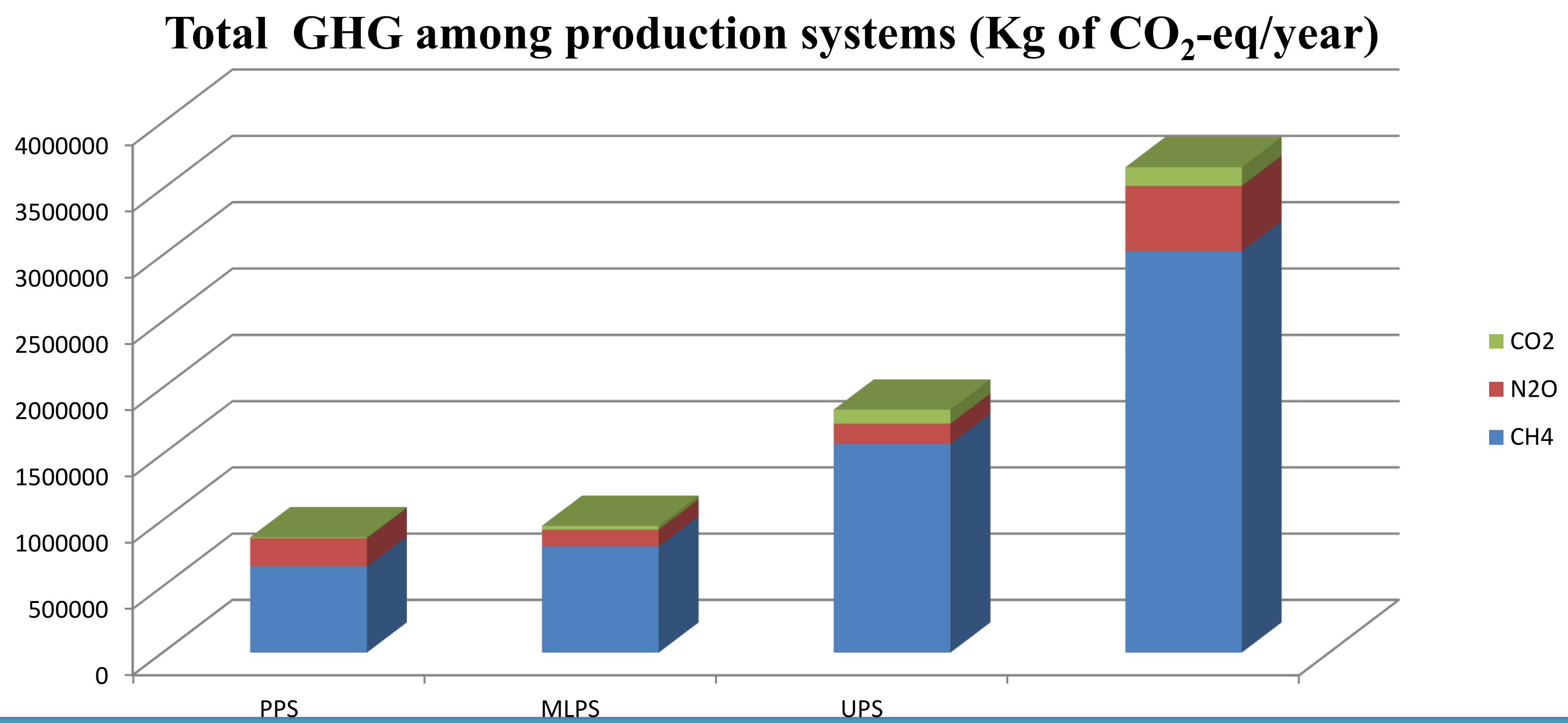
Why care about livestock emission from developing countries?

FIGURE 9. Regional variation in cattle milk production and GHG emission intensities



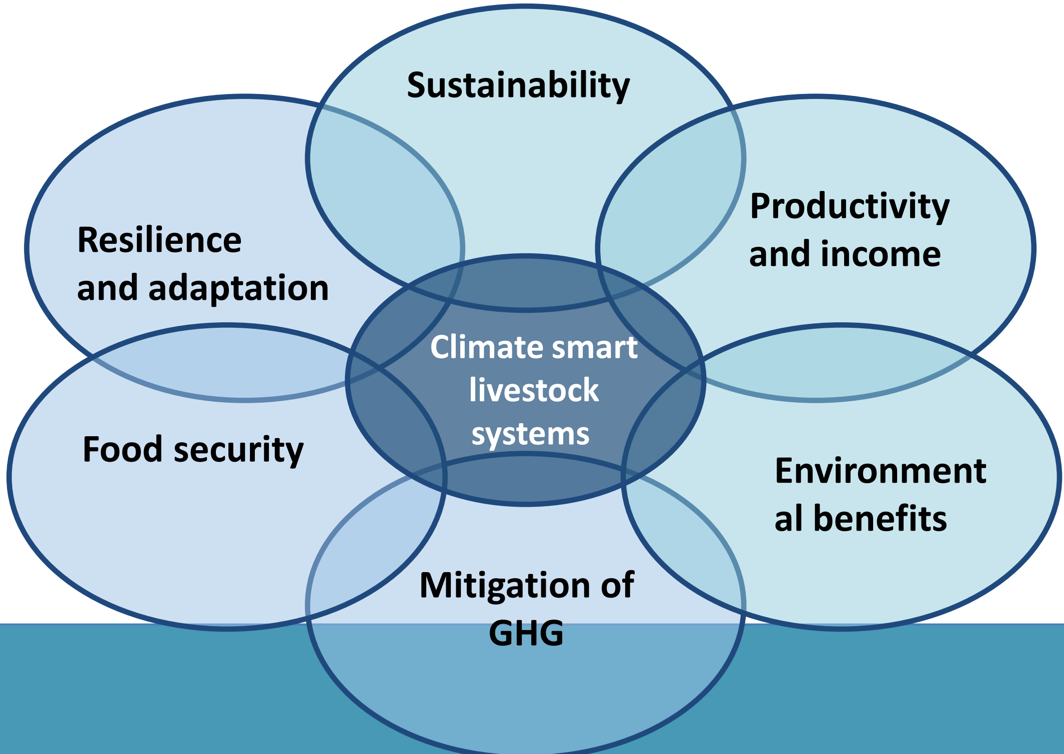
Source: GLEAM.

