Time2Graze: Decision Support System Advances for Colombia and Brazil

The Alliance of
Bioversity International and CIAT

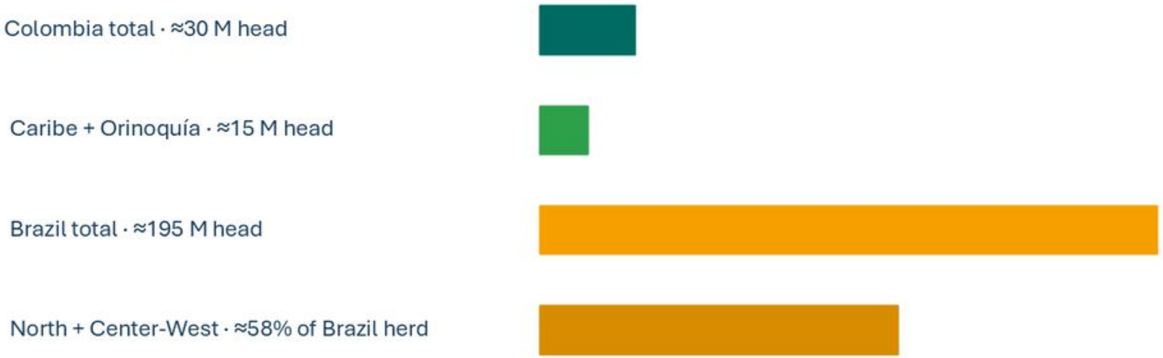
Andres Felipe Ruiz and
Juan Andres Cardoso

Alliance
Bioversity & CIAT

CGIAR

1 | Two countries, four regions, very different livestock realities

Cattle herd scale



Colombia	Brazil
Caribe: mainly double-purpose Orinoquía: mainly cría ≈15M cattle in target regions	Cerrado: large cultivated-pasture economy Amazonia: frontier + floodplain systems >50% of herd in North + Center-West

2 | What stakeholders are telling us

Researchers, farmers and local partners repeatedly point to the same adoption signal: useful decisions, not another burden.

They do not want...

1. Another dashboard to check
2. Extra data entry in daily routines
3. A lecture about “right” or “wrong” practices
4. Technical jargon such as “digital twin” as the entry point
5. Public exposure in WhatsApp groups

They do want...

1. Climate-risk information, not generic weather data
2. Forage material recommendations
3. Simple, actionable grazing guidance
4. Information through familiar channels such as WhatsApp
5. Privacy and anonymity when exchanging information

Recurring message

“The interface should feel like a service that answers a question, not a reporting platform that asks for work”

3 | From scattered information to one decision service

The objective is to bring fragmented evidence together and return only the information needed for the next decision.

Satellite / biomass	Climate	Forage knowledge	Farm context	Farmer feedback	→	Time2Graze Decision layer
current forage signal	risk + seasonal outlook	species · heights · suitability	paddocks · animals · water	local observations		

Alliance Bioversity & CIAT

CGIAR

4 | Positive deviants: local champions for adoption and sustainability

Early adopters can help turn a tool into locally owned practice, not just a project output.

What is a positive deviant?

A producer who achieves unusually good results despite facing similar conditions and constraints as neighboring farmers.

Early adopter	Tests new practices and technologies sooner
Local example	Visible results make change credible to neighbours
Technology transfer	Hosts visits, shares lessons, explains trade-offs
Appropriation	Adapts the tool to local needs and routines
Sustainability	Helps practices continue after external support ends

For Time2Graze they can be...

- **Early users**
- **Co-designers**
- **Demonstration farmers**
- **Local champions**
- **Trusted intermediaries**

Why this matters

Technology is more likely to last when farmers understand it, adapt it, trust it, and make it part of their own decision-making.

Work with positive deviants not only as "beneficiaries," but as partners in testing, translation and scaling.

4 | Positive deviants: local champions for adoption and sustainability

Early adopters can help turn a tool into locally owned practice, not just a project output.

What is a positive deviant?

A producer who achieves unusually good results despite facing similar conditions and constraints as neighboring farmers.

Early adopter	Tests new practices and technologies sooner
Local example	Visible results make change credible to neighbours
Technology transfer	Hosts visits, shares lessons, explains trade-offs
Appropriation	Adapts the tool to local needs and routines
Sustainability	Helps practices continue after external support ends

For Time2Graze they can be...

