6th International Symposium for Farming Systems Design

Agricultural systems by design

A Multi-Model Systems Approach For Identifying Low Emissions Development Pathways-- Analyzing Synergies and Trade-Offs in Semi-Arid Agriculture In India

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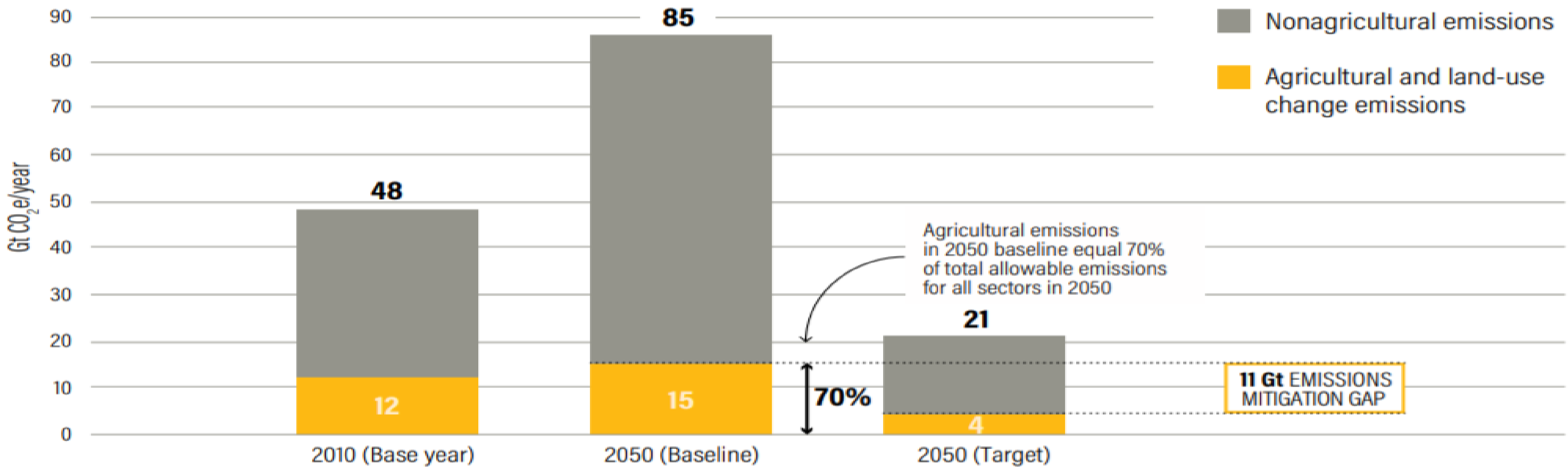
ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Need for Low emissions development pathways

IPCC Chapter 7: "The full mitigation potential assessed in this report will only be realized if agricultural emissions are included in mainstream climate policy (high agreement, high evidence)"

World Resources Institute: Creating a sustainable food future
Course 5: Reduce Greenhouse Gas Emissions from Agricultural Production



Sources: GlobAgri-WRR model, WRI analysis based on IEA (2012); EIA (2012); Houghton (2008); OECD (2012); and UNEP (2013).

Pathways – Both supply and demand side

Supply Side

- Enteric fermentation
- Manure
- Synthetic fertilizers
- Rice management
- Other farming practices

Demand Side

- Reducing food wastes
- Shifting to healthier diets

Should smallholder farmers contribute to mitigation efforts?

WHY NOT?

Smallholders are already poor, at risk from food insecurity –
Low emission practices may create disproportionally higher risks and costs

BUT

Early adoption of some Low emission practices may provide economic benefits for smallholders?

WHY NOT?

Social equity issues

BUT

Market and non-market mechanisms may balance?

Are there win-win low emission development pathways absent any carbon markets or incentives?

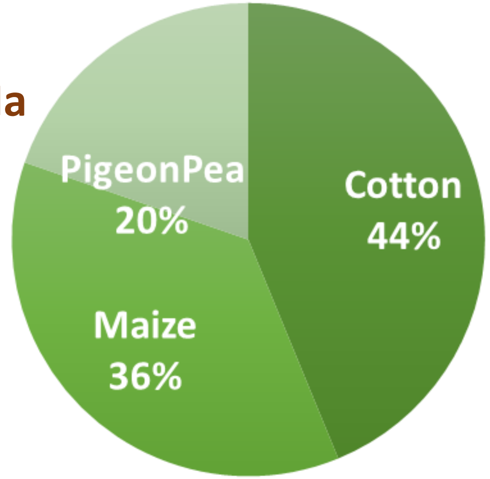
What low emission practices can provide immediate economic benefits for smallholders?

