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BANANA-N model: a dynamic model to simulate nitrogen balance in agroecological banana cropping systems

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HORTICULTURE FOR A WORLD IN TRANSITION
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31ST INTERNATIONAL HORTICULTURAL CONGRESS

SOCIETAL DEMAND

INTRODUCTION

Intensive monocropping → agroecological systems

↗ cover crops (CC) ↗ organic fertilizers (OF)



but …

- NITROGEN BIOAVAILABILITY ?
- COMPETITION ?
- IMPACT ON YIELD?

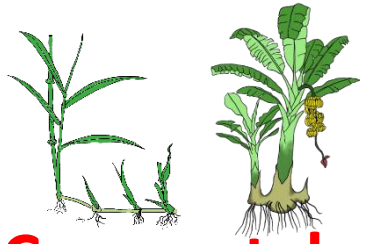
To sum up we want

- ✓ To explore complex and diversified banana agrosystems
- ✓ To better understand the dynamics of nitrogen fluxes
- ✓ To better manage nitrogen fertilization

We need → A crop simulation model

1- Identify key processes and build model

✓A dynamic model at weekly time step during three crop cycles



Crop uptake **Leaching**

$$SMN_t = \underbrace{NRESBAN_t + NRESCC_t}_{\text{Crop residues}} + \underbrace{MINf_t + ORGf_t}_{\text{Fertilizers}} + \underbrace{S_t}_{\text{Soil organic matter}} - UCC_t - UBAN_t - NL_t$$

Adapted from Dorel et al., 2008; Ripoche et al., 2012

2-Field experiments

'CIRAD 925'

Tolerant to black sigota disease

No leaf removal
No fungicide

Shorter crop cycle

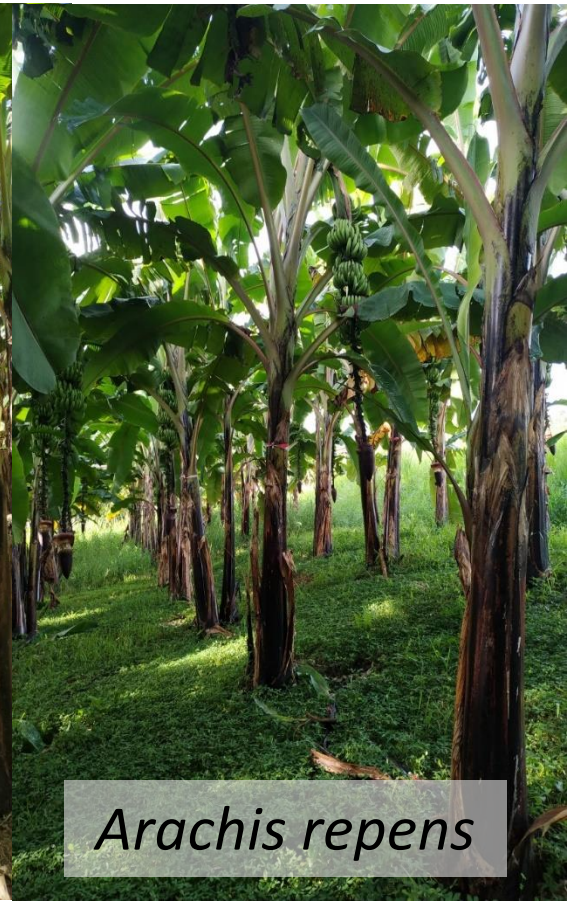
More data over a shorter time period

Experiment A : Nmin dynamics with ≠ N managment

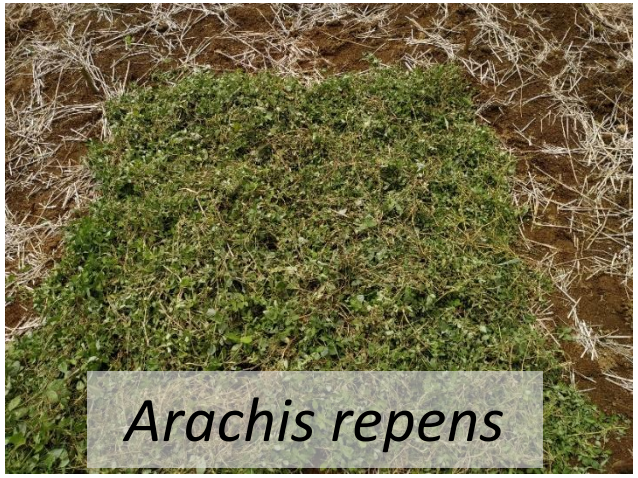
Exp A (0,57 ha)

