Improving the Efficiency of Low- Solubility Organic and Mineral Phosphate Fertilizers through the Inoculation of PGPB

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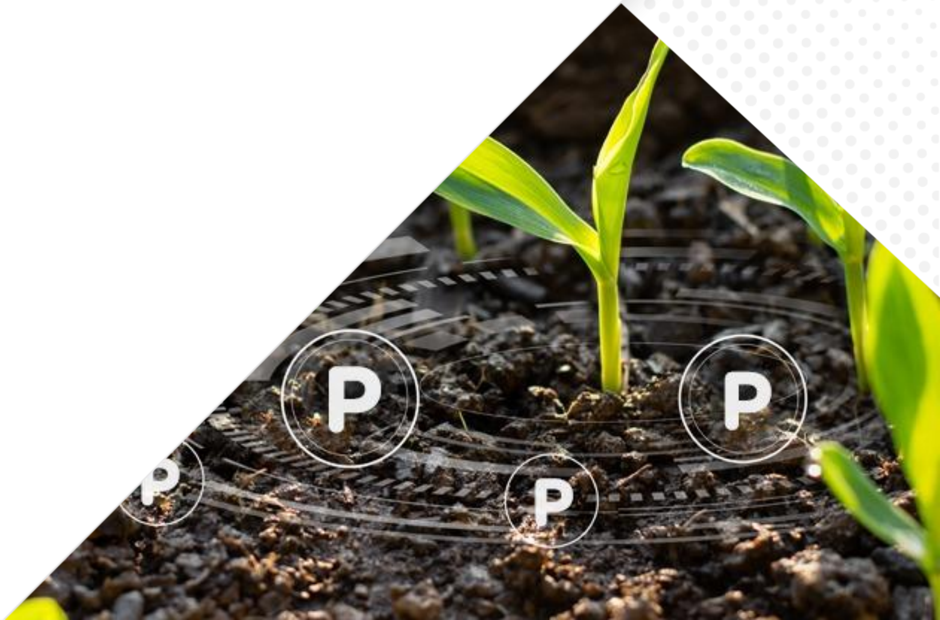

Phosphorus

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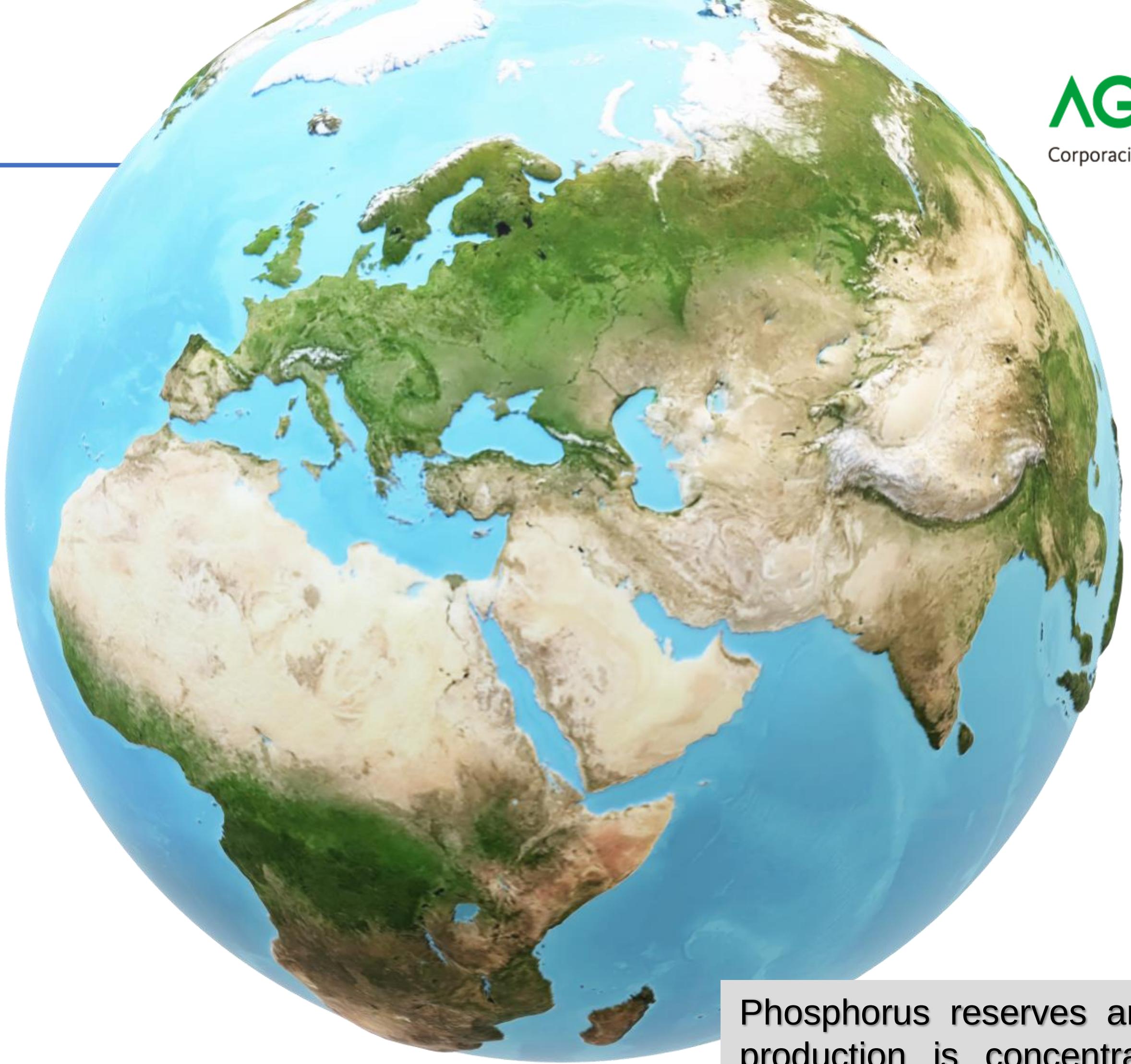
15
P
Phosphorus
30.97