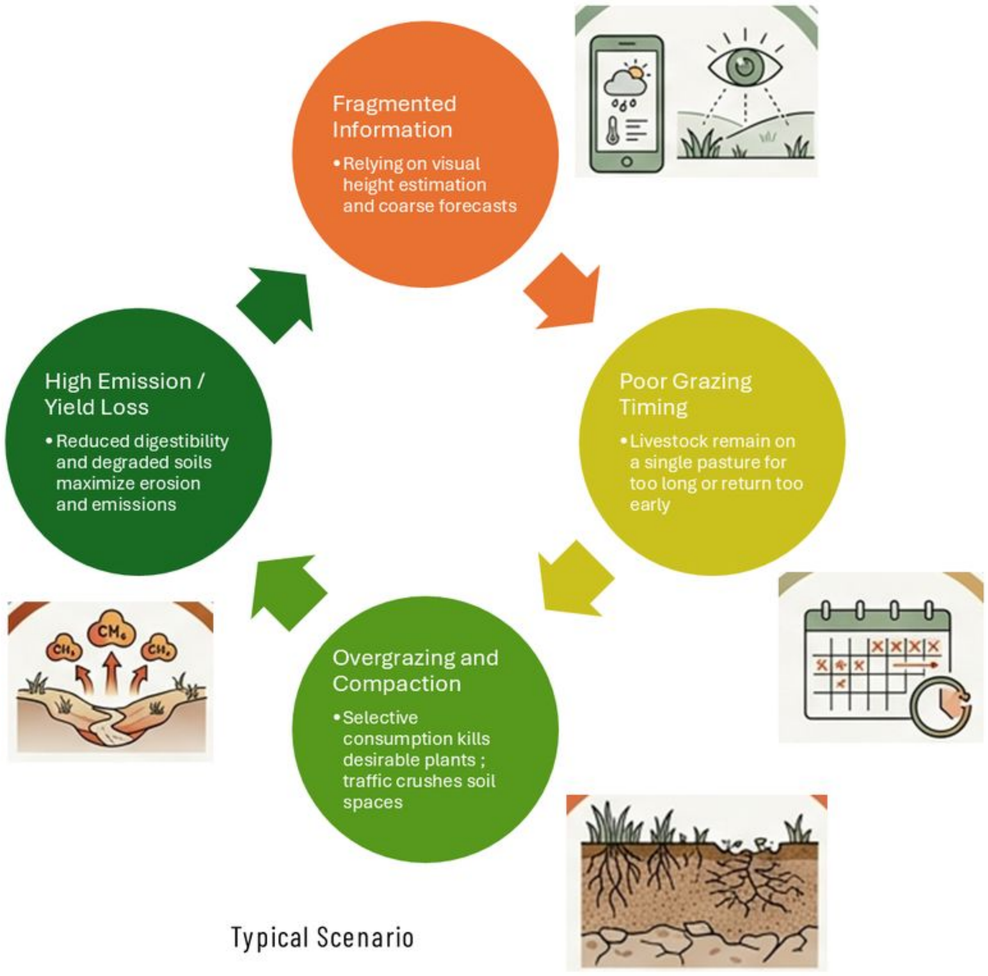
- **Early users**
- **Co-designers**
- **Demonstration farmers**
- **Local champions**
- **Trusted intermediaries**

Why this matters

Technology is more likely to last when farmers understand it, adapt it, trust it, and make it part of their own decision-making

Work with positive deviants not only as "beneficiaries," but as partners in testing, translation and scaling.