Not all systems in developing countries are the same



(Berehe et al., 2020)

Climate smart livestock



(FAO, 2013)

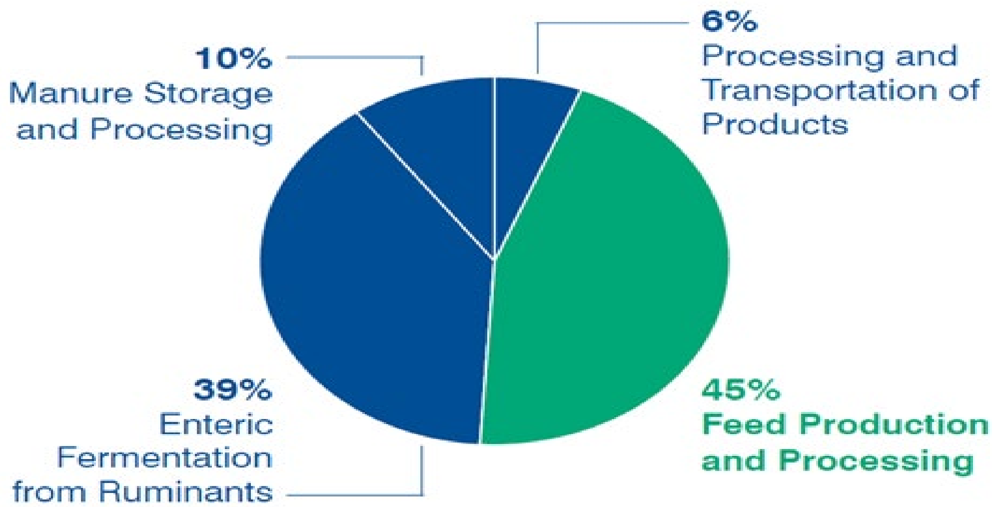
Climate smart interventions

- Breeding more productive animals
- Improving diets so that animals produce more protein with less feed and lower emissions
- Better manure management (e.g. composting)
- Better herd management to improve output, including better herd health management with less reliance on antibiotics
- Better management of grassland (e.g. sowing improved varieties of pasture, rotational grazing)
- Range and pastureland rehabilitation to improve biomass yield carbon stocks

Feed provides an excellent opportunity for climate smart interventions ?

- Feed provides opportunities for multiple gains (economic, food security, and GHG reduction)
- A reduction of CH_4 emission by 15-30% by feed interventions (Knapp et al., 2014).
- 58% of all rangeland in Africa degraded (UNEP, 1992)
- Rangeland rehabilitation the most opportune intervention for dual win increase in supply of quality feed and improve carbon stock and sequestration)

Global emissions from animal agriculture production



(FAOSTAT, 2019)

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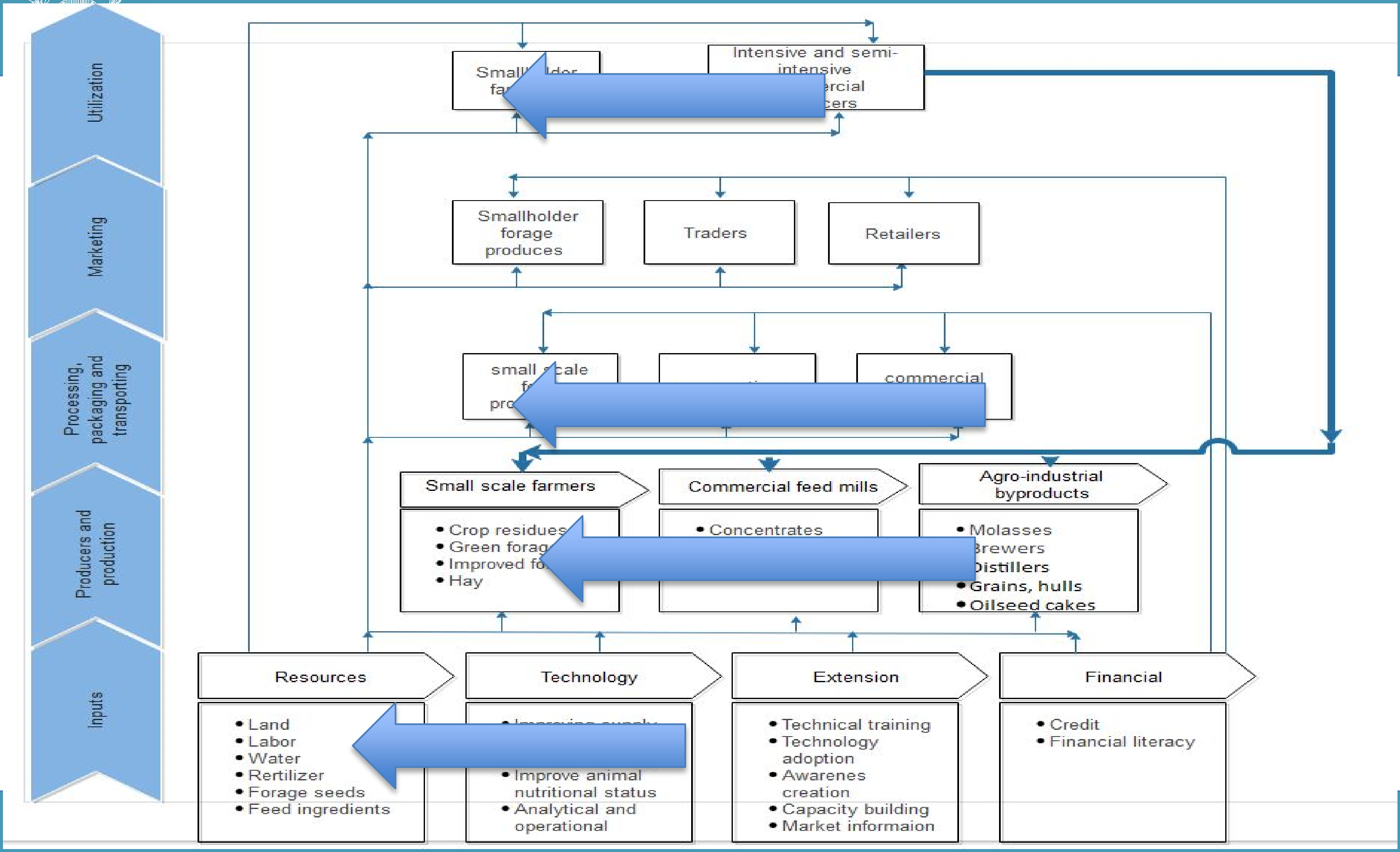