Phosphorus reserves are finite, and 85% of its production is concentrated in countries facing geopolitical conflicts.

Dependence on the use of soluble phosphate fertilizers.

Low short-term efficiency. Requires higher application doses.

ESTIMATED
ROCK PHOSPHATE RESERVES IN THE WORLD

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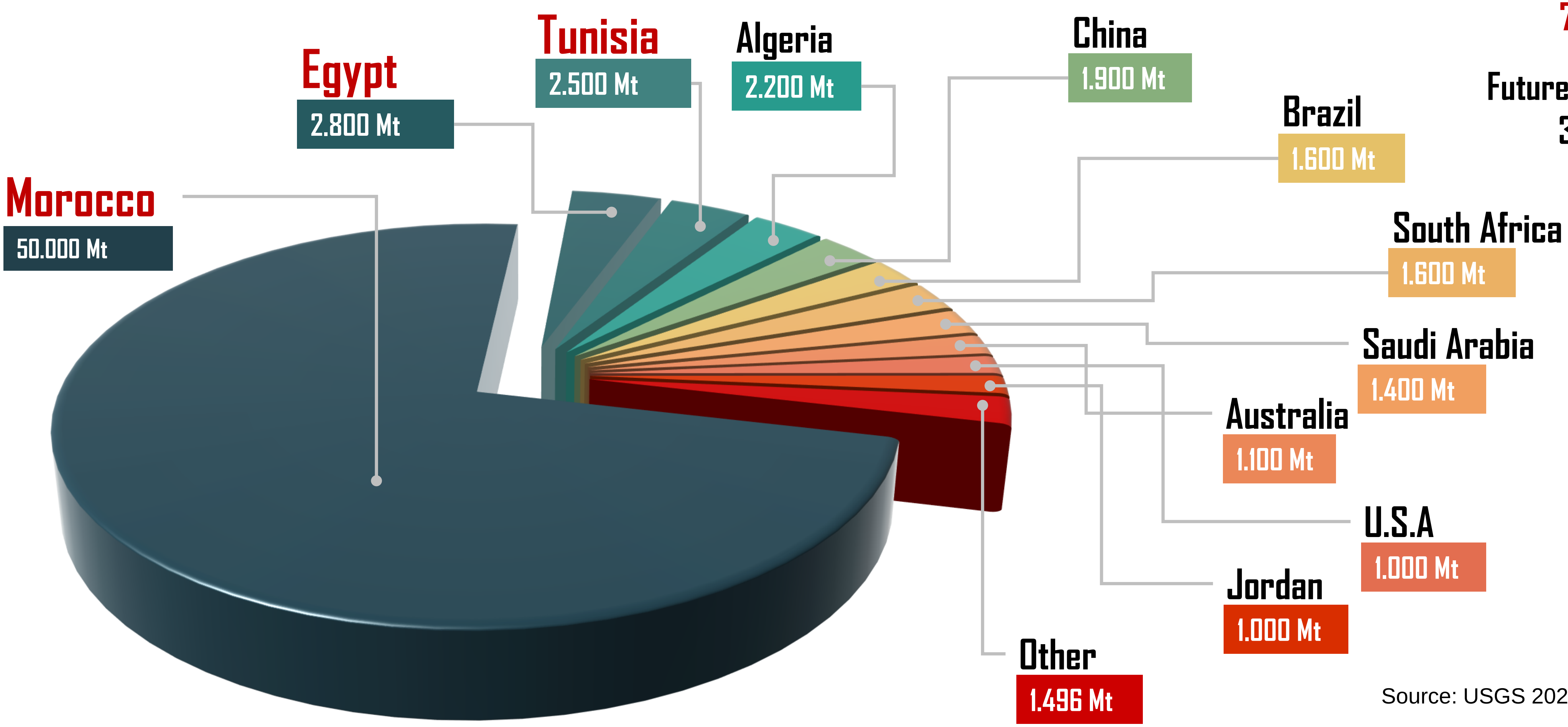
World Total Reserve
72.000 Mt