Challenges



Typical Scenario

Common Challenges

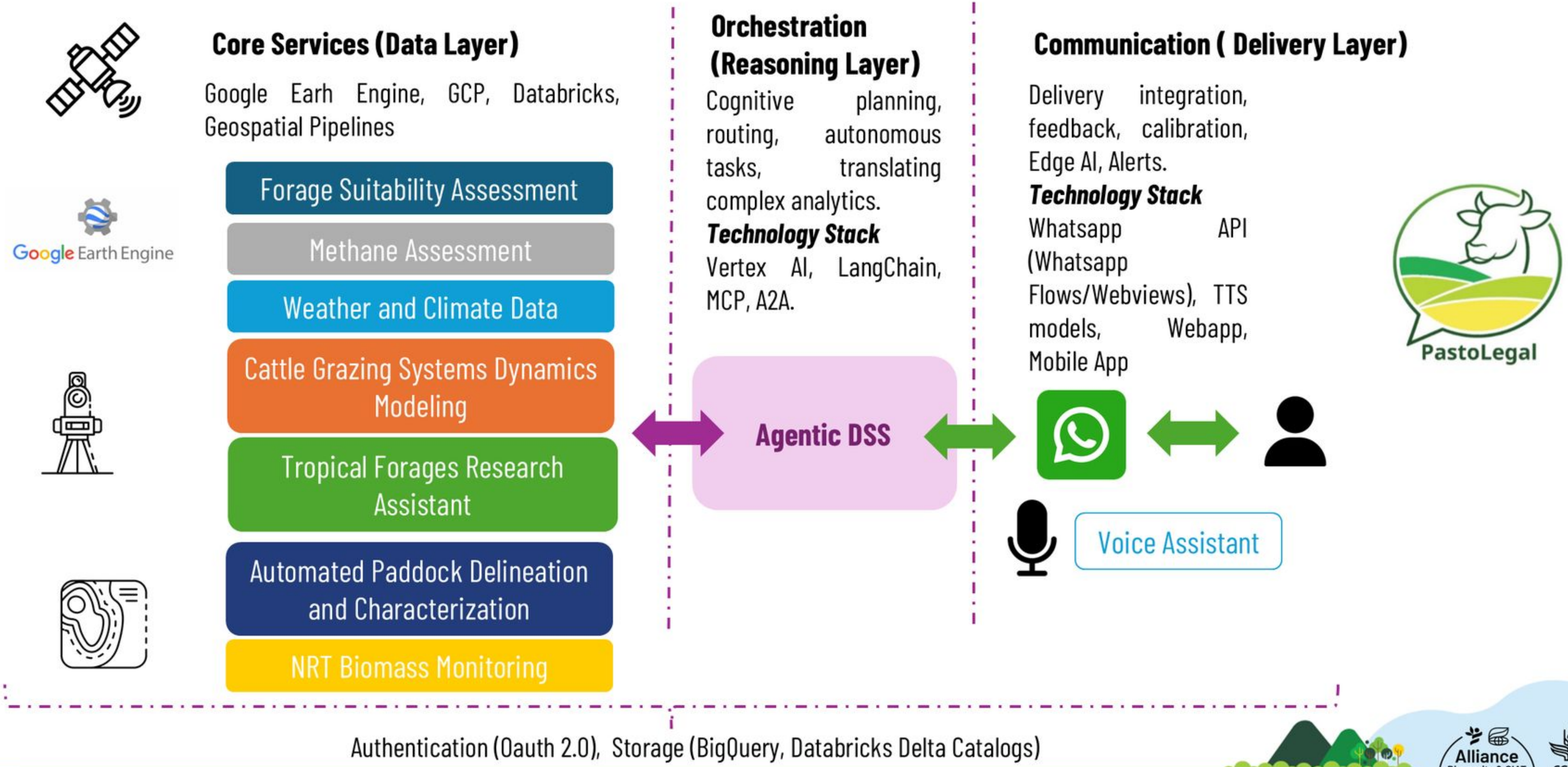
- ***Subjective measurement:*** visual guesswork replaces objective data, driving poor management and the silent lost of soil fertility
- ***Out of context technology:*** Models not calibrated to local conditions
- ***Black box systems:*** Producers reject opaque, one-size-fits-all solutions because they cannot validate or are not sure of how they work
- **Adaptation disparity:** Some commercial systems already routinely measure whereas other do not, creating a steep gap in how fast they can adopt new technologies.
- ***Implementation Barrier:*** information alone is insufficient. Producers simply cannot execute the recommendation if tools, materials, support or maintenance systems are not available.
- ***Knowledge transfer crisis***: Changes in generational handover and labor dynamics leaves farms lacking skilled workforce to sustain operations or adopt innovations.

Challenges

How do we get the right information, to the right person, in the right language, at the right moment... without requiring them to change how they work?