How can we incorporate mitigation objectives into existing development projects?

Study area & Characterization of farmers: Mahbubnagar, Telangana, India

Representative farmer – Cluster 1

Total farmland 0.5 Ha



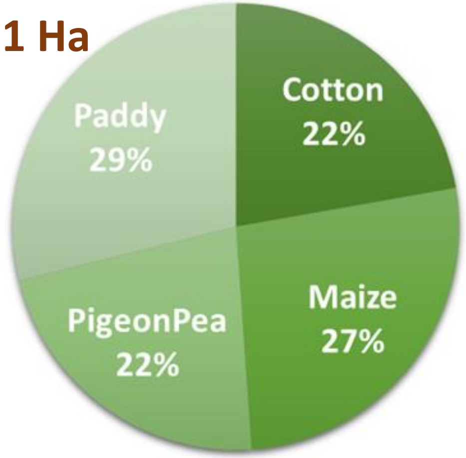
Fertilizer usage <70% of recommended

Representative farmer – Cluster 2

Total farmland 1 Ha

Buffalo - 2

Cow - 1



Fertilizer usage >20% of recommended

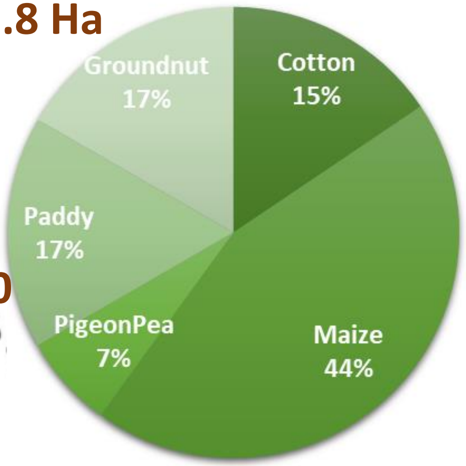
Representative farmer – Cluster 3

Total farmland 1.8 Ha

Buffalo - 3

Cow - 1

Goat - 20



Fertilizer usage >30% of recommended

ICAR-ICRISAT Collaborative Project: Climate Smart Agriculture practices inventory

Practices	Profitability	Mitigation
Diversification of Crop and Livestock Systems	✔	✘
Improved livestock feeding	✔	✔
Integrated Nutrient Management	✔	✔
Reduced use of Agrochemicals	✘	✔
Reduced use of Machinery	✘	✔
Use of conservation agricultural practices	✔	✔
Improved residue management	✔	✔
Integrated soil and water conservation efforts	✔	✔
Improved management of wetland rice areas	✘	✔
Insurance	✔	✘
Use of Climate Information	✔	✘
Agroforestry	✔	✔

Identified interventions that confer economic and mitigation benefits

Plot-Level Crop Management Interventions:

1. **Integrated Nutrient Management - Recommended Nitrogen and Farm yard manure**
2. **Reduced Tillage**
3. **Residue Management**