Future Reserve:
327 years



Source: USGS 2023

Colombia´s situation

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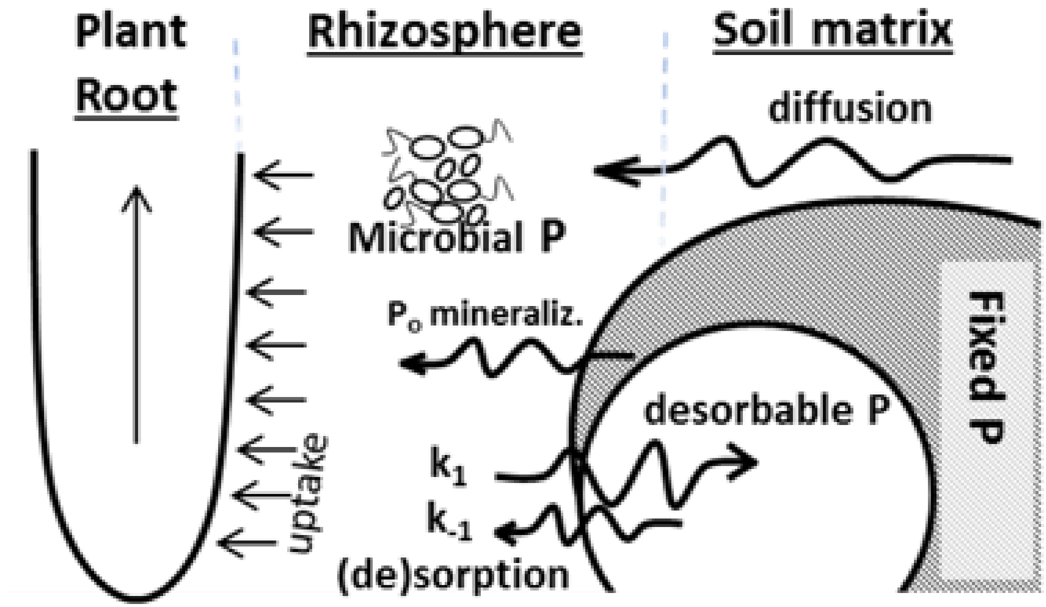
20 Mt
0,027 %