- The system needs context, and context needs reliable calibrated data
- Leverage and integrate multiple expert data sources, not a single model
- User-centric: the system adapts to the user (their language, their role, their question)
- Responses range from simple alerts to complex scenario analysis (driven by user need)

Time2Graze DSS Architecture

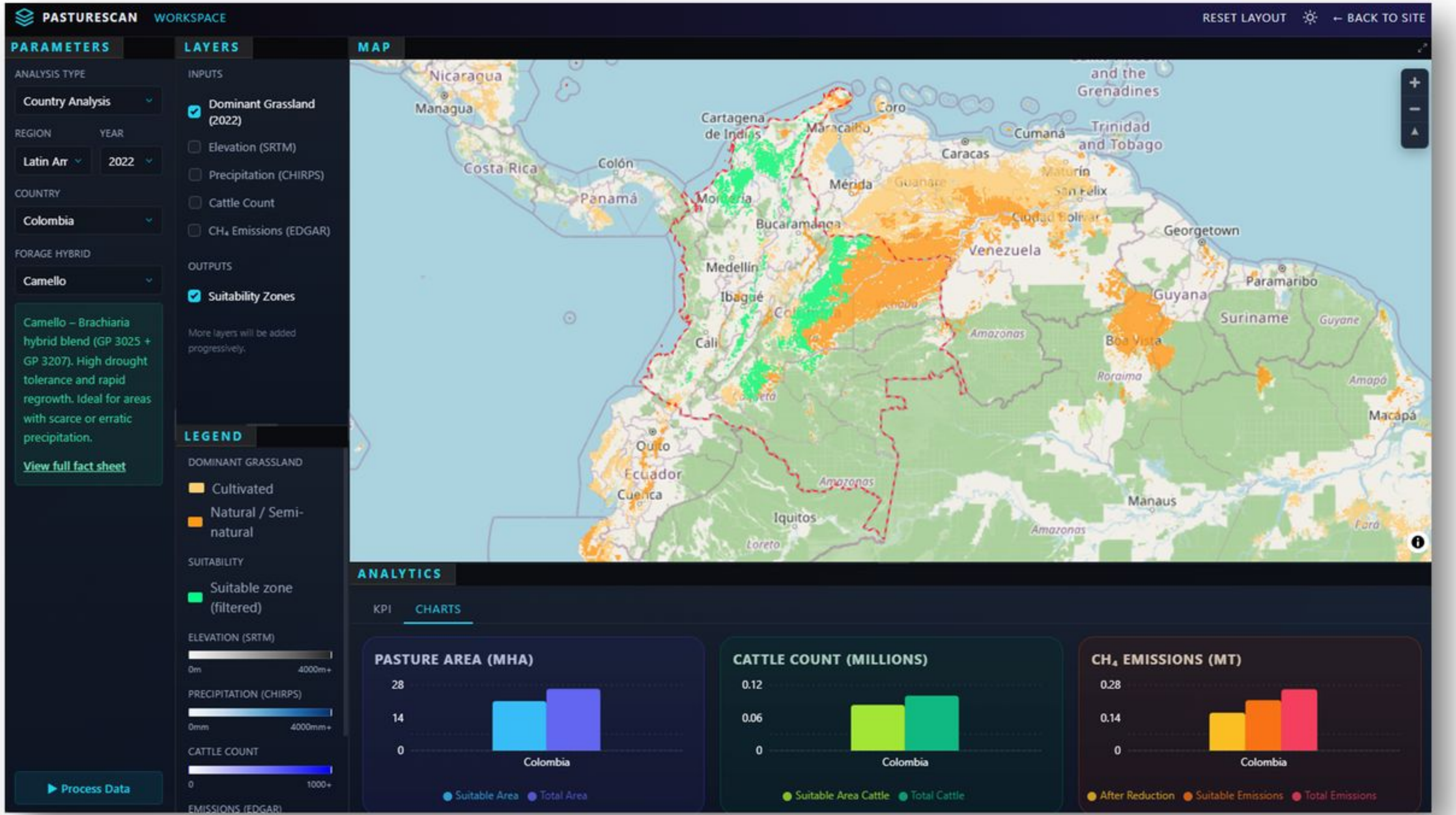


Forage Suitability Assessment

Data

Evaluate and map the suitability of tropical forages grasses to support sustainable pasture management.

