Livestock, Climate and System Resilience

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Bioversity International

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

CGIAR

Agroecological transformation of tropical livestock production through silvopastoral systems

Jacobo Arango et al.

Theme leader

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TropenTag 2022, Prague, Czech Republic, 14–16 September 2022

Importance of sustainable Livestock production systems

17
BILLION

The estimated total number of livestock worldwide

(including cattle, sheep, goats, pigs, chickens, and about a dozen lesser known species, like guinea fowl, yaks, and camels).

About two-thirds of the world's total agricultural area

4.9 Bha

is used to feed livestock, including

3.3 Bha
Of grazing land

25%
Total crop area

The value of livestock as a global asset reaches

USD3.1
TRILLION

that accounts for some

1.3 Billion jobs

~200 MHa

In America Latina alone, have been **degraded by overgrazing and other unsustainable production practices.**

This negative impact is similar in most areas used for feed 70% of sweet water to agriculture, 22% to livestock

The annual contribution of livestock to climate change, which is about

8.1 billion tCO_2eq

50% Of total agricultural emissions

15% of all human-induced greenhouse gas emission

These includes emissions from deforestation to make way to pastures.

Peters et al., 2013

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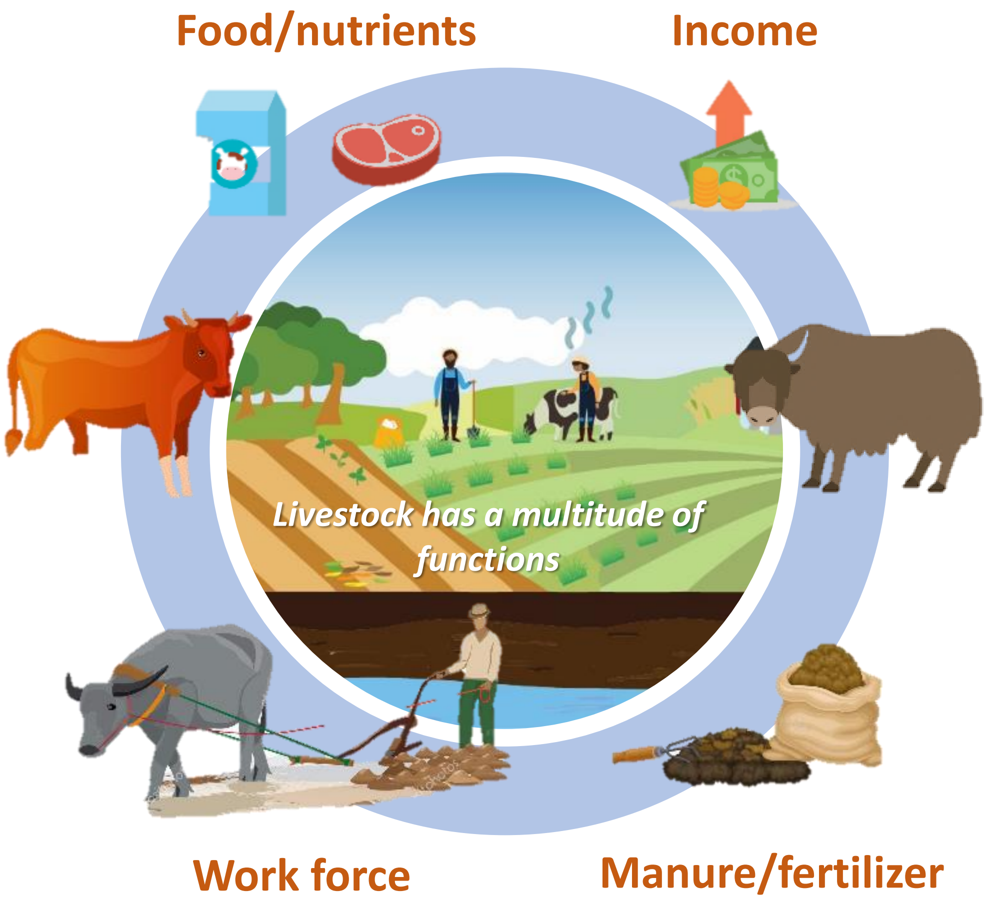
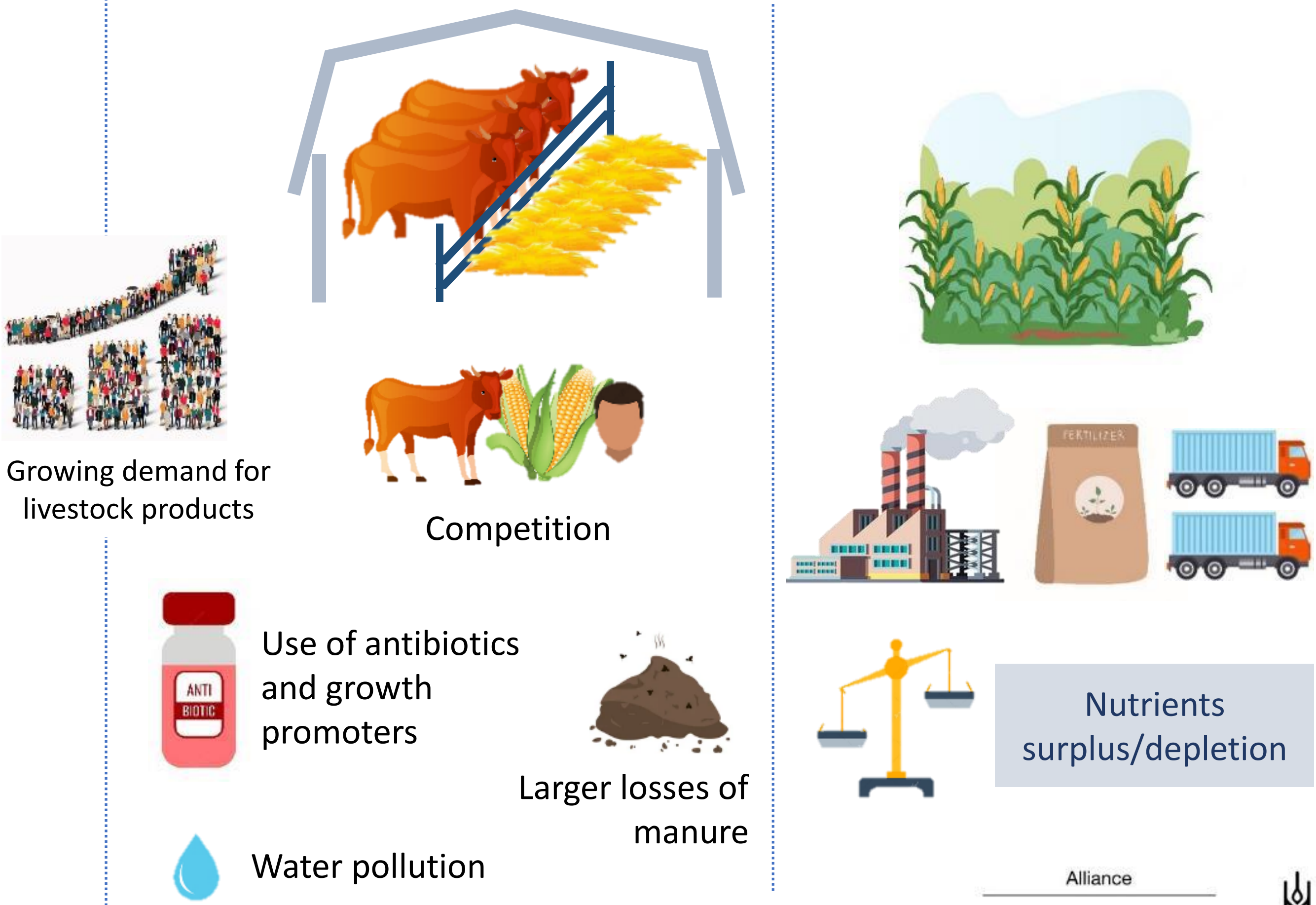
Importance of sustainable Livestock production systems