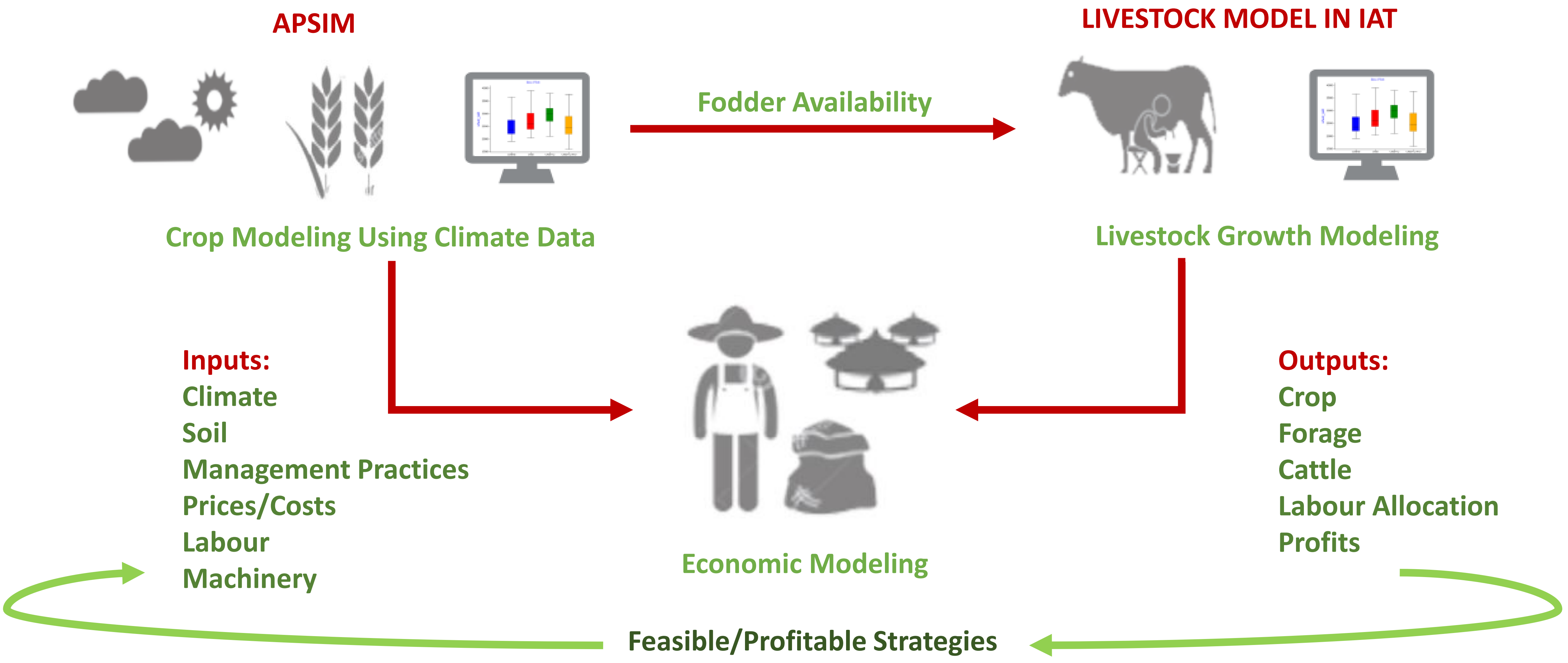
Farm-Level Enterprise Interventions:

1. **Improved Livestock Feed Management – Supplementary high protein feed such as cotton seed/groundnut seed meal**
2. **Agroforestry – Mango trees as per land availability on bunds**

Scenario Descriptions

No	Name	Management practice description
1	INM	Recommended N + 3 tons Manure
2	INM+RM	Recommended N + 3 tons Manure + 50% Residue Retained
3	INM+RT	Recommended N + 3 tons Manure + Reduced Tillage
4	INM+RM+RT	Recommended N + 3 tons Manure + 50% Residue Retained + Reduced Tillage
5	INM+RT+LI	Recommended N + 3 tons Manure + Reduced Tillage + Livestock Feed Management
6	INM+RT+LI+AF	Recommended N + 3 tons Manure + Reduced Tillage + Livestock Feed Management + Agro-forestry

Whole-farm systems modelling



Calculating Emissions through Cool Farm Tool

Emission sources	GHGs calculated using Cool Farm Tool
Use of Fertilizers	CO2 - from fertilizer production and fertilizer application
Direct and Indirect field N20	N20 - from N-fertilization and N emissions from crops (Indirect)
Residue Management	CH4, N20 - emissions from burning, mulching
Burning of Fossial Fuels	CO2
Livestock enteric emissions	CH4
Livestock manure management	N20, CH4
Livestock feed	CO2
Carbon Pools	
Soil Organic Carbon	

% Change from baseline in Integrated Nutrient Management Scenario

Cluster 1	Cluster 2	Cluster 3
Absolute Emissions	Absolute Emissions	Absolute Emissions
↑ 22%	↑ 2%	↓ 4%
Whole-farm profitability	Whole-farm profitability	Whole-farm profitability
↑ 11%	—	↓ 3%
Emissions Intensity	Emissions Intensity	Emissions Intensity
↑ 16%	↓ 1%	↓ 5%