- Map optimal areas for specific forages base on different features (soil, rainfall, temperature, etc.)
- Evaluate regions from global to local level.
- Automatically estimate total suitable area, cattle capacity, and methane emissions.
- Simulate environmental benefits of adopting improved grasses.



Challenges

- Spatial resolution
- Availability of all input layers

PastureScan — Geospatial Analytics Platform

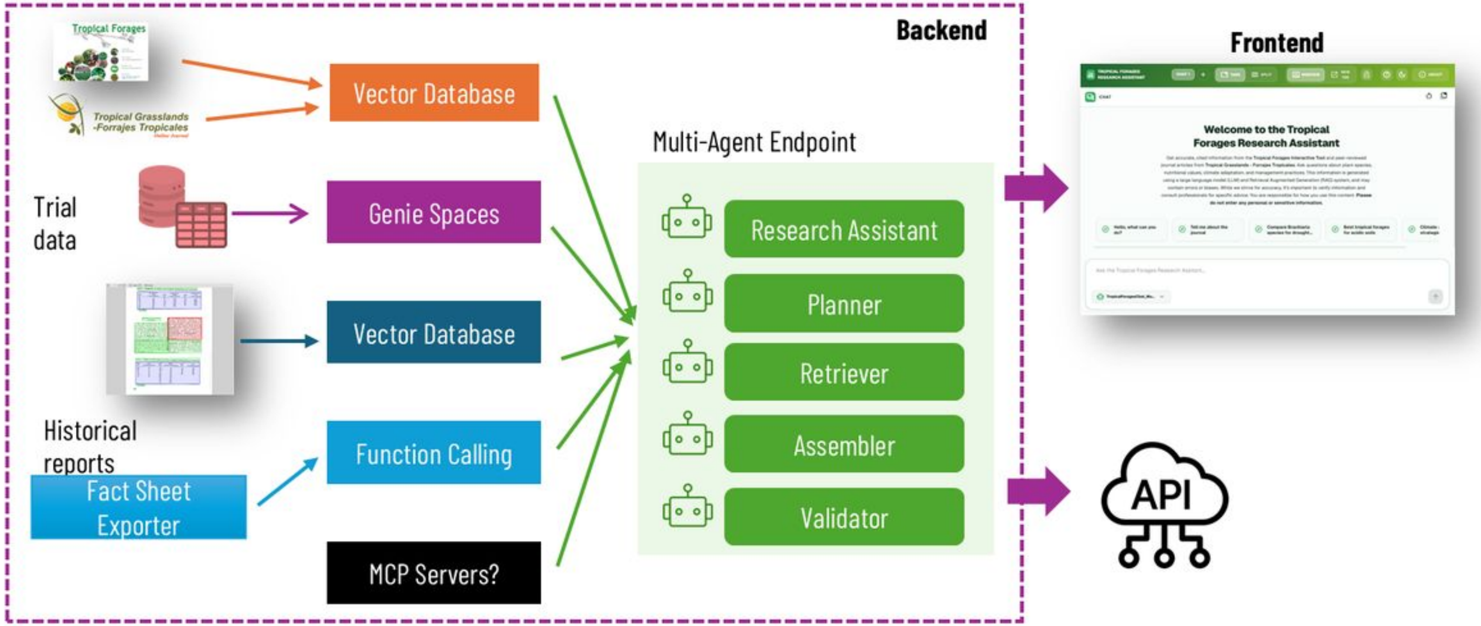
Tropical Forages Research Assistant

Knowledge base

- Multi-Agentic RAG System
- Data extraction and summarization
- Insights and referenced information
- Integration via API

Challenges

- Token usage
- Hallucinations
- Verification



https://tropicalforageschat.alliance.cgiar.org/

Additional core services

CLEANED (iCleaned)

R-based environmental model that takes feed quality, herd composition, land area, and management decisions as inputs and produces

Output	What it tells the DSS
Enteric methane (kg CO_2eq/kg LW sold)	Environmental footprint of current herd and forage
Nitrogen balance	Soil nutrient sustainability under current stocking
Water use per feed item	Resource efficiency of forage choices
Soil organic carbon change	Whether management is building or losing carbon
Carrying capacity	Sustainable stocking rate for the current forage mix
Scenario comparison	Quantified answer to "what if I change this?"