In **family farming**, livestock production mainly occurs in **mixed crop-livestock** systems



In **specialized livestock production** systems, crops and livestock are spatially **decoupled**



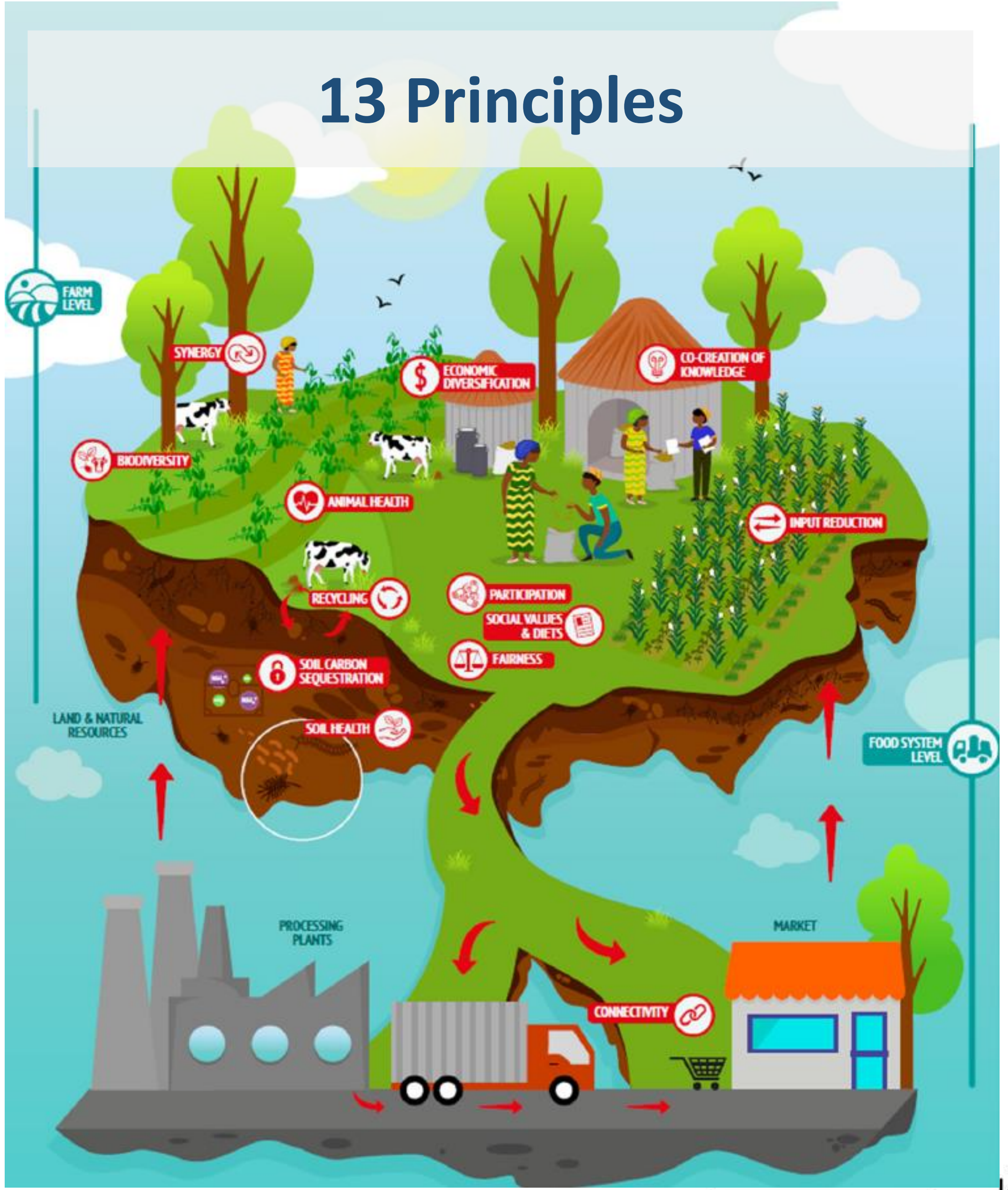
The agroecological framework

Agroecology

“A set of principles and practices intended to enhance the sustainability of a farming system, and it is a movement that seeks a new way of food production”

3 components:

1. Is a scientific discipline, studying the ecology of agricultural systems
2. Has evolved into a set of agricultural practices
3. Has turned into a movement that incorporates social justice, food sovereignty and the preservation of cultural identities

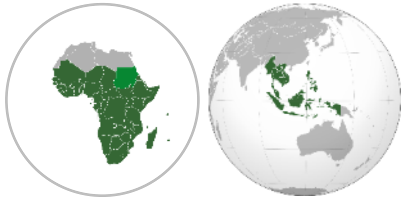


Ensuring system sustainability through integrating improved forages in mixed crop-tree-livestock systems in the tropics

In the Global **South**, livestock production takes place in a **variety** of production systems

Latin America & the Caribbean

Permanent grasslands

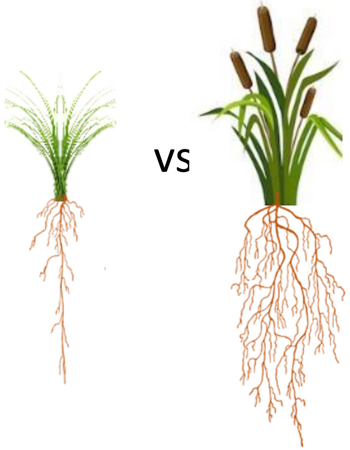


Sub-Saharan Africa & South East Asia

Cut and carry

The power of **Improved** forages

Highly productive



Better feed quality

But also adapted/tolerant to…

BIOTIC

Spittlebug pest

Rhizoctonia foliar blight

ABIOTIC

Soil acidity

Water scarcity

Water excess

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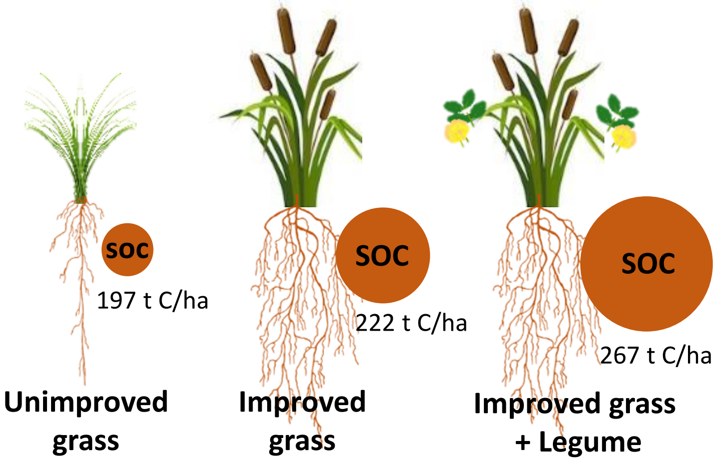
Ensuring system sustainability through integrating improved forages in mixed crop-tree-livestock systems in the tropics

Gaviria et al 2021. Fron. Vet. Sci.

Sustainable intensification of (**improved) forage**-based systems, combining genetic, ecological and socio-economic intensification processes, increases the efficiency of the systems, has the potential to improve livelihoods, and yields a range of environmental co-benefits.