World reserve

0,041 Mt

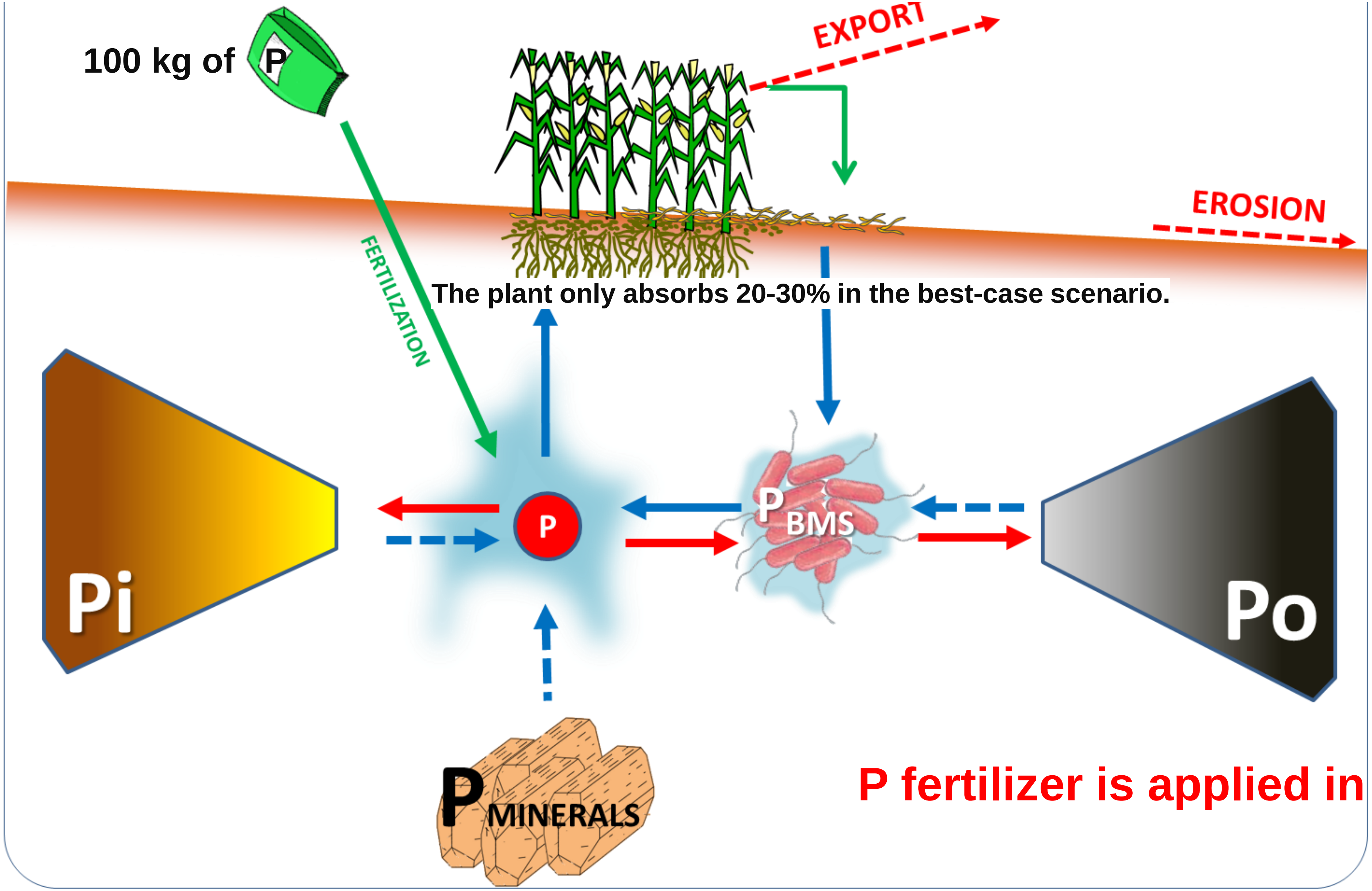
World production

Soil P dynamic



1. Highly reactive element (Ehrlich et al., 2016)
2. Low concentration of the element in the soil solution (Behera et al., 2014)
3. Transport by diffusion in the soil (Chapin, 1980)
4. Low availability for plants (Schachtman et al, 1998)

Soil P dynamic



P fertilizer is applied in excess

Optimizing P utilization is essential

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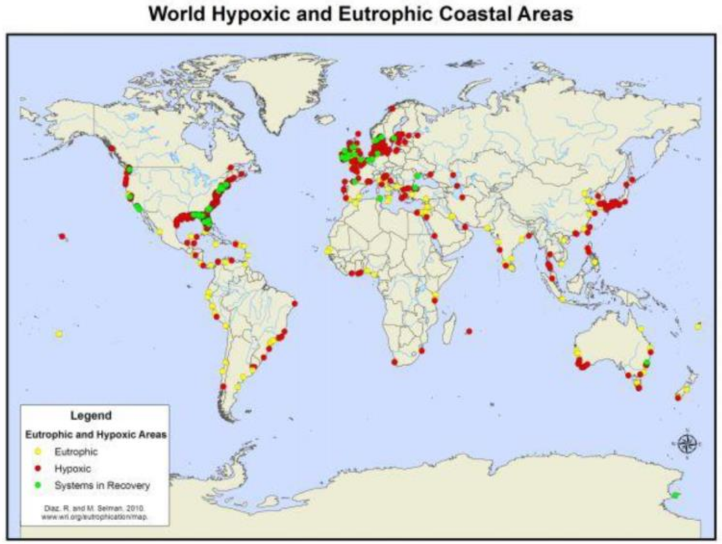
- Excessive application of P fertilizers is related with eutrophication and soil degradation
- Importance of implementing sustainable agriculture practices
- Enhance soil quality and productivity
- Low fertility of tropical soils



Eutrophication (algal blooms) in Big Mallard Marsh.
(Photo courtesy of North Dakota Department of Environmental Quality)
A fish kill in North Dakota.
(Photo courtesy of North Dakota Game and Fish Department)

Environmental Implications of Excess Fertilizer and Manure on Water Quality

Mary Keena, Extension Livestock Environmental Management Specialist, Carrington Research Extension Center
Miranda Meehan, Extension Livestock Environmental Stewardship Specialist
Tom Scherer, Extension Agricultural Engineer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Inicio > Noticias > Educación > El exceso de fertilizantes está causando graves daños al medioambiente

El exceso de fertilizantes está causando graves daños al medioambiente

23 de julio de 2006

Un total de 140 investigadores y técnicos de empresas han analizado en la Universidad los métodos para mejorar la alimentación y minimizar el impacto ambiental.

Our objective: Adding value to agricultural waste by increasing the efficiency of low-solubility phosphate fertilizers

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Partners: FENAVI Federación Nacional de Avicultores de Colombia; EMPRESA DE FOSFATOS DE BOYACA

1. Organo-mineral fertilizer development

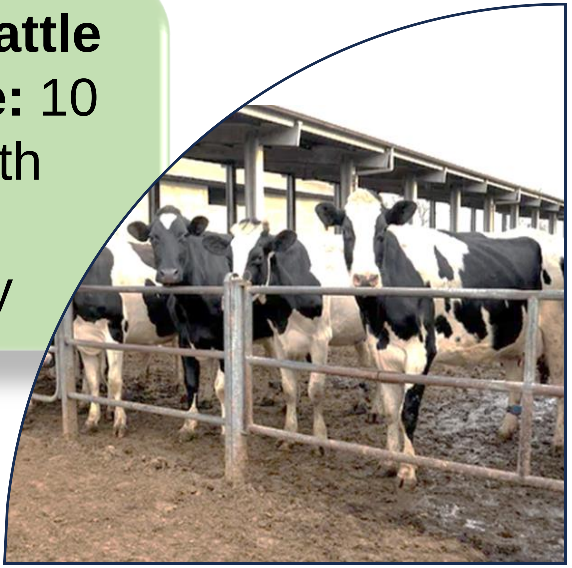
Pilot plant for the development of a 'smart fertilizer' at the C.I. Tibaitatá.