Challenges

- Input data

Knowing **"you have X kg DM/ha"** is necessary but not sufficient. The farmer's real question is:

"Can I keep my 80 cows here for another 15 days, or will I damage the pasture and degrade the soil?"

If I introduce U. Brizantha on 30% of my area, what happens to my stocking rate and my methane emissions over the next 5 years?

Systems Integration

NRT Biomass Monitoring Data

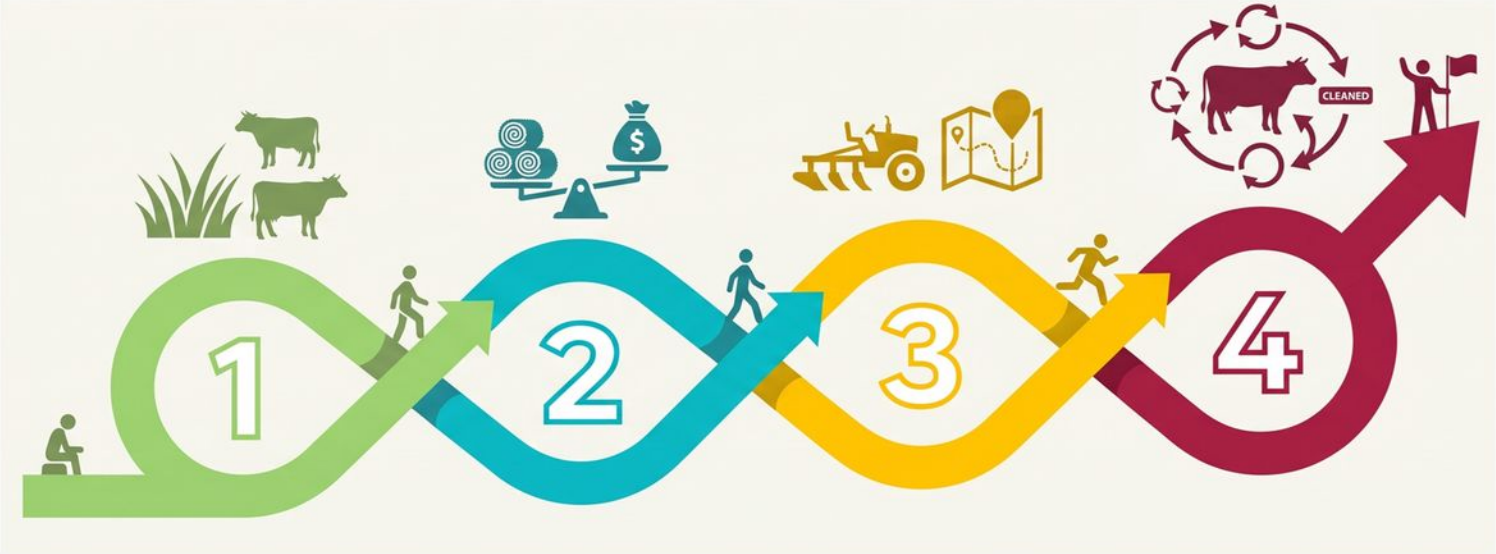
Decision	Without NRT biomass	With NRT biomass
When to move cattle in	Visual inspection, fixed calendar	Actual DM crossing entry threshold
When to pull cattle out	After visible damage (too late)	Before critical minimum floor is breached
Dry season preparation	Estimated from last year	6-week trend vs historical baseline
Buy feed vs sell cattle	Financial intuition	Projected days of forage at current stocking rate
Forage species comparison	Trial-and-error over years	Side-by-side comparison same farm same week

The value is not in the data; it is in the decision it enables

Systems Integration

Challenge	Why it matters for decisions	Status
Cloud cover	• 2-3 week gaps in wet season . • When growth is fastest and decisions most frequent. • Very common in many Colombian regions	• Backup data sources falling back to MapBiomas annual data • Gap modelling being explored
LUE calibration uncertainty	• Model can be off for a specific forage species in a specific soil type	• Field Calibration for Colombia being planned following LAPIG's protocol. • Confidence interval not yet established
Paddock vs farm boundary	• Official information gives the perimeter • Internal structure is where rotation decisions are made	• Active research question • Automated paddock delineation being explored
Biomass not equal forage quality	• Satellite measures DM quantity not digestibility or crude protein	• Partially addressed via Tropical Forages MCP Suitability maps (limits in resolution and data avilability)
Connectivity in remote areas	• WhatsApp requires data coverage many farms lack	• SMS fallback and offline-first delivery under consideration