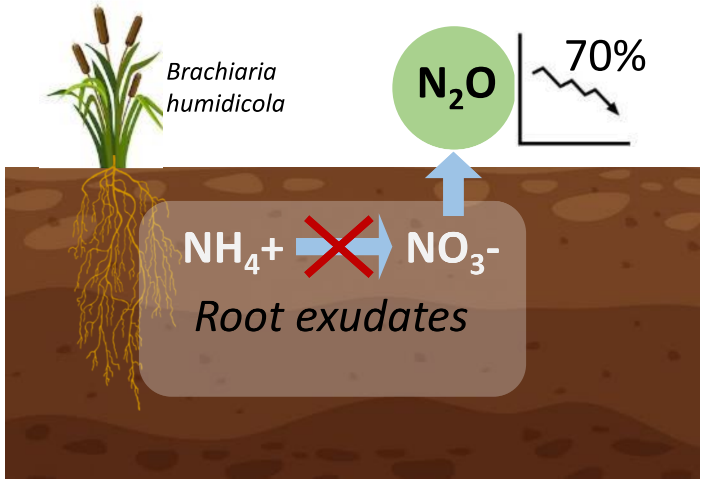
Carbon sequestration



Fisher et al 1994. Letters to Nature

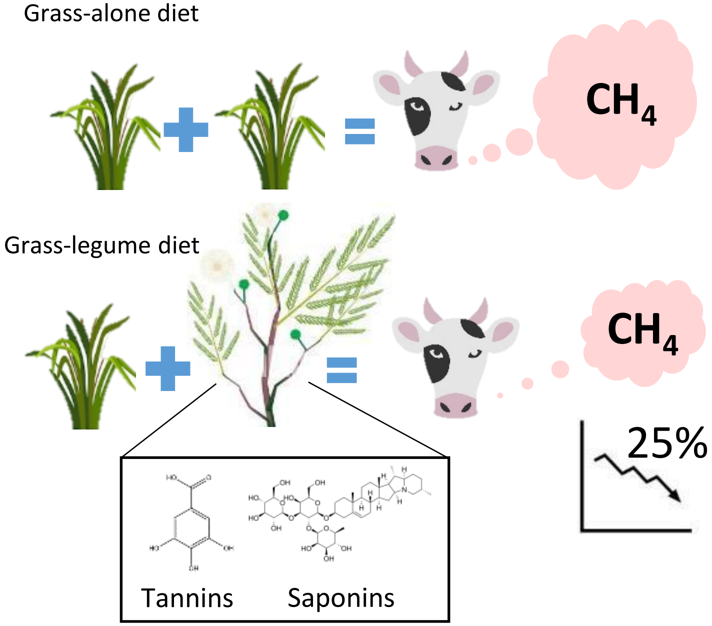
Mitigation of N_2O emissions

Biological nitrification inhibition (BNI)



Subbarao et al 2009. PNAS

Mitigation of CH_4 emissions

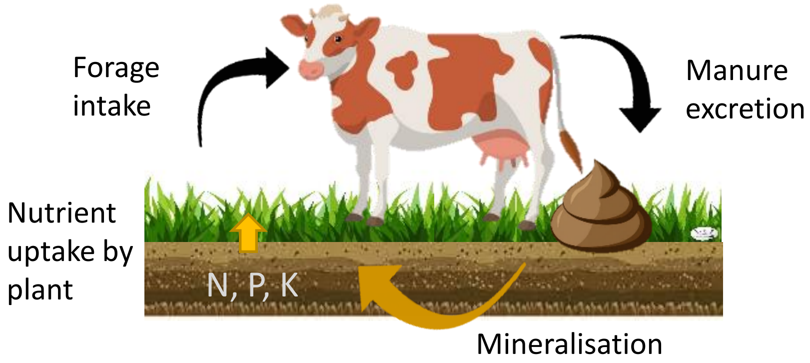


Contributions of improved cultivated forages to Agroecological transformation

Villegas et al 2020. Diversity

1. Recycling

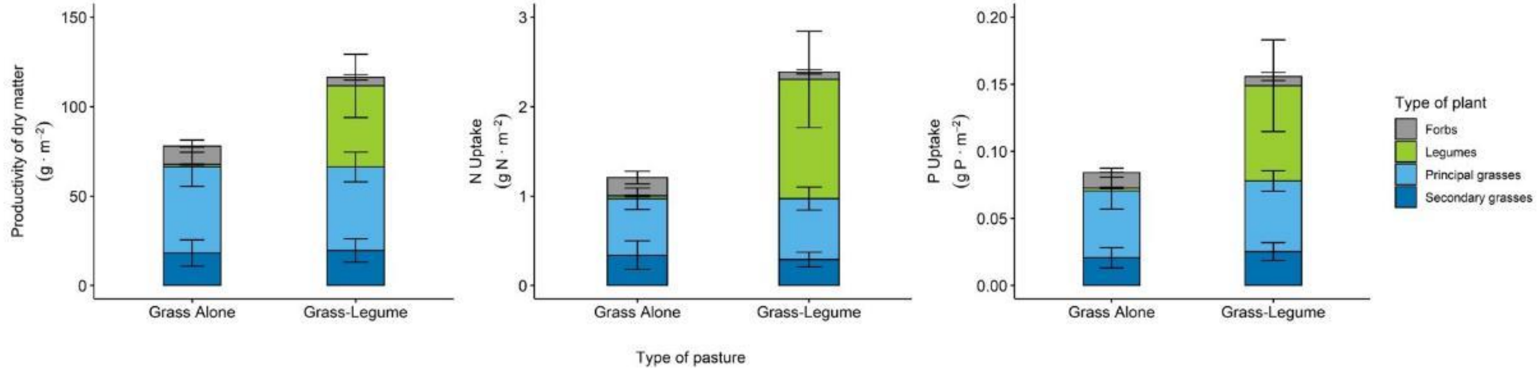
Use **local** renewable resources as much as possible and close as far as possible resource cycles of nutrients and biomass