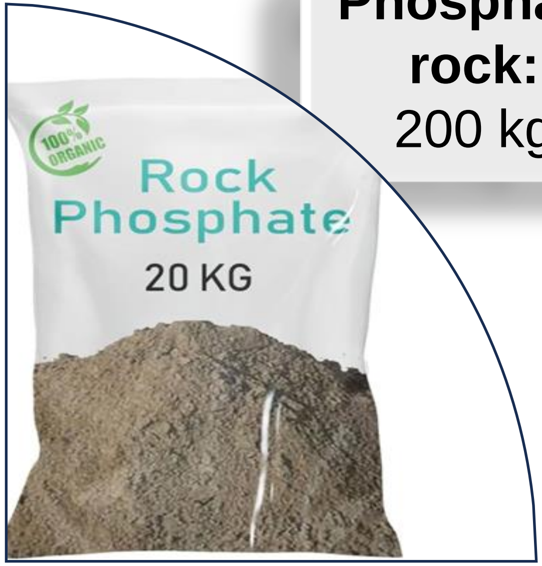
2. Biofertilizers to increase the agronomic potential of organo-mineral fertilizer (OMF)


Fertilizer application in C.I. Tibaitatá

1. Organo-mineral fertilizer (OMF) production process

Dairy cattle manure: 10 parts with 60% of humidity





Phosphate rock: 200 kg

Grass pruning: 20 parts

Initial C:N ratio of 25-30:1
Duration of composting process: 90 days
Composting Piles:
- Turning every week
- Temperature monitoring every day

OMF production process : monitoring

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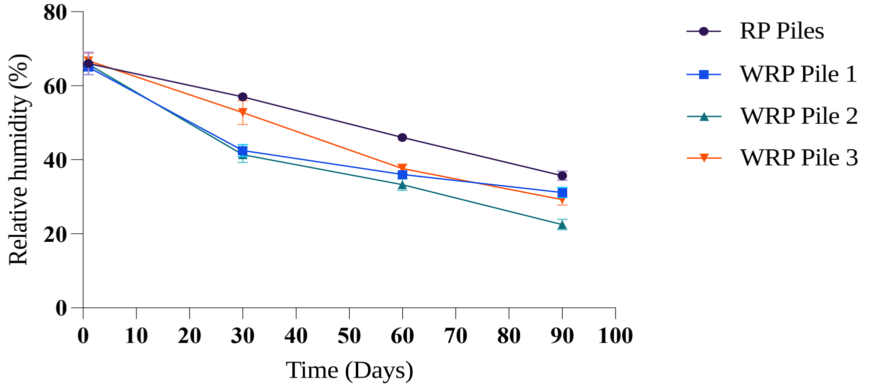

Figure 1. Behavior of relative humidity over 90 days. The RP piles correspond to an average of seven experimental units. The WRP piles correspond to three experimental units.

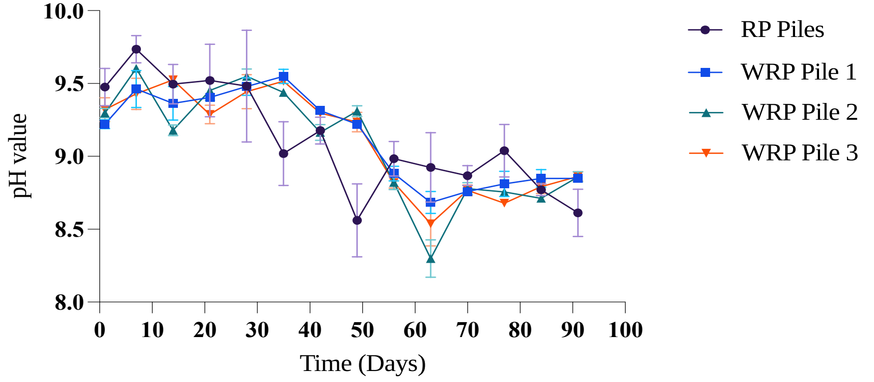

Figure 2 . Behavior of pH over 90 days The RP piles correspond to an average of seven experimental units. The WRP piles correspond to three experimental units.