Timescales

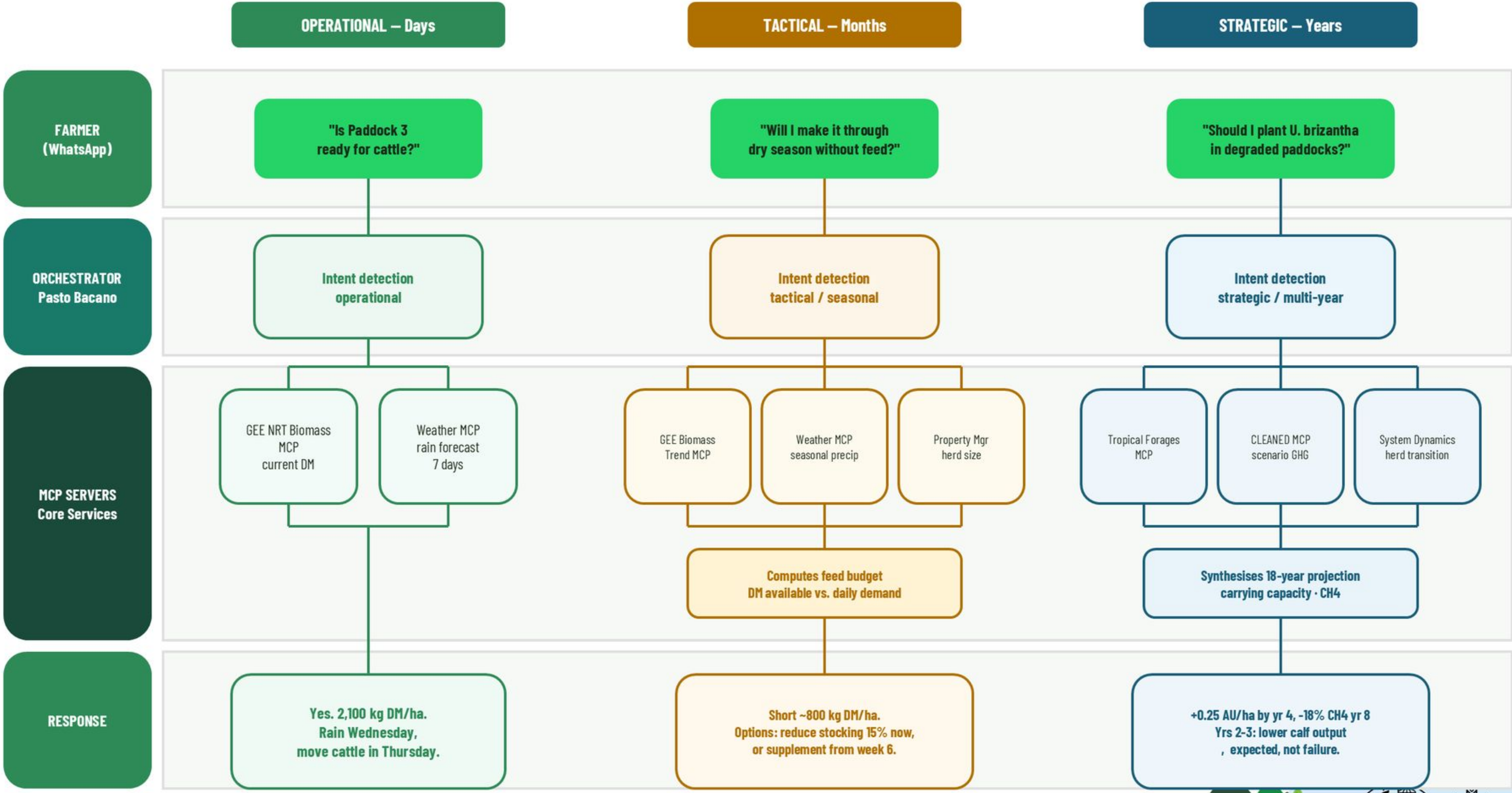


Days (1-14) Paddock Management	Weeks-months (1-6) Forage Allocation	Season-year (6-18 mo) Pasture Renewal	Years-decade (3-15 yr) System Transition	
Is this paddock ready? When to move out?	Enough forage for dry season? Sell now or buy supplement?	Renovate this paddock? Sustainable stocking rate?	Introduce new forage species? Transition to full-cycle beef?	**The farmer question**
NRT biomass (5-day) weather forecast	Biomass trend + seasonal baseline + precipitation forecast	Biomass trend LULC change pasture age	System dynamics scenarios CLEANED comparison	**Data that answers it**
Overgrazing damage costs 2-3 seasons to recover	20-30% of annual farm income	-600/ha renovation; wrong timing = major loss	Investment decisions shaping entire production system	**Economic stakes**

Decisions happen at different timescales, DSS must match all of them?

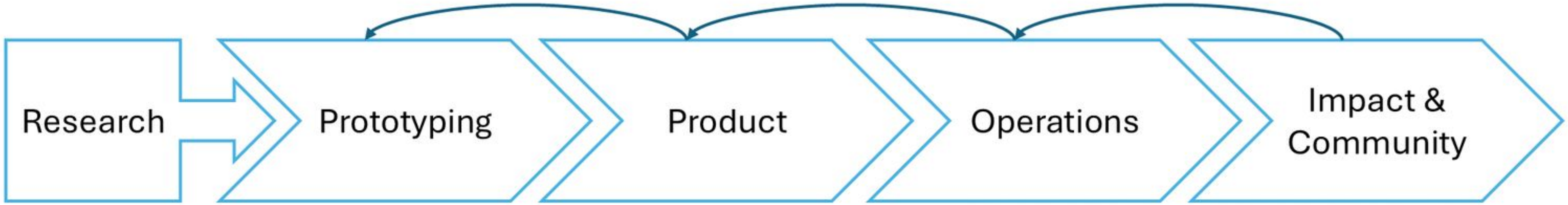
Key insight from system dynamics modelling:
Introducing U. brizantha in year 6 does not show its full methane effect until year 14. A farmer watching years 7-9 in isolation may conclude the intervention is failing - when the system is transitioning correctly. Without a long-horizon model early signals are systematically misread (Vera-Infanzón et al., 2025).

https://doi.org/10.1016/j.agsy.2025.104301



Alliance
Bioversity & CIAT
CGIAR

Product Lifecycle



Barrier	How most tools handle it	Potential approach
New interface to learn	Training sessions manuals	No new interface - farmer uses WhatsApp already
Data entry burden	Long onboarding forms	AI assistance; agent infers what it can; only asks what it cannot