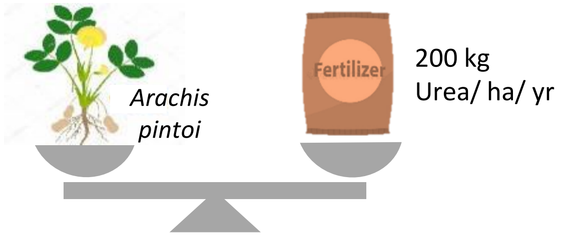
2. Input reduction

Reduced need for **external** inputs (feeds, agro-chemicals and water)

Biological N fixation (BNF) of tropical forage legumes



- The integration of legumes increased pasture **biomass** production by about 74%
- N and P **uptake** were improved by two-fold.
- The legumes derived about 80% of their N via symbiotic N_2 **fixation**.

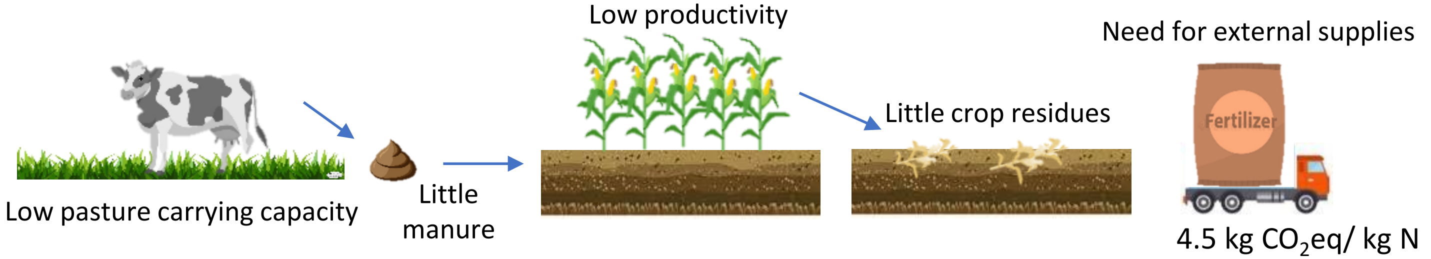


Contributions of improved cultivated forages to Agroecological transformation

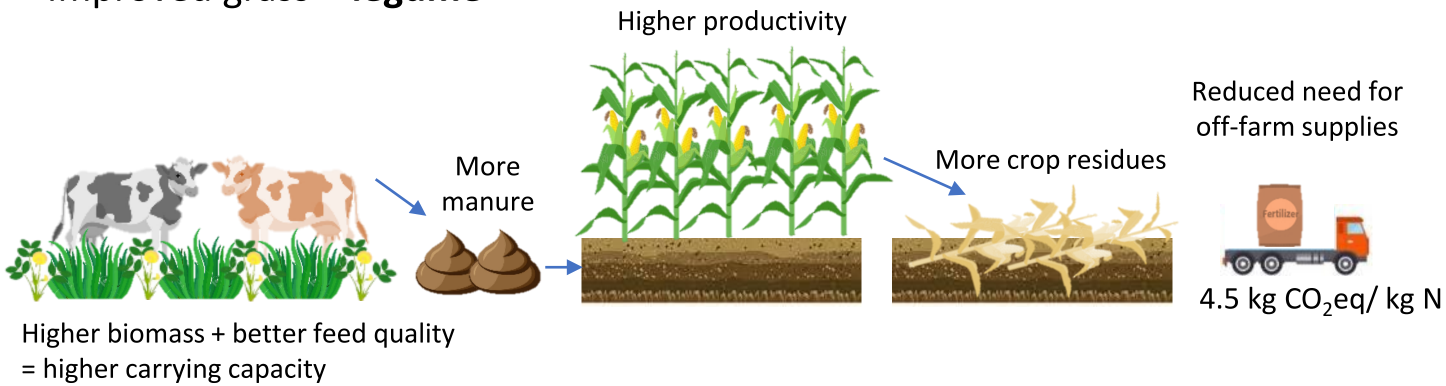
Gaviria et al 2020, Fron. Vet. Sci.