(Balehegn et al., 2020)

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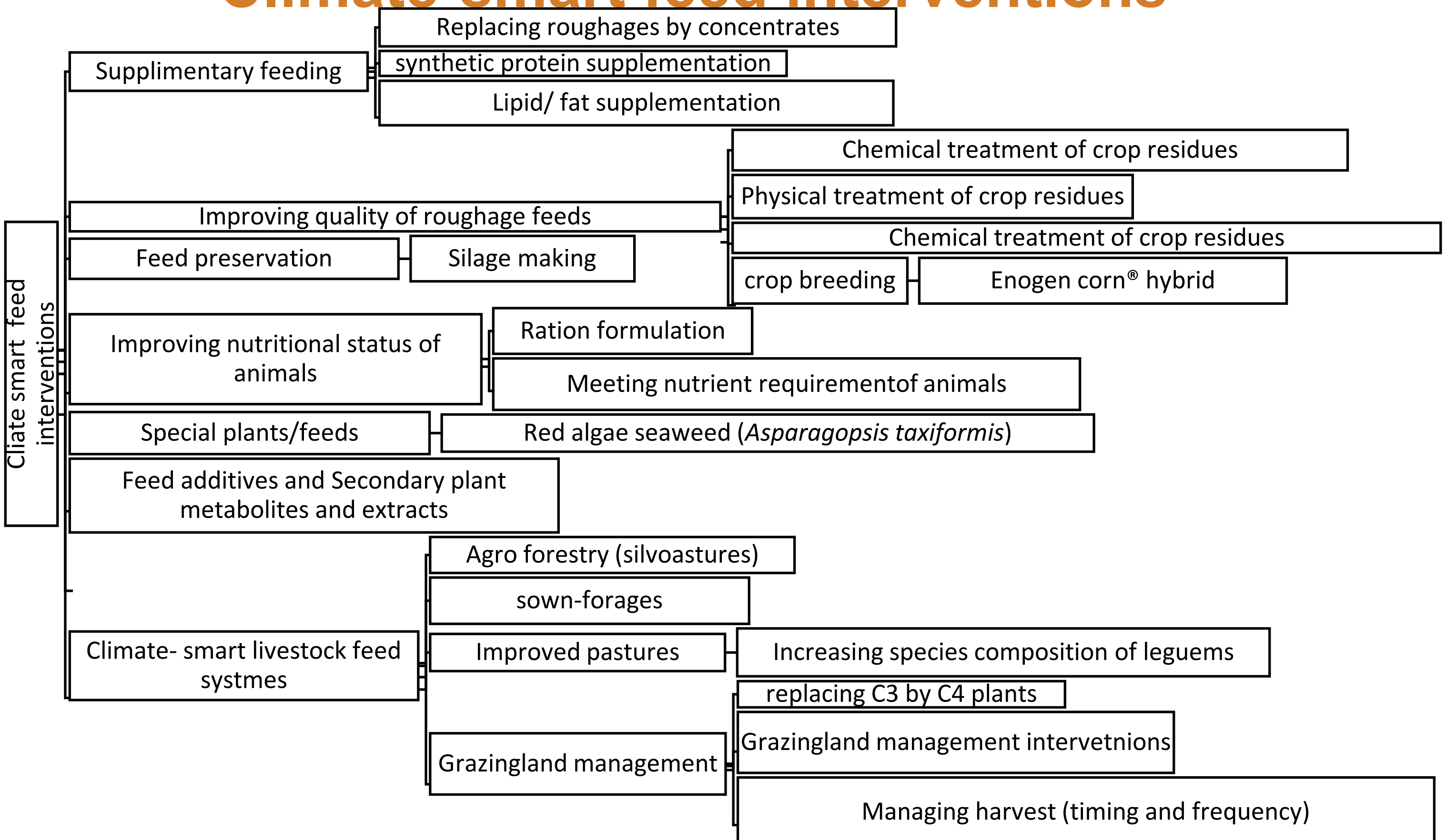