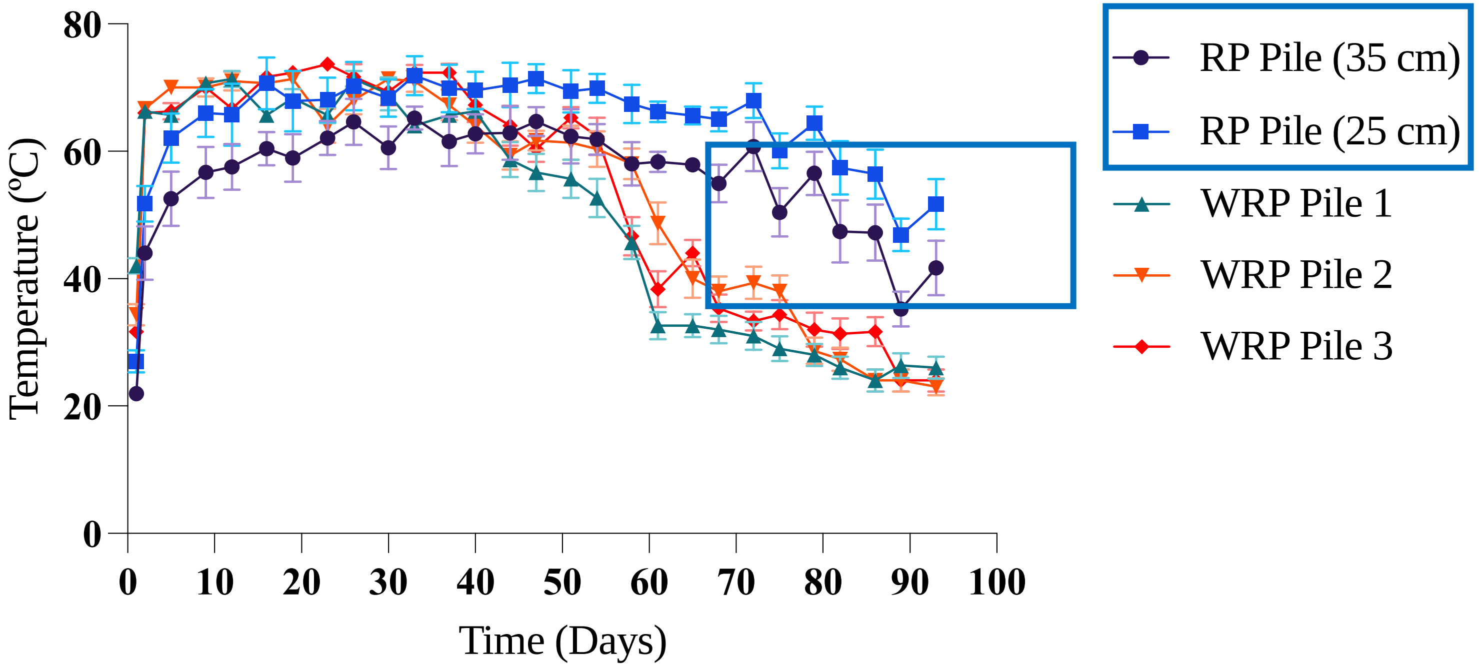

Figure 3. Behavior temperature over 90 days. The RP piles correspond to an average of seven experimental units. The WRP piles correspond to three experimental units

OMF – chemical characterization

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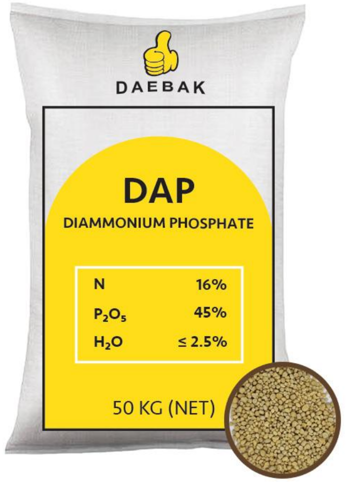
Variable	Units	Weight	Dry weight	kg/ Ton Wet Basis
Moisture Percentage	% (V/ w)	34,18 (±)2,52		
Bulk Density	g/cm3	0,73 (±)0,05		
Cation Exchange Capacity (CEC)	cmol+ /kg	42,3 (±)2,22	64,53 (±)5,22	
Organic Carbon	% (w/w)	11,87 (±)0,8	18,08 (±)1,29	
Organic Matter	% (w/w)	25,75 (±)1,73	39,24 (±)2,79	
Carbon Ratio	p:p	8,26 (±)0,98	8,26 (±)1,79	
pH (Acidity Reaction) (1:2)	_log H+	8,23 (±)0,2		
Electrical Conductivity	dS/m	34,56 (±)4,89		
Total Nitrogen (N)	% (w/w)	1,49 (±)0,15	2,29 (±)0,45	14,9 (±)2,5
Ammoniacal Nitrogen (NH4)	% (w/w)	0,02 (±)0	0,03 (±)0,01	0,18 (±)0,04
Nitrate Nitrogen (NO3)	% (w/w)	0,12 (±)0,02	0,18 (±)0,03	1,21 (±)0,3
Phosphorus (P)	% (w/w)	1,84 (±)0,26	2,79 (±)0,33	18,42 (±)3,1
Potassium (K)	% (w/w)	1,87 (±)0,1	2,86 (±)0,2	18,74 (±)0,93
Calcium (Ca)	% (w/w)	7,22 (±)0,9	10,92 (±)1,56	72,17 (±)13,34
Magnesium (Mg)	% (w/w)	0,39 (±)0,03	0,59 (±)0,06	3,84 (±)0,36
Sulfur (S)	% (w/w)	0,47 (±)0,12	0,71 (±)0,16	4,72 (±)1,1
Iron (Fe)	mg /kg	3901,63 (±)137,9	5944,43 (±)345,85	3,9 (±)0,16
Manganese (Mn)	mg /kg	248,2 (±)23,82	377,29 (±)30,27	0,25 (±)0,02
Copper (Cu)	mg /kg	9,93 (±)1,54	15,17 (±)2,66	0,01 (±)0
Zinc (Zn)	mg /kg	119,69 (±)18,98	182,57 (±)30,65	0,12 (±)0,02
Boron (B)	mg /kg	19,57 (±)1,99	29,81 (±)3,37	0,02 (±)0