% Change from baseline in INM + Residue Retention and Reduced Tillage Scenario

Cluster 1

Absolute Emissions

↓ 4%

Whole-farm profitability

↑ 11%

Emissions Intensity

↓ 10%

Cluster 2

Absolute Emissions

↑ 1.75%

Whole-farm profitability

↑ 4%

Emissions Intensity

—

Cluster 3

Absolute Emissions

↓ 6.5%

Whole-farm profitability

↓ 2%

Emissions Intensity

↓ 7 %

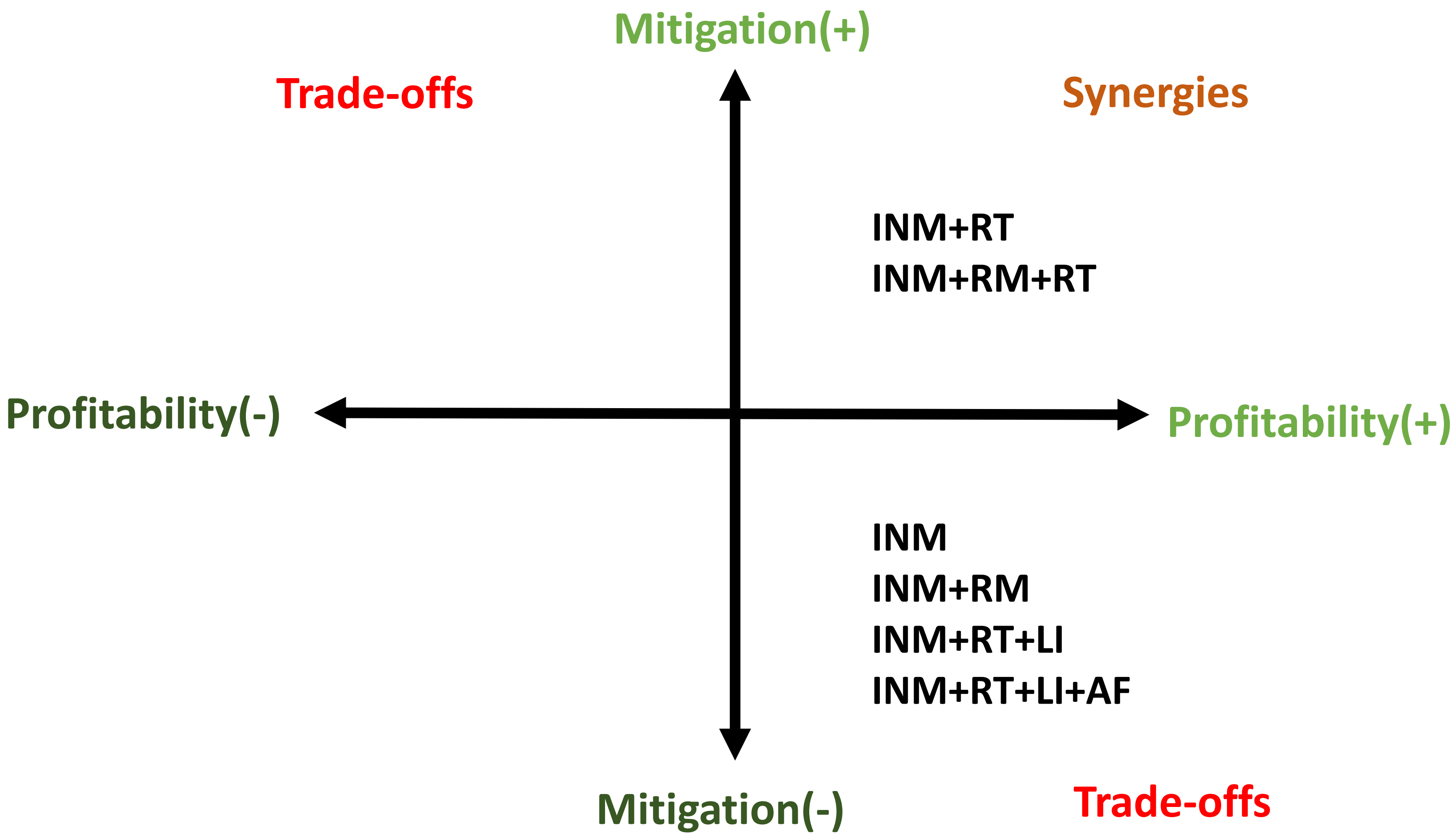
% Change from baseline in INM+ RT+ Livestock Feed Management Scenario

	Cluster 1	Cluster 2	Cluster 3
Absolute Emissions	↑ 160%	↑ 13%	↑ 9%
Whole-farm profitability	↑ 101%	↑ 34%	↑ 20%
Emissions Intensity	↑ 50%	↓ 13%	↓ 6 %