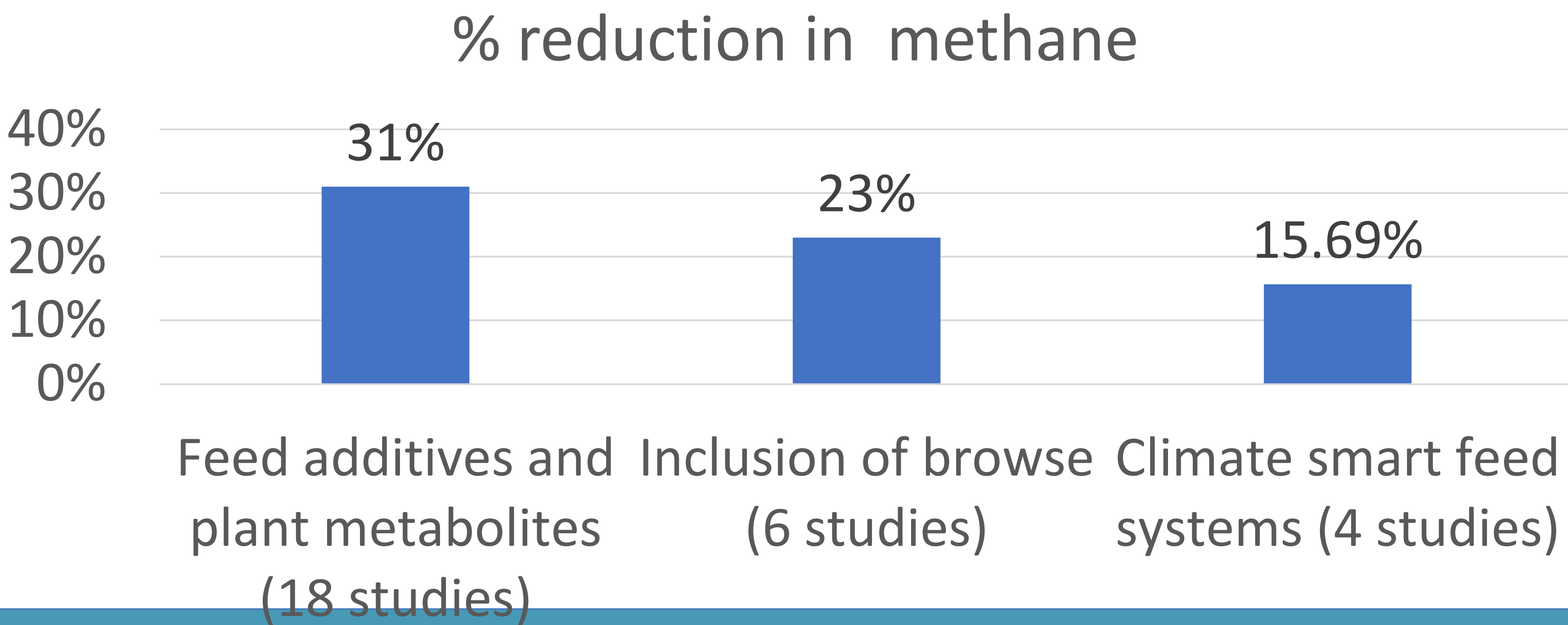
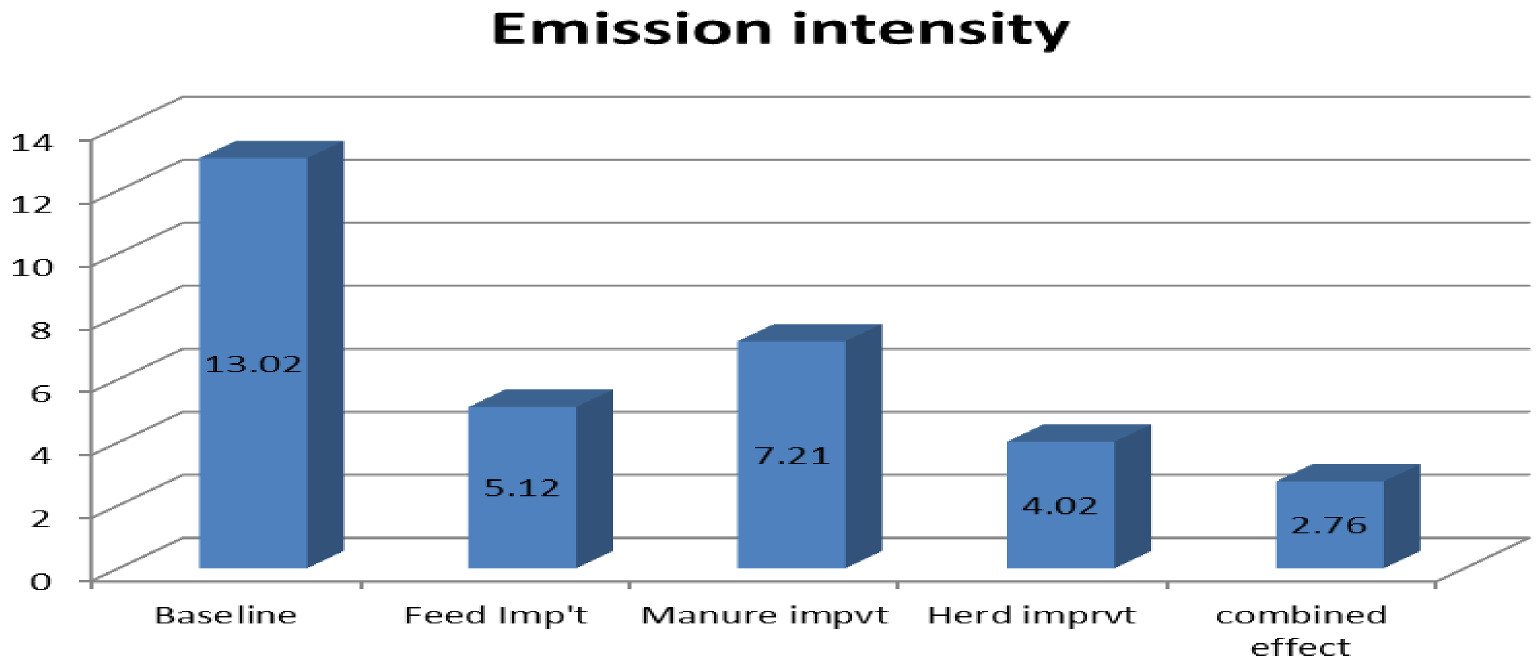
Climate-smart feed interventions