1 ton OMF = 18,4 kg P or 91,7 kg of DAP



OMF - sequential P fractionation (P Dynamic)

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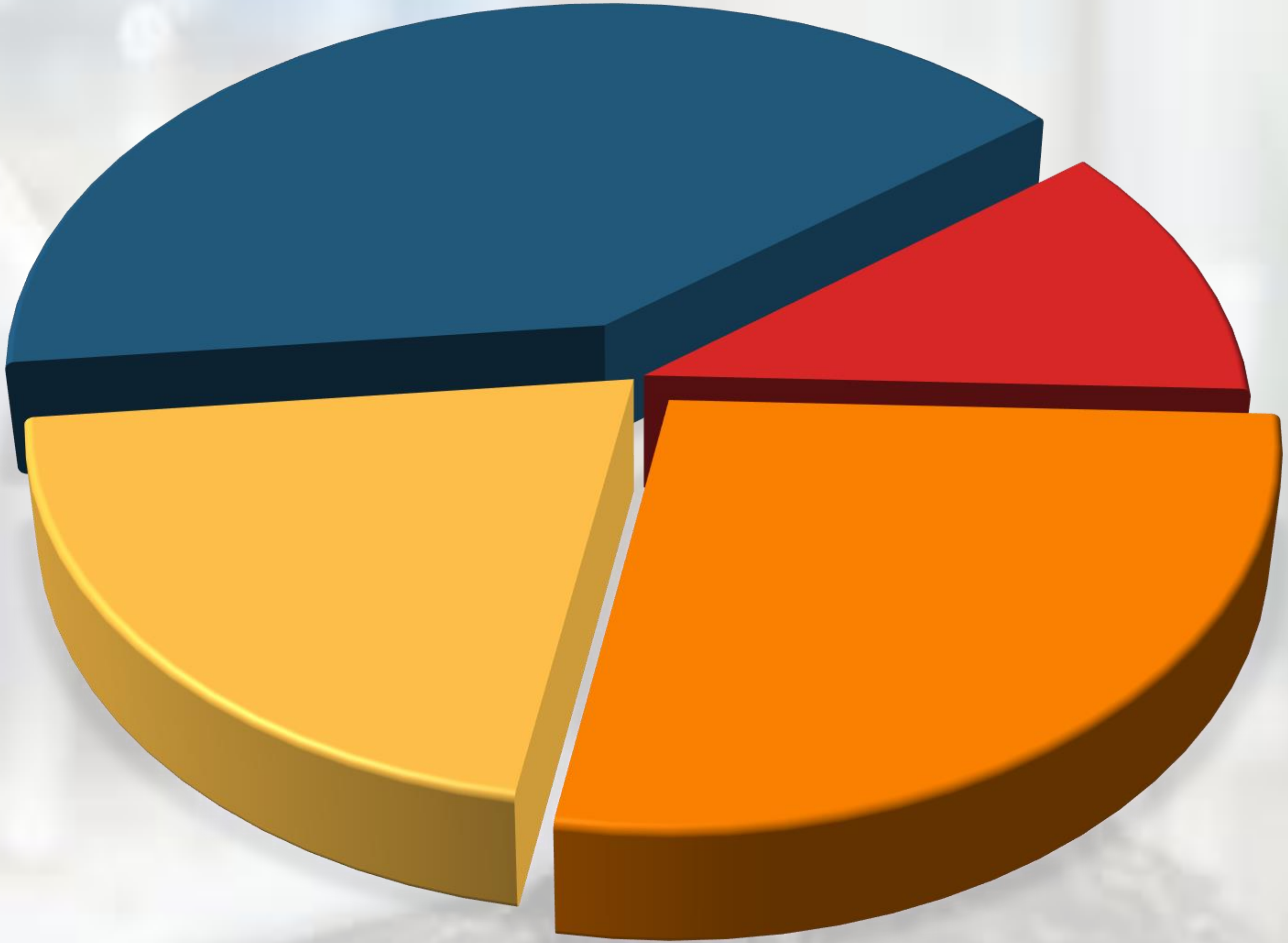