5 treatments (x 4 rep)

	×	Synthetic			CTRL
	×		×		ML
	×		×		MG
	×	Organic	×		OL
	×		×		OG



Experiment B : Net nitrogen mineralization

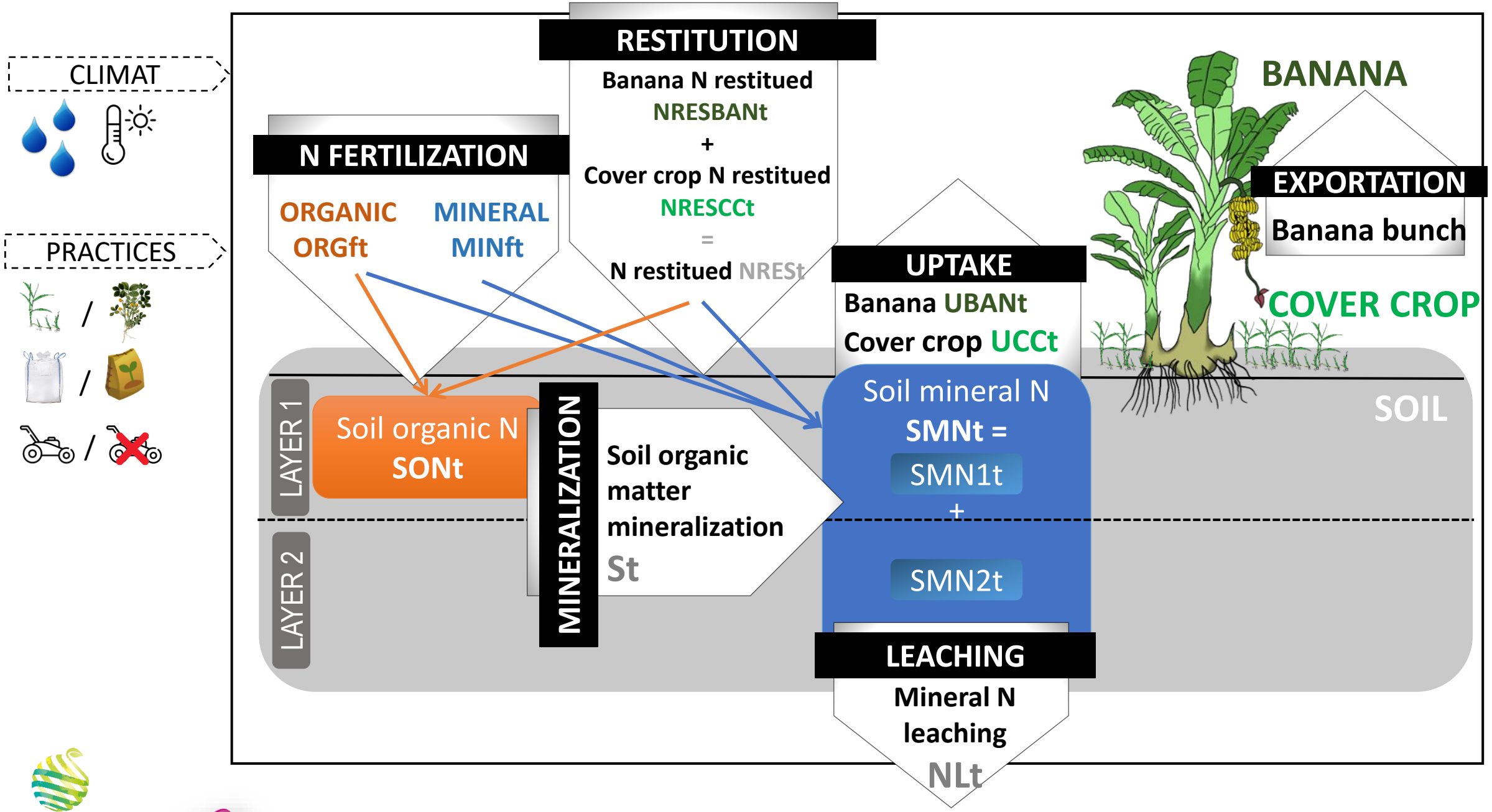


Exp B (0,06ha)