Impact of CS interventions

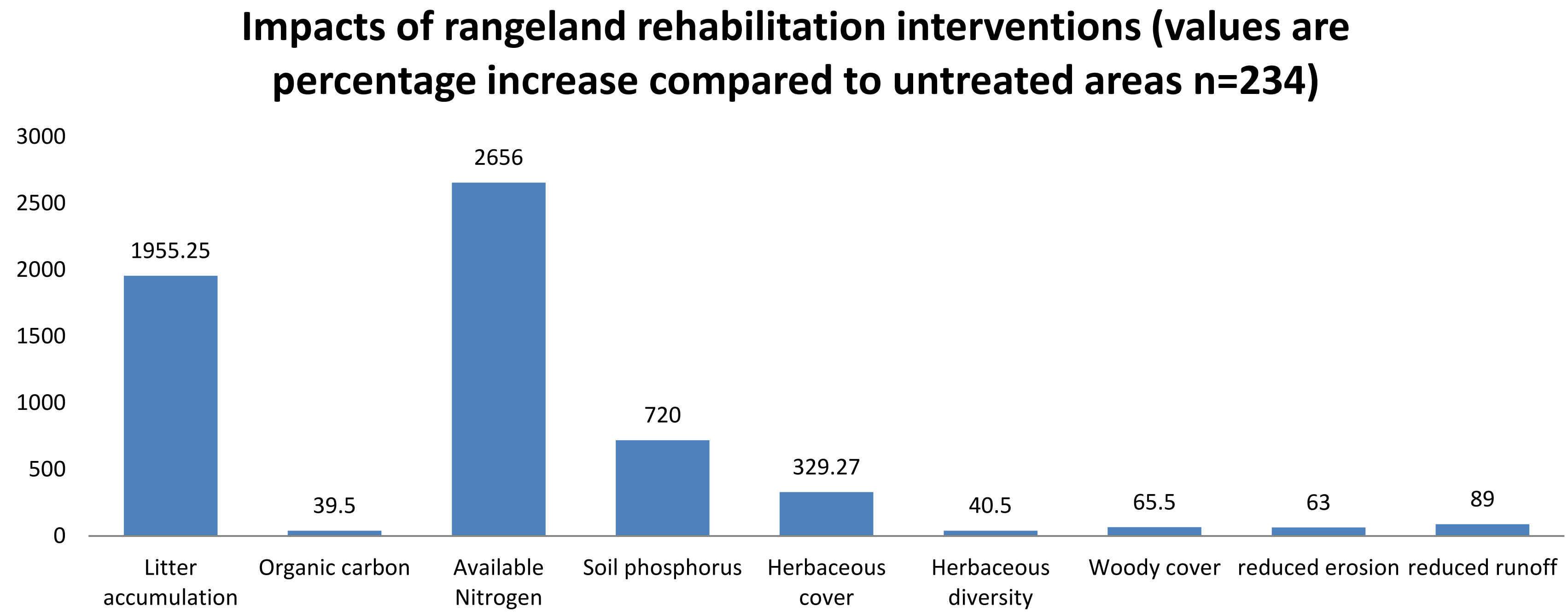


Impact of integrated climate smart interventions



(Berhe et al., 2020)

Impacts of rangeland rehabilitation interventions



(Balehegn et al., 2019)

Restoring degraded land - Ethiopia

FEED II project

- Constructed dams, rehabilitated a gully, sowed plants and forage.

Forage yields nearly doubled from 2016 to 2017.

Value of harvested forage ($40,000)

Healthier more productive livestock.

Farmers' incomes increased by 20%

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Tigray: Livestock/environment integrated interventions

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AMERICAS-TEST-2 AUGUST 22, 2017 / 8:22 AM / UPDATED 5 YEARS AGO

Ethiopia's Tigray Region bags gold award for greening its drylands

By Alex Whiting, Thomson Reuters Foundation

3 MIN READ

ROME (Thomson Reuters Foundation) - A major project to restore land in Ethiopia's Tigray Region to boost millions of people's ability to grow food won gold on Tuesday in a U.N.-backed award for the world's best policies to combat desertification and improve fertility of drylands.

Feed additives and plant metabolites

Technologies/ interventions	Impact (% reduction in GH_4)	Relevance and practicality to developing countries	References
(Lemon grass) (Cymbopogon citratur) supplement	33%	Practical	(Vázquez-Carrillo et al., 2020).
Extracted condensed tannins	30%	Practical, trade-off I reduction in digestibility and reduction in CH_4 emission. Research (in vitro) has mixed results	.(Abdalla et al., 2012)(Tavendale et al., 2005)(Tiemann et al., 2008)(Waghorn, Tavendale and Woodfield, 2002)
Tea Saponins	13 to 26%	Possible, but tea seed meal is expensive	(Hu et al., 2005)
Garlic oil	20-74%	Possible, more research required on impact on palatability and cost	(Busquet et al., 2005)(Macheboeuf et al., 2006)(McAllister and Newbold, 2008) (Mitloehner et al., 2020)
Organic acids	16%-75%	Practical, required in limited amount	(Foley et al., 2009)(Wallace et al., 2006)
Essential oils	10- 20%	Practical, required in small amounts,.	(Mitloehner et al., 2020)
Ionophores	30%	Expensive and illegal	(Guan et al., 2006)(Martin, Morgavi and Doreau, 2010) (Guan et al., 2006)
Lipids and fats	9%	Possible	(Eugène et al., 2008)
Chloroform	50%	Safety hazards	Farooq Iqbal et al., 2008)
3-NOP (3-nitrooxypropanol	30%	Possible feed additive	(Mitloehner et al., 2020)