Trust in the technology	Marketing demos	Locally calibrated data farmers can verify against their own knowledge
Relevance to real decisions	Generic reports and dashboards	Agent responds to actual question in farmer language
Cost	Subscription tiers free trials	Free at point of use. WhatsApp. No hardware requirements.

Potential Impact metrics

Which criteria should be used to measure impact?

Level 1 - Adoption

- Active users: 100+ farms/month across 3+ countries
- Message-to-decision conversion documented
- User retention >50% at month 3
- 20+ extension workers using DSS regularly

Level 2 - Agronomic

- Reduction in overgrazing events (satellite time series?)
- Improved forage utilization ratio (DM harvested/produced)
- Forage species diversification (change detection)
- Stocking rate optimized over time

Level 3 - Environmental

- Enteric methane intensity vs baseline (CLEANED)
- Positive SOC trend in managed paddocks
- Reduction in degraded pasture fraction (MapBiomas/Dominant grassland)
- Farms meeting Verra VM0042 or equivalent

Nex steps

- *Continue implementation of DSS for Colombia integrating multiple available core services*
- *Deploy a simple demo for initial users just as Pasto Legal did, to establish the need and usability for core services*
- *Determine the computational resources associated to answer: cost of operation? Cost of maintenance and upgrades? Self-sustainability? Scalability?*
- *How to measure real impact (users improving their grazing management)?*
- *Can we implement a robust system despite data gaps?*

Thanks!

alliancebioversityciat.org