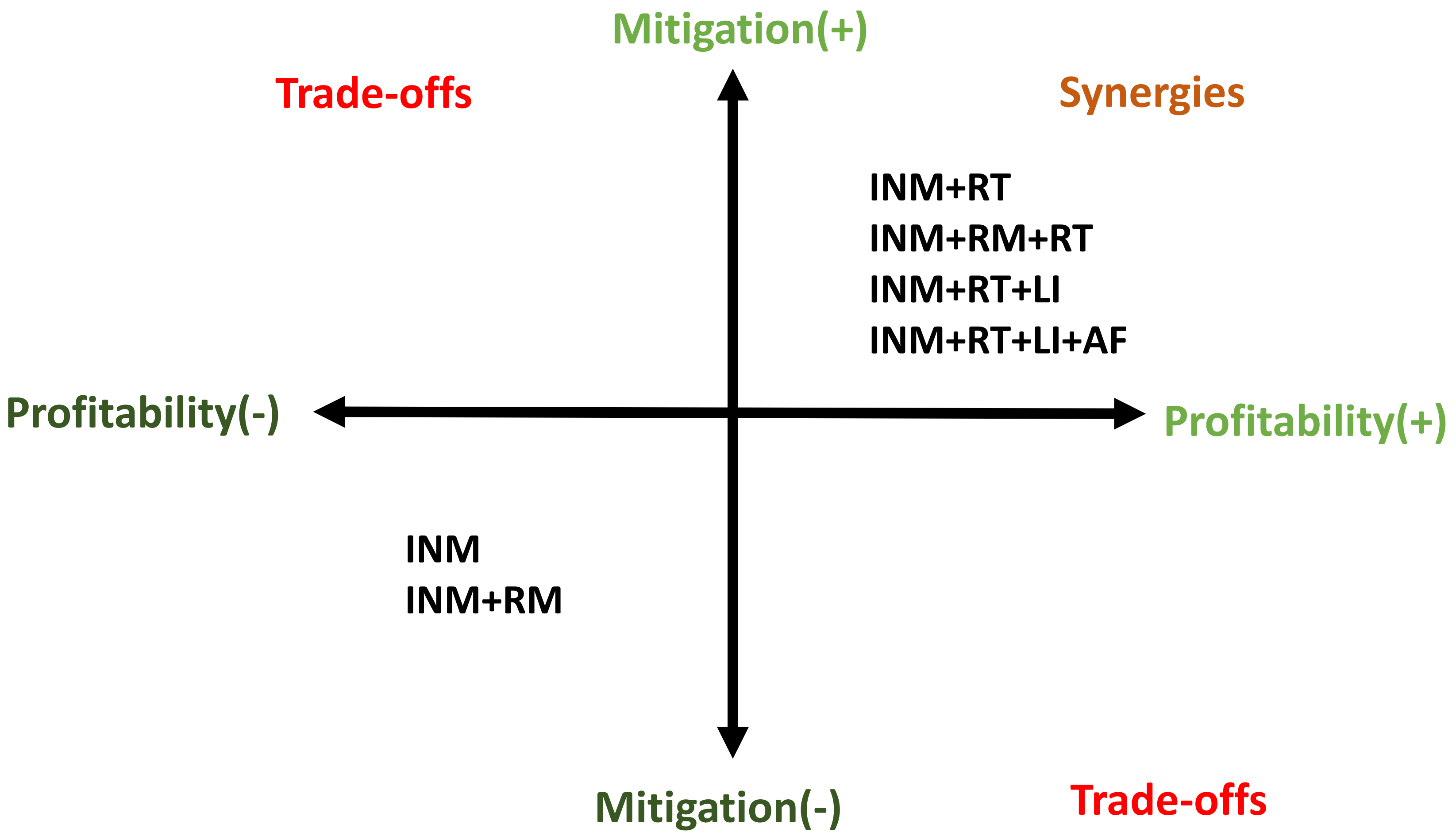
% Change from baseline in INM+ RT+ LI+ Agroforestry scenario

Cluster 1	Cluster 2	Cluster 3
Absolute Emissions	**Absolute Emissions**	**Absolute Emissions**
↑ 150%	↑ 11%	↑ 7%
Whole-farm profitability	**Whole-farm profitability**	**Whole-farm profitability**
↑ 117%	↑ 41%	↑ 26%
Emissions Intensity	**Emissions Intensity**	**Emissions Intensity**
↑ 31%	↓ 20%	↓ 14 %