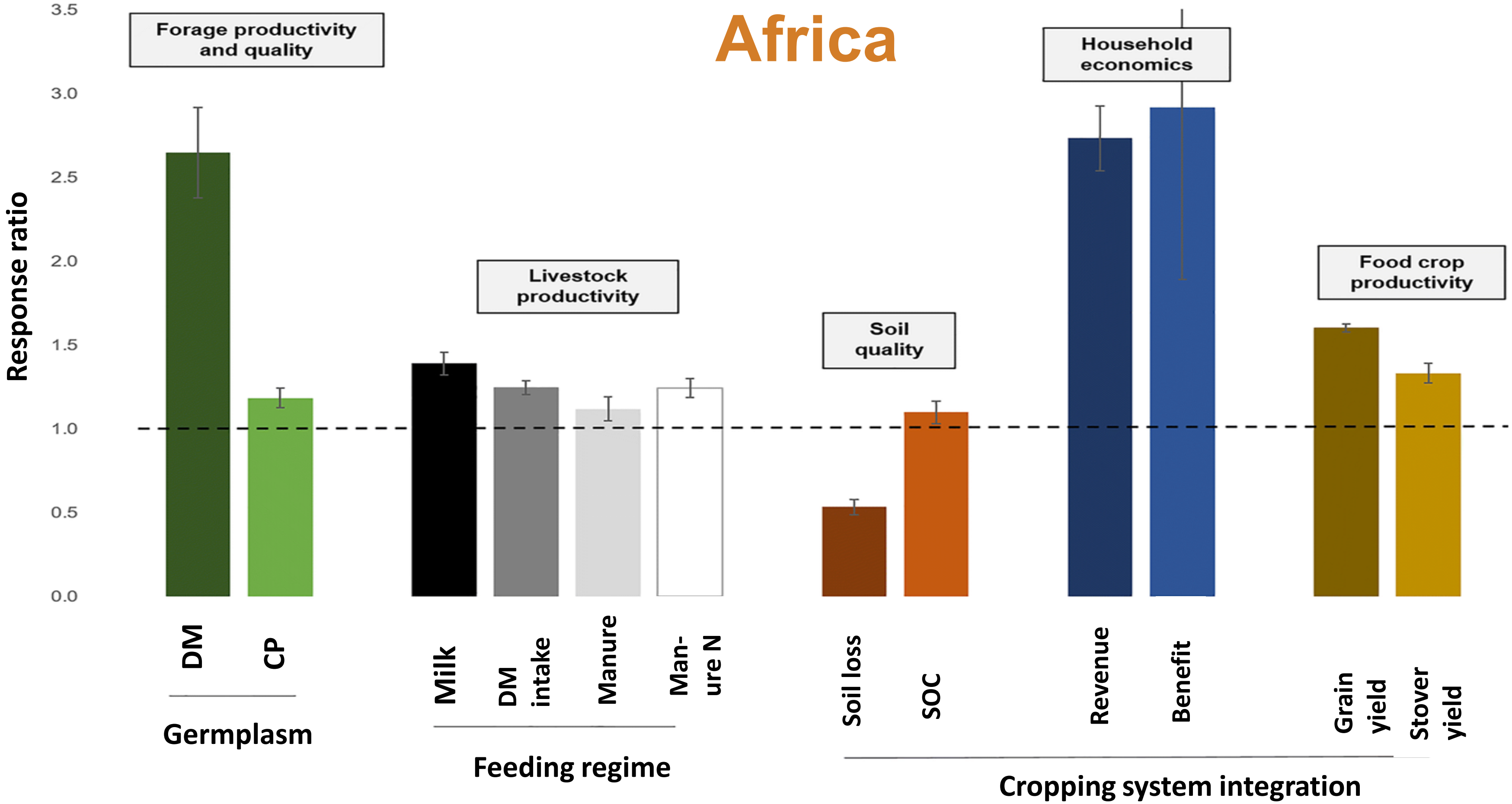
Inclusion of browses

Technology/ intervention	Impact (reduction in CH_4 or CO_2-eq sequestered)	Relevance to developing countries	References
Replacement of grasses by legumes	10%	Practical	(McCaughey, Wittenberg and Corrigan, 1999)
Replacement of crop residues by browse	Results in mitigation of 143 Mt CO_2-eq per year).	Traditional practice	(Thornton and Herrero, 2010)
Tanniniferous browse-Mimosa caesalpineaefolia	31.2%	Common	(Abdalla et al., 2012)
Tanniniferous browse (Leucaena leucocephala)	20%	Common	(Montoya-Flores et al., 2020)
Saponine and tannin containing browse (Samanea Saman).	57%	Traditional practice	(Salazar et al., 2018)
Enterolobium Cyclocarpum and Gliricidia sepium leaves and pods	6.3%	Common	(Molina-Botero et al., 2019)
Tannifereous plant-Terminalia chebula (seed pulp)	13%	Common	(Patra et al., 2011)

Climate smart feed interventions

Intervention/ technology	Impact (reduction in CH_4 or CO_2-eq sequestered)	Applicability	References
Harvesting forage at optimal stage of maturity	5-6.5%	Practical	(Robertson and Waghorn, 2002)
Pasture improvement (Improving botanical composition of high-quality forage species)	14%	Practical.	(Dini et al., 2018)
Crop breeding	10%	Possible to introduce improved varieties.	(Mitloehner et al., 2020;)
Cut and carry system as compared to extensive grazing	475 _144 g CO2 equiv. m_2 year_1 under cut and carry system compared to 228 _ 283 g CO_2 equivalent m_2 year_1 in extensive grazing	Practical	(Koncz et al., 2017)
Silvopastures	Emission of 1.7 kg CO_2-eq. per kg milk lowest compared to other farms	Practical	(Gaitán et al., 2016)
Silvopastures	Total C 90% compared to only 60% in native forests	Practical	(Amézquita et al., 2010)
Agroforestry	Increase in topsoil C by1.6 Mg C ha–1 y–1 compared to continuous maize cropping	Practical	(Mutuo et al., 2005)
Exclosures	Increase in carbon stock by 187.24% compared to freely grazed area	Practical in degraded rangelands	(Balehegn et al., 2019)
Silage making	A 33% reduction in CH_4	Practical with affordable inputs	(Benchaar, Pomar and Chiquette, 2001)(Shingfield, Jaakkola and Huhtanen, 2002)
Urea treatment of crop residues	20-10%	Practical	(Dong et al., 2004)

Benefits of improved forages in sub-Saharan Africa



72 study meta analysis

Paul, et. al (2020)

Cowpea in Nigeria, Burkina Faso

Improved cowpea adoption in a 2020 survey of 1,525 farms

	Adopters (38%)	Non -adopters (62%)	P value	% change
Cowpea yield, kg/ha	6.3	4.9	**	26.4
Net returns, Naira/ha	10.3	6.4	*	61.4
Total variable costs, Naira/ha	10.0	8.7	*	14.4

*= P< 0.05; ** P<0.01

I ha of improved cowpea can give an extra 50 kg of meat, plus 300 kg more grain due to improved soil fertility and animal manure.