2. Input reduction

Unimproved Grass-**alone**



Improved grass + **legume**



3. Animal health

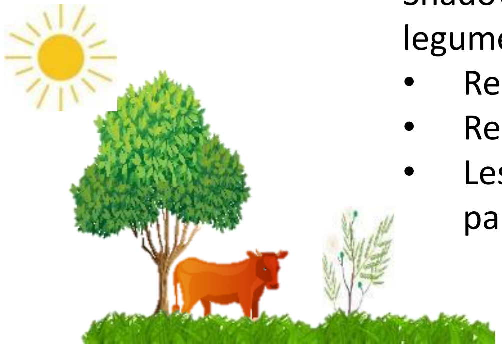
Improved animal nutrition

TABLE 1 | The nutritional value of five different diets based on tropical-forages (treatments) evaluated offered to Brahman cattle steers.

	Cay1	Cay2	CayLl*	CayLd**	Hay
DM	391	213	211	238	632
CP, g kg DM^{-1}	44.5	83.3	96.2	128.5	62.3
NDF, g kg DM^{-1}	709.8	682.2	638.5	580.9	612.6
ADF, g kg DM^{-1}	414.2	349.1	359.2	299.3	388.9
Ash, g kg DM^{-1}	118.3	121.4	124.5	175.6	140.3
GE, Mj kg DM^{-1}	16.2	17.2	16.7	17.5	14.1
IVDMD, g kg^{-1}	511	618	610	606	479

Higher protein, digestibility and energy in grass-legume diets

Animal welfare



Shadow provided by trees or shrub legumes in **silvopastoral** systems

- Reduced heat stress/ water loss
- Rest areas
- Less walking around the paddock = energy loss

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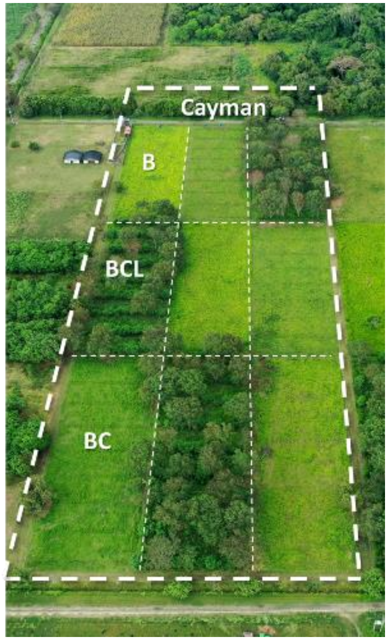
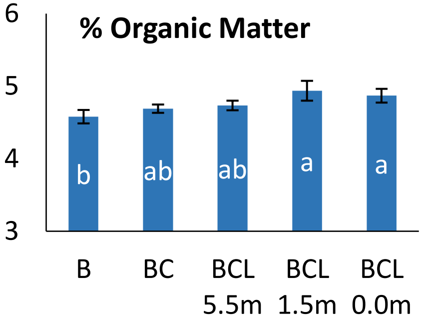
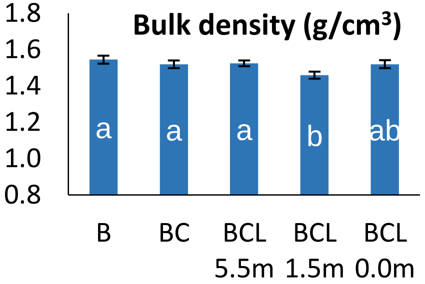
4. Soil health

B = *Brachiaria* grass-alone pasture
BC = *Brachiaria* + *Canavalia* herbaceous legume
BCL = *Brachiaria* + *Canavalia* + *Leucaena* tree legume