5 treatments + 1 CTRL(x 4 rep)

→ Assessing nitrogen leaching

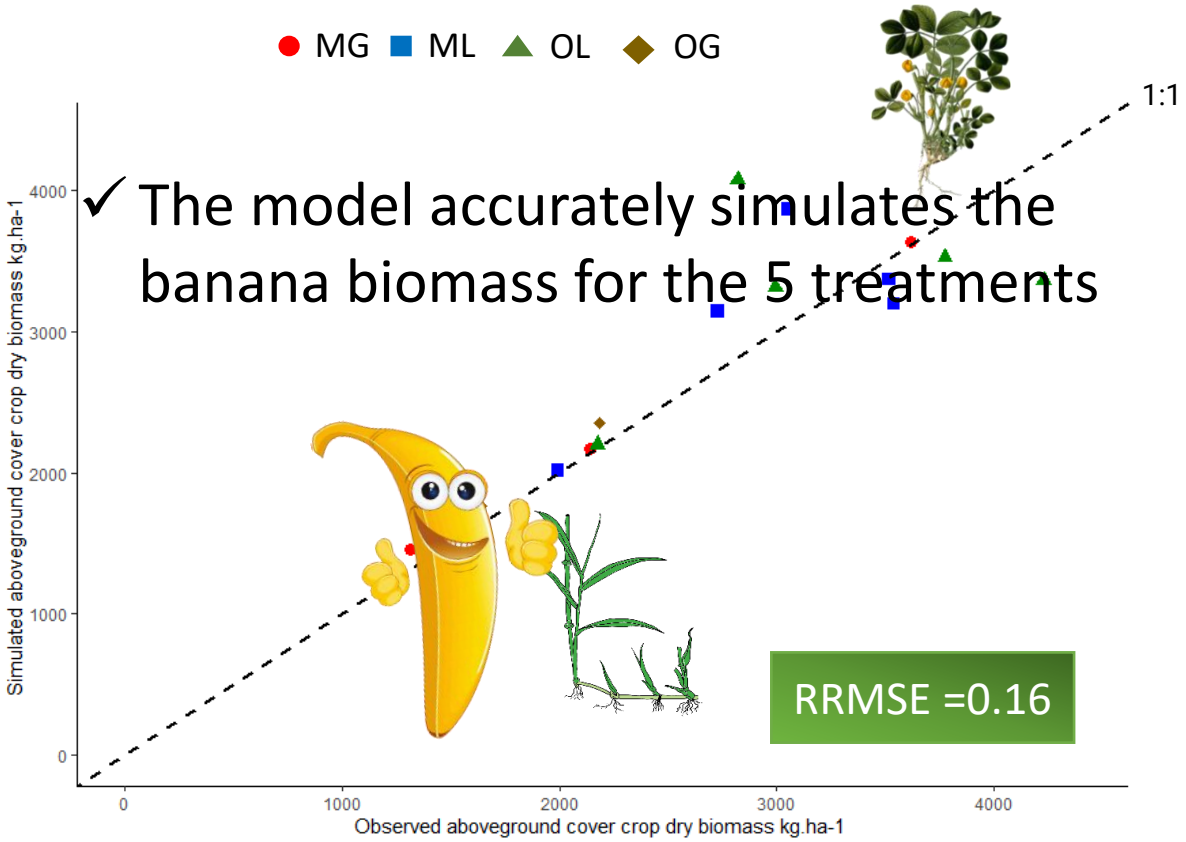
RESULTS
MODEL OVERVIEW


CLIMAT
PRACTICES
RESTITUTION
Banana N restituted
NRESBANt
+
Cover crop N restituted
NRESCCt
=
N restituted NRESt
N FERTILIZATION
ORGANIC
ORGft
MINERAL
MINft
BANANA
EXPORTATION
Banana bunch
UPTAKE
Banana UBANt
Cover crop UCCt
COVER CROP
SOIL
LAYER 1
LAYER 2
Soil organic N
SONt
MINERALIZATION
Soil organic matter mineralization
St
Soil mineral N
SMNt =
SMN1t
+
SMN2t
LEACHING
Mineral N leaching
NLt