Tarawali et al, 2003; Manda et al., 2020

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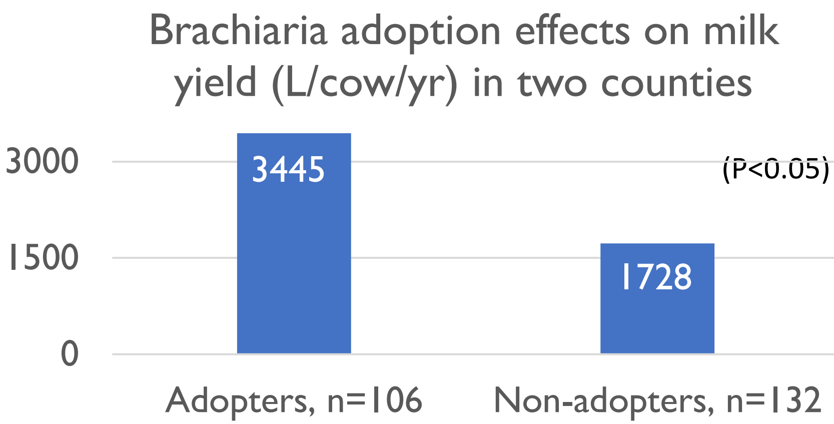
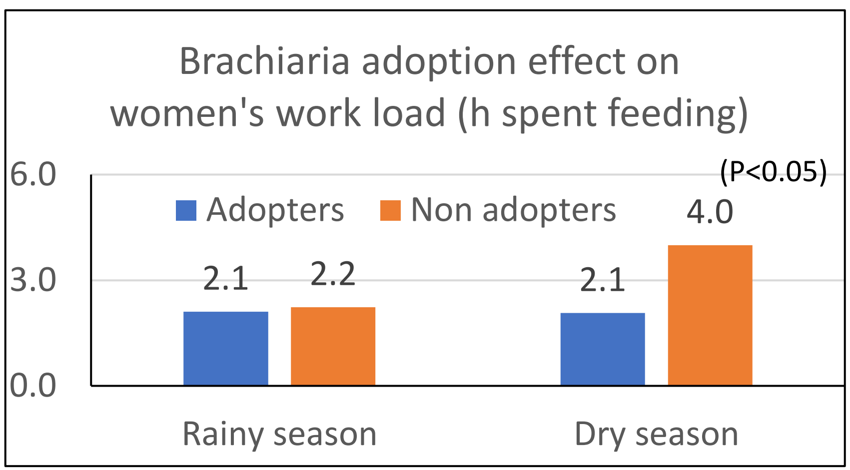
Brachiaria in Kenya

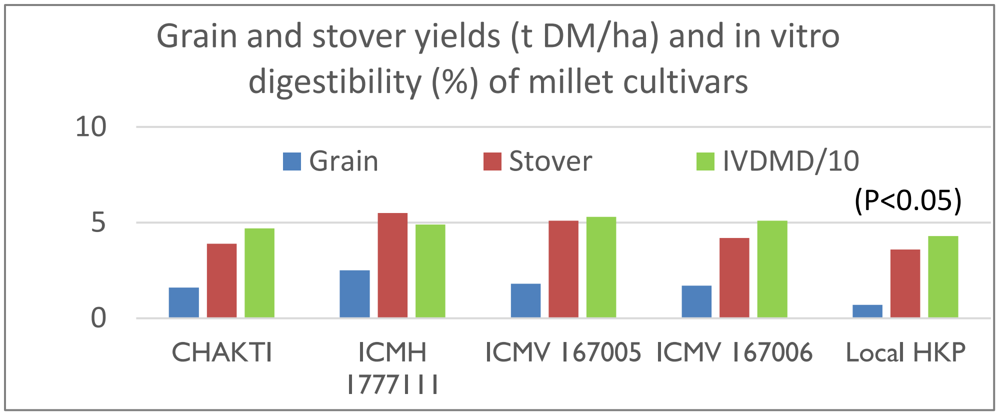




Maina et al., 2020

- Thousands of E. African dairy farmers switching from Napier to climate-smart Brachiaria
- Trap crop for stem borers
- 27.6 to 40% greater milk yield among adopters
- Greater yield, crude protein, N efficiency than Napier; acid soil tolerant, promotes soil health
- Tolerates grazing, cut and carry, and is easily established and disease resistant

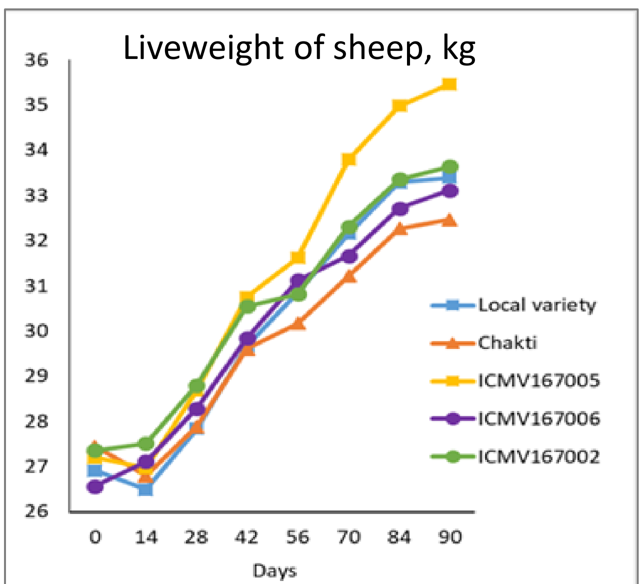
Pearl millet in Niger



Adoption of improved varieties in 2009

Country	Area, million ha	Area (%)
Burkina Faso	1.2	2.6
Mali	1.5	31.1
Niger	3.7	25
Nigeria	1.0	34.5