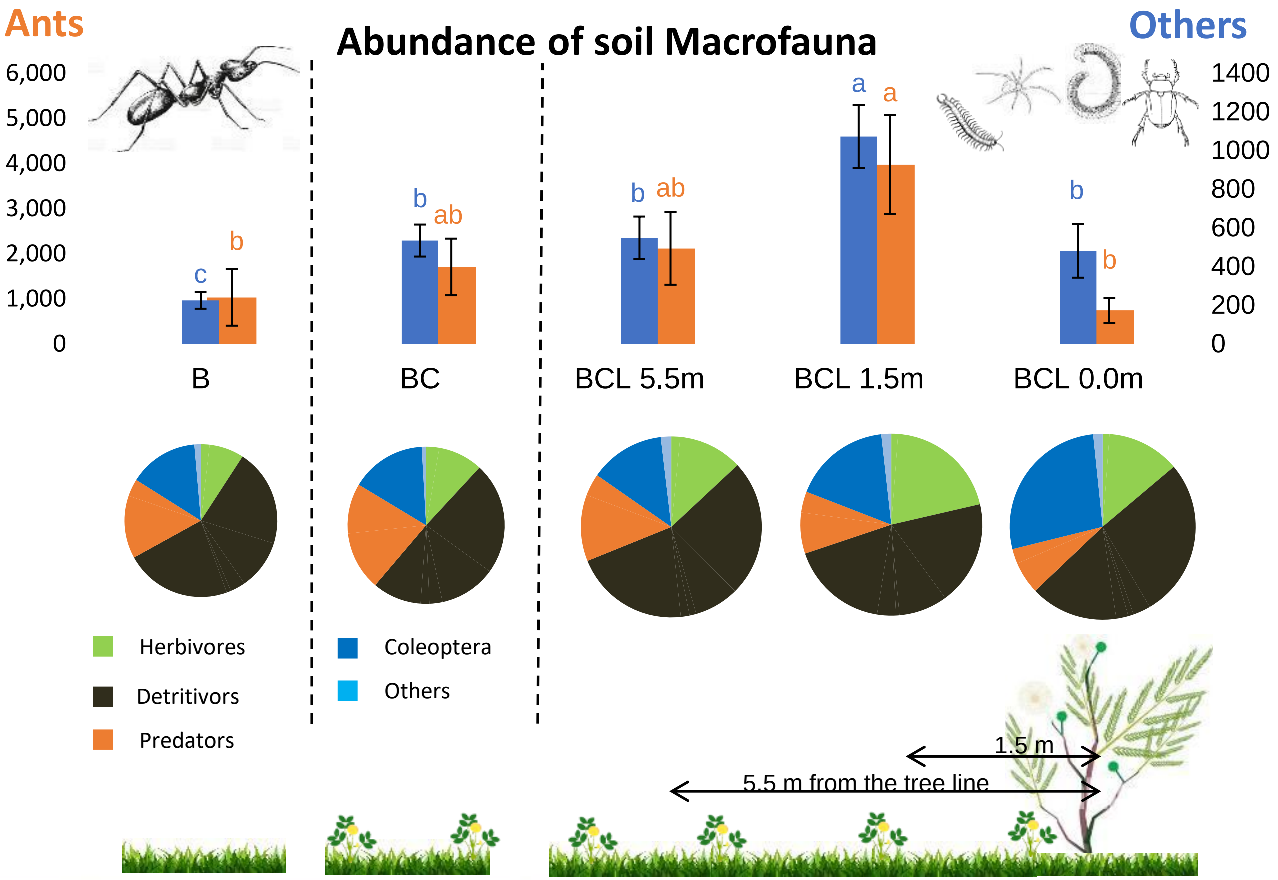






Biogenic Aggregate

5. Biodiversity



Vazquez et al 2020. AGEE

Contributions of improved cultivated forages to Agroecological transformation

Charry et al 2016. Tropentag

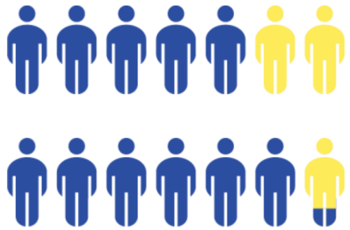
7. Economic diversification

Crop-tree-livestock systems

- Increased animal productivity (weight gain)
- Cattle (=savings)
- Timber
- Fruits
- Payment for ecosystem services
    - C sequestration
    - Water quality
    - Shadow
    - Biodiversity (insects, pollinators, birds)
- Ecotourism (bird watching)

9. Social values & diets

Animal source foods for human nutrition

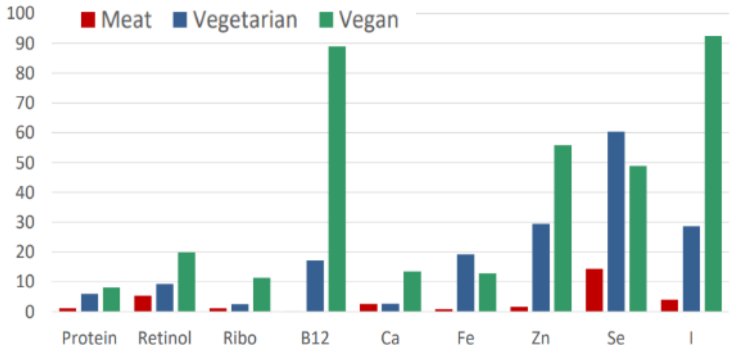


2 billion people suffer malnutrition for micronutrients

800 million suffer caloric defficiencies

Global Nutrition Report, 2016

% of inadequate intake of nutrients in meat consumers, vegetarians, and vegans.



EPIC Study UK (n=≈24000; Sobiecki 2016)

10. Fairness

Economic indicators improved in mixed pastures

Evaluated technologies	Grass-alone	Grass+legume
Net income system (US$ $ha^{-1} y^{-1}$)	356	695
NPV (US$)	(473)-(288)	1,716-2,055
Prob NPV<0 (%)	72	0
IRR (%)	10-11	21-22
Payback period (years)	6	4
B/C ratio	0.96-0.98	1.12-1.13
Minimum area required to have a profitable system (ha)	6.54	3.76

Enciso et al 2019. TGFT

Consumers are willing to pay **price premiums** for "eco-friendly" and "animal welfare compliance" labels in the city of Cali, Colombia.

Table 1 WTP for "eco-friendly" and "animal welfare compliance" labeled beef

Label	No information	With information
Eco-friendly	$ 0.74	$ 1.18
Animal Welfare	$ 0.83	$ 0.84

* Average WTP for conventional beef in samples: USD $4.73/lb
** Prices in USD/lb of meat (USD/COP XRT 08/22/2016)

Outlook

There is increased research interest and understanding of the economic, social and agroecological dynamics related to improved forages and their integration in mixed crop-tree-livestock systems.