RESULTS
MODEL SIMULATIONS

ABOVEGROUND BIOMASS

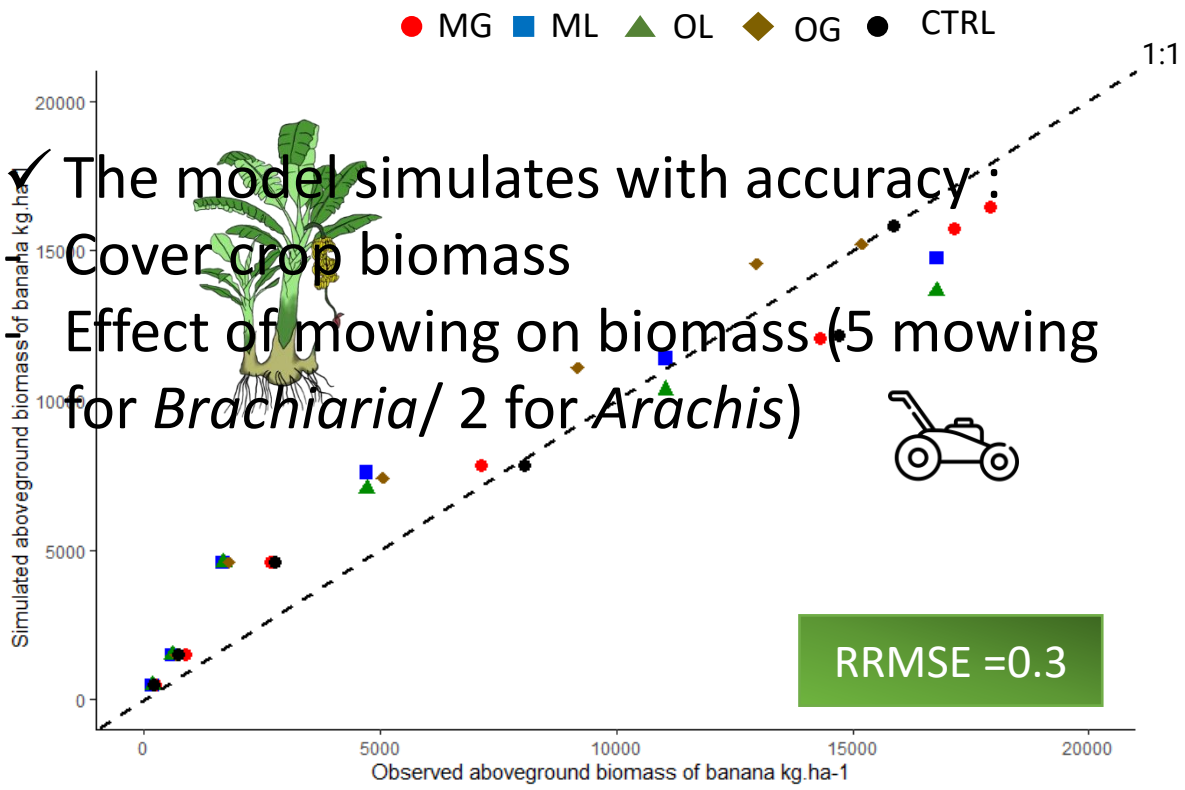
COVER CROP ~ CYCLE 1



✓ The model accurately simulates the banana biomass for the 5 treatments

RRMSE =0.16

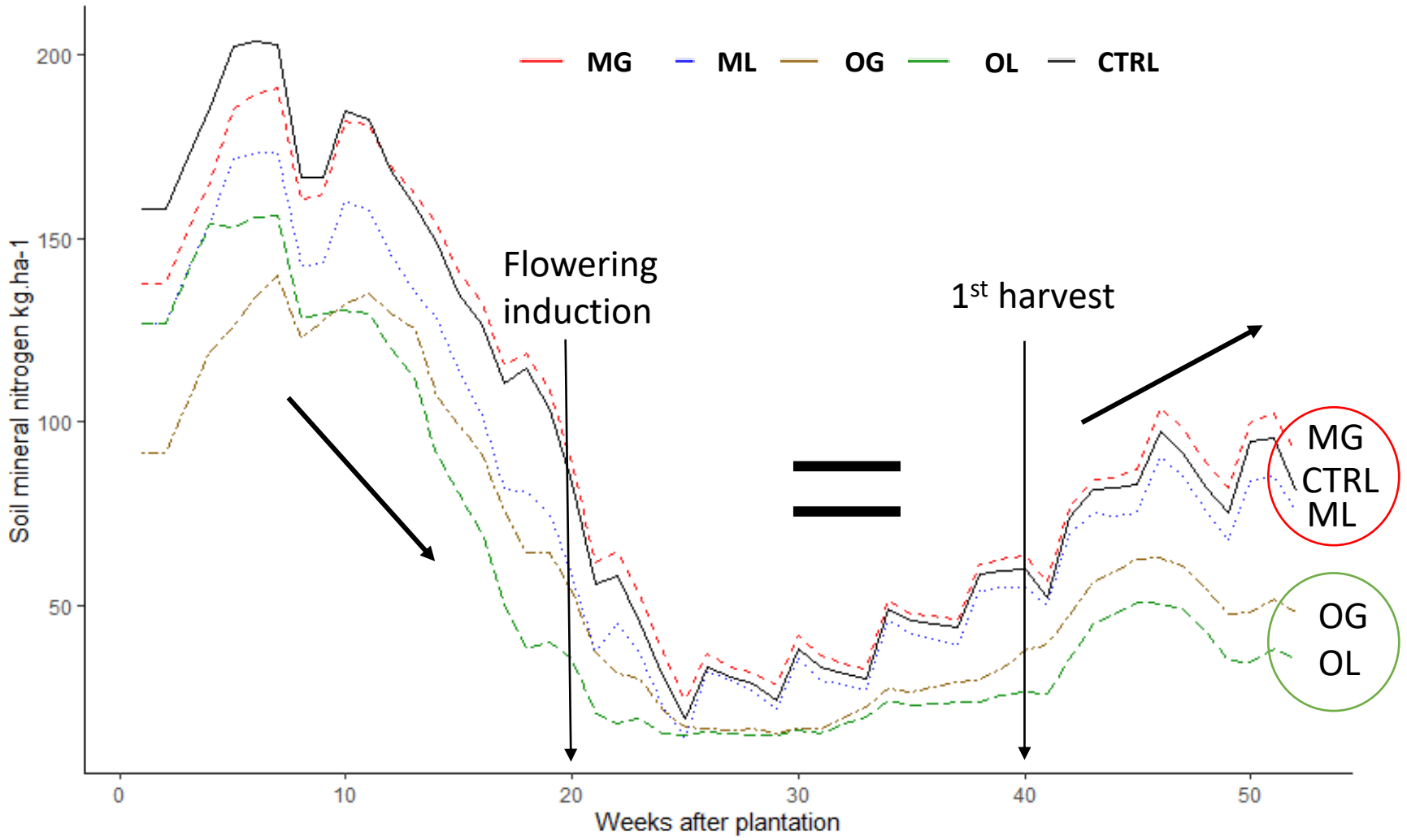
BANANA ~ CYCLE 1



✓ The model simulates with accuracy :
Cover crop biomass
Effect of mowing on biomass (5 mowing for *Brachiaria*/ 2 for *Arachis*)

RRMSE =0.3

SIMULATED SOIL MINERAL N ~ CYCLE 1



Organic < Synthetic (cycle 1 only)

No significant ≠ between cover crop

The model simulates crop management (CC, fertilizer, mowing) with accuracy

Conclusions and prospects

✓ The model simulates with accuracy :

- Banana and cover crop aboveground biomass
- Crop management (cover crop specie, mowing, N fertilizer)

→ Testing different nitrogen management (mowing frequency, N fertilizer application frequency…)

We need

→Testing model on several successive crop cycles (>3)

→Testing model with other cover crop species, organic fertilizers in order to design innovative agroecological systems

Thank you for your attention and Thank you for technical assistance

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Soil mineral nitrogen at flowering induction (kg.ha-1)

Ksom : Soil organic matter mineralization parameter

Eb: Light energy conversion to aboveground biomass parameter

	MG			ML			OG			OL			CTRL		
Parameters	-10%	=	+10%	-10%	=	+10%	-10%	=	+10%	-10%	=	+10%	-10%	=	+10%
Ksom	30	54	89	15	35	58	11	32	54	9	13	35	28	50	83

Ksom ↗ Soil mineral nitrogen ↗ significantly (**) → Measured parameter

Eb ↗ Soil mineral nitrogen ↘ but no significantly → Optimized by fitting iterative procedure