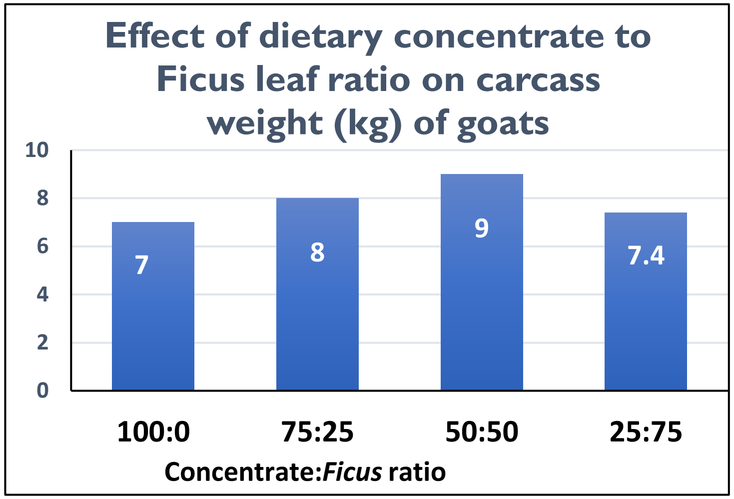
Ndjuenga et al., 2015

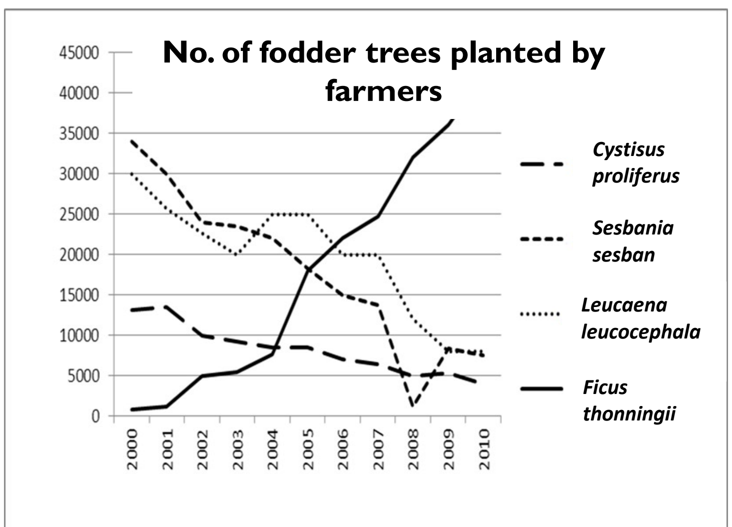


- Drought tolerant dual-purpose varieties ideal for semi-arid areas
- Higher crude protein, DM yield than local varieties
- Newer more digestible brown midrib varieties

Bado et al., 2020

Ficus thonningii in Ethiopia





- Easy to establish, matures in < 5 yr, withstands lopping, quick leaf regrowth, drought tolerant
- High CP (≤ 21%), DM digestibility (≤ 85%), yield
- Up to 5x the yield of other fodder trees
- Adopted by more than 20,000 households
- Contributed to rehabilitation of grazing lands
- Increased biodiversity (wild birds and weeds)

Balehegn et al. 2014; 2015.

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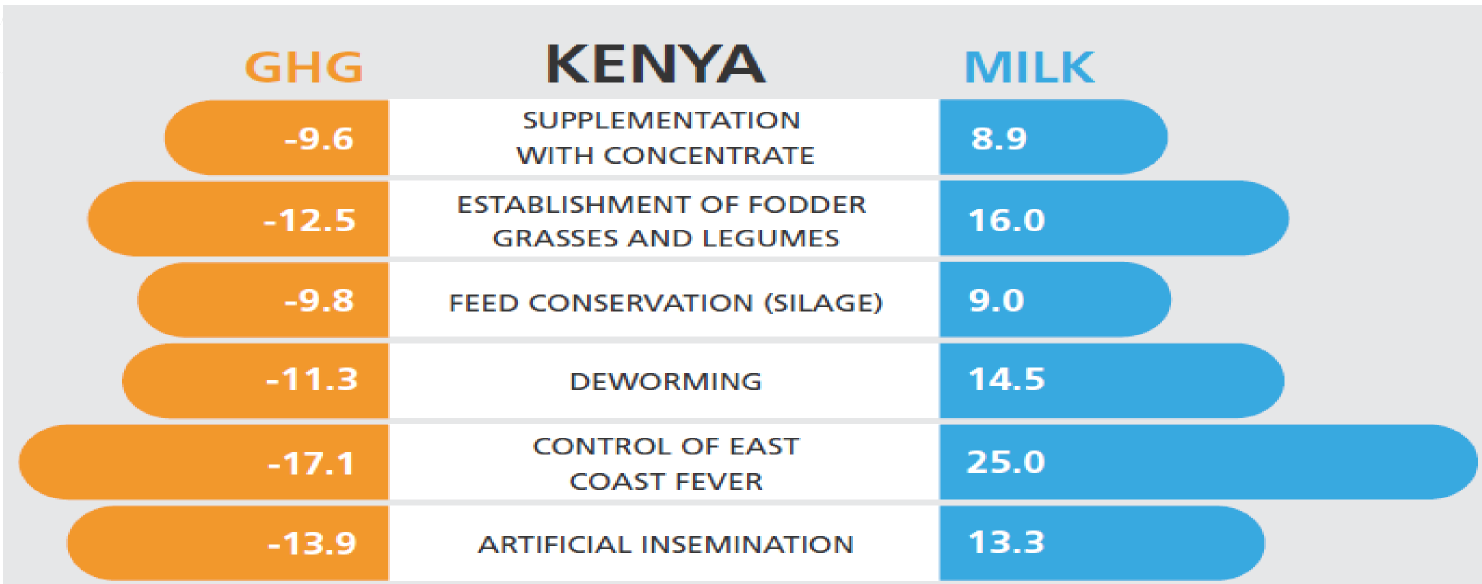
Integrated solutions for productivity and environment wins



http://www.fao.org/in-action/enteric-methane

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Take home messages

- The need for integrated assessment, GHG quantification missing from most studies.
- Several examples of working intervetions exist, but most GHG reduction strategies need refining
  - Economic, environmental and long-term efficacy merits, especially considering the complex biophysical and social settings of smallholder producers in developing countries.
- Need for scaling of successful technologies
- Greater policy support and synergy in efforts of governments, donors, private sector are needed

Specific recommendations

- Balance animal diets with low inclusion of roughages and higher incorporation of forage grasses/legumes and energy concentrates
- Improve the quality of crop residues through various treatments
- Use crop cultivars with superior residue quality (selection, breeding)
- Reduce particle size of roughages (chopping, grinding) before feeding
- Use feed additives such as organic acids, lipids, fats, yeast, enzymes and 3-nitrooxy propanol (3-NOP) that can reduce enteric methane production after assessing their techno-economic feasibility and practicality of field application
- Promote climate smart livestock systems (silvopasture, range and pastureland rehabilitation, integrated with breed improvement and manure management).

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