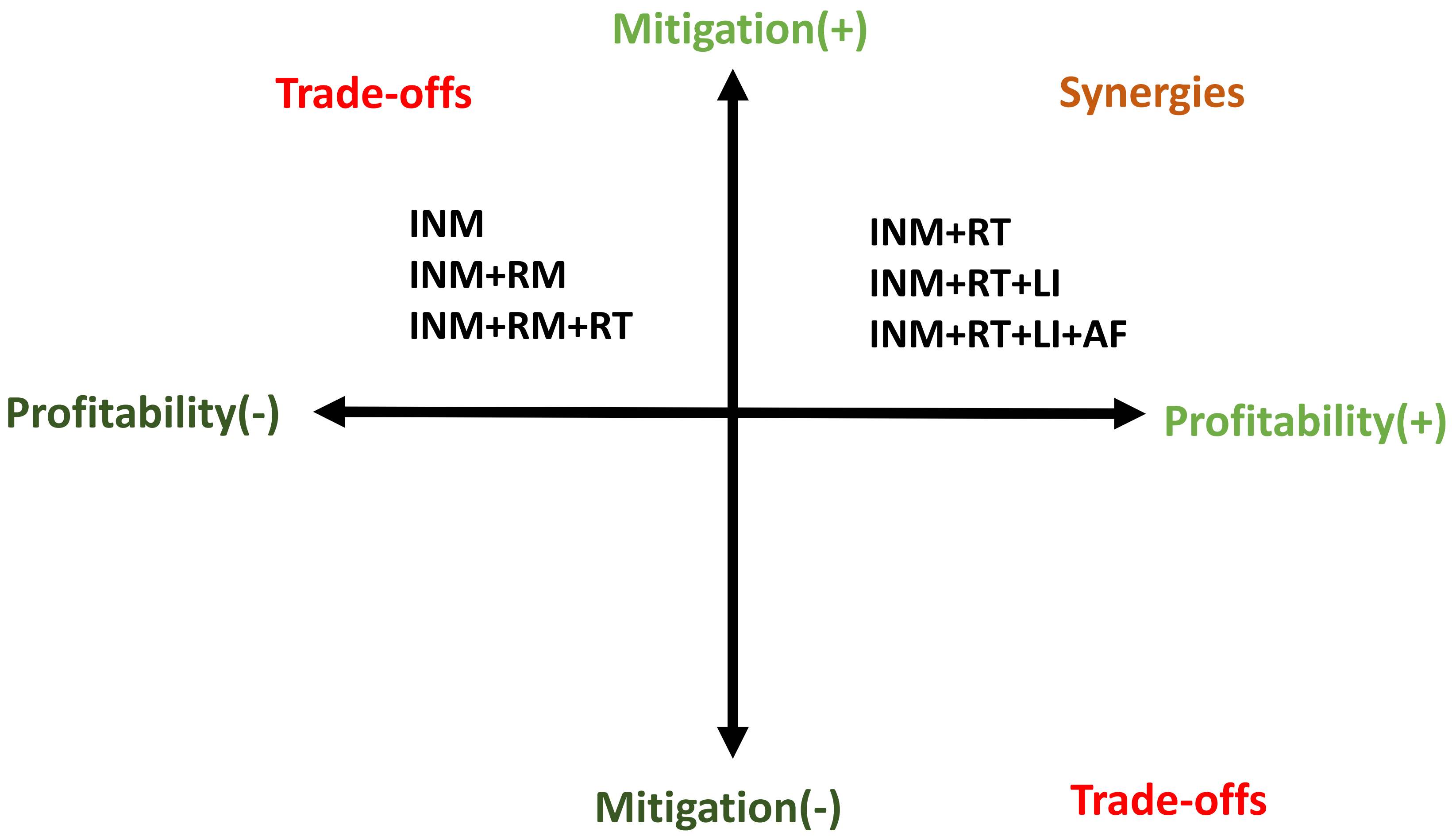
Synergies and Trade-offs for cluster 1 farmers



Synergies and Trade-offs for cluster 2 farmers



Synergies and Trade-offs for cluster 3 farmers



Limitations of the study

Necessary assumptions & simplification ~~ overestimation or underestimation of some impacts

Input & Output prices are static – liquidity is assumed

Assumption on markets for feed supplementation and investment costs calculations

Management practices are constant and not flexible

Short-run simulation of 10 years (economic model) – failure to capture harsher growing conditions

Inherent uncertainty of emissions factors – overestimation or underestimation of mitigation potential

Summary and way forward – Pragmatic policy?

Win-wins plausible – but of-course share the same constraints of system transitions

Yield gaps

Low-input Low-output
High-input Low-output
→ Low-input High-output

Carbon market mechanisms likely to take long to reach smallholders

Focus on achieving maximum mitigation as co-benefits by leveraging existing development projects

More efforts towards such feasibility studies

GHG emissions – costly to quantify, better uncertainty measures?

THANK YOU!