Knowledge gaps:

- Forage varieties tolerant to a wide range of biotic and abiotic stress factors
  - Boosted by state-of-the-art genomics and phenomics
- Multiple interacting impacts of improved forages at the food system level
  - Reduce agro-environmental trade-offs
  - Understand drivers of uptake of improved forages, especially within agroecological initiatives, is needed for guiding large-scale investments and supporting the decision-making processes around that.
- Influential communication targeting policymakers and the different publics
  - Raising awareness at different decision-making levels should aim to differentiate, label and promote livestock products derived from agroecosystems based on agroecological principles

CGIAR initiative on Livestock, Climate, and System Resilience (LCSR)

CGIAR | Livestock, Climate and System Resilience

	Strengthening household capacities	Reducing climate risk with digital services	Leveraging landscapes	Financing the transition	Policy environment
Work packages	Strengthening household capacities	Reducing climate risk with digital services	Leveraging landscapes	Financing the transition	Policy environment
Outcomes	80,000 households implement climate smart livestock technologies	500,000 livestock value chain actors access climate information	Land managers implement governance & restoration practices on 500,000 ha	Climate investors commit $25 million to finance the transition	5 policies build on LCSR scientific evidence and outputs
Innovations	Adaptation pioneers, on-farm GHGe intervention testing, gender inclusion	Bundling CSI and CSA, drought risk finance, gender and youth inclusion	Participatory rangeland management, land use planning, tradeoff analysis	Technical assistance to define the opportunity and track progress	MRV and adaptation tracking protocols, global advocacy partnerships

Partners

United Nations · The World Bank · FAO · IUCN · UN environment programme · WWF · IFAD · International Land Coalition · AGNES · SNV · Global Research Alliance on Agricultural Greenhouse Gases · Alliance Bioversity International CIAT · CGIAR

Further reading

frontiers in Sustainable Food Systems

REVIEW
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Tapping Into the Environmental Co-benefits of Improved Tropical Forages for an Agroecological Transformation of Livestock Production Systems

An M. O. Notenbaert[1], Sabine Douxchamps[2], Daniel M. Villegas[3], Jacobo Arango[3], Birthe K. Paul[1], Stefan Burkart[3], Idupulapati Rao[3], Chris J. Kettle[4,5], Thomas Rudel[6], Eduardo Vázquez[7], Nikola Teutscherova[8], Ngonidzashe Chirinda[9], Jeroen C. J. Groot[10], Michael Wironen[11], Mirjam Pulleman[3], Mounir Louhaichi[12], Sawsan Hassan[13], Astrid Oberson[5], Sylvia S. Nyawira[1], Cesar S. Pinares-Patino[14] and Michael Peters[1]*

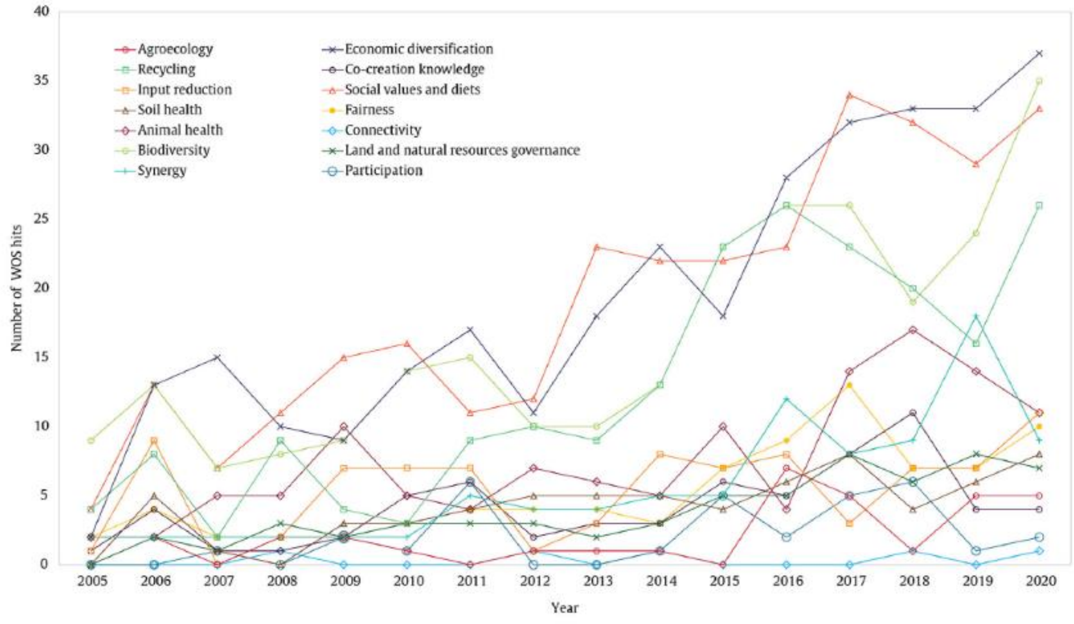

FIGURE 3 | Evolution of the interest of the scientific community for the different nexi between forages and principles.

Notenbaert AMO, Douxchamps S, Villegas DM, Arango J, Paul BK, Burkart S, [...] Peters M (2021) Tapping Into the Environmental Co-benefits of Improved Tropical Forages for an Agroecological Transformation of Livestock Production Systems. *Front. Sustain. Food Syst.* 5:742842. doi: 10.3389/fsufs.2021.742842

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Thanks!

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