Available — Labile – P: 20,6 (%)

Low liberation — Moderately Labile – P: 41 (%)

Low liberation — Organic – P: 11,2 (%)

Non Labile – P: 27,2 (%)

FOM P Dynamic (Gatiboni and Condron (2021))

2. A consortium to optimize the use of nutrients in low-solubility fertilizers

Biofertilizer formulated as a concentrated suspension ($1x10^{8}$ CFU/mL) based on the PGPB consortium of three bacterial strains: *Herbaspirillum* sp. AP21, *Azospirillum brasilense* D7, and *Rhizobium leguminosarum* T88, designed to promote plant development under environmental stress.

Benefits

- **Consortium for Pastures, Forages, and Vegetables (Bejarano-Herrera et al., 2024; Torres-Cuesta et al., 2023)**
- **Capability to reduce chemical fertilization of both phosphorus and nitrogen by up to 50% (Pardo-Díaz et al., 2021)**
- **Biofertilizer with the ability to mitigate drought in grasses and legumes used in animal feed (Cortés-Patiño et al., 2022 and 2021)**
- **First Biofertilizer that includes the potential new *Herbaspirillum* species (Santos-Torres et al., 2021)**

Pastures

Cabbage

Corn

Biofertilizer to optimize the use of nutrients in low-solubility fertilizers

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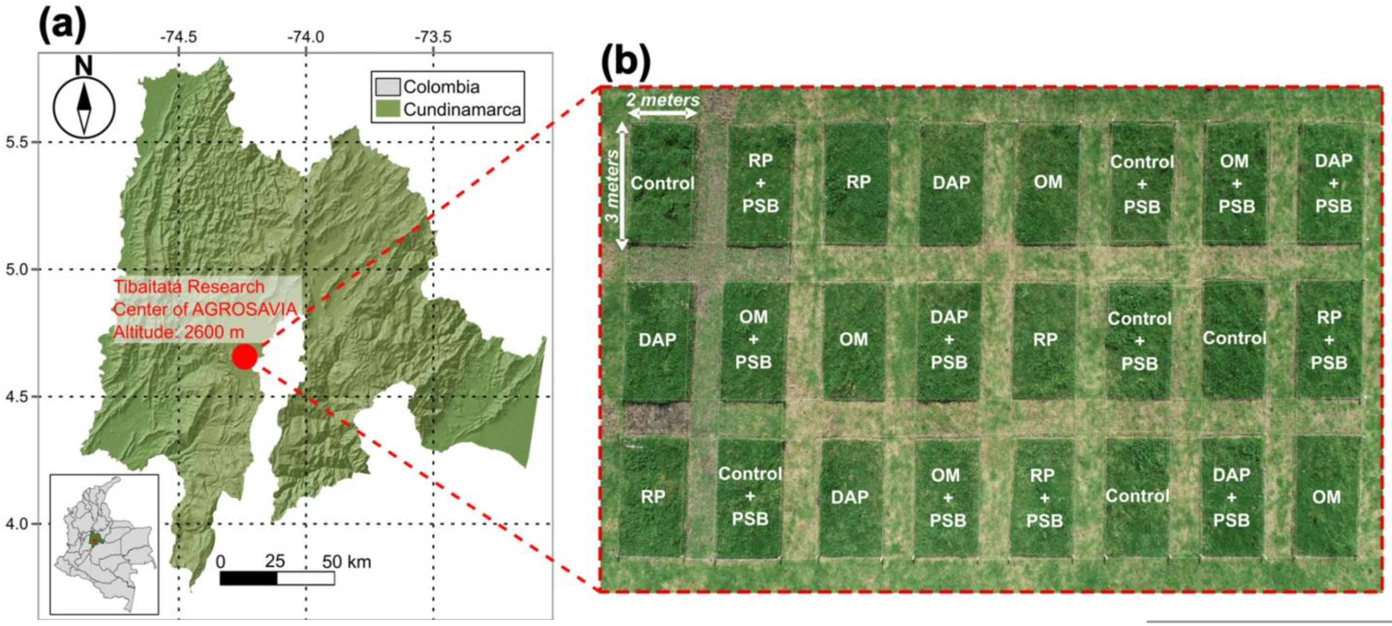

The experiment was evaluated for 18 months

Daniel Torres.
MSc Suelos y Aguas.

triEstimul

Herbaspirillum sp. AP2
Azospirillum brasilense D7
Rhizobium leguminosarum T88

Treatments	
T1	Without fertilization
T2	Soluble P source (DAP) (46% P_2O_5)
T3	Co-inoculation
T4	Rock phosphate (RP) (26 % P_2O_5)
T5	Organo-mineral fertilizer (OM) (1,8 % P_2O_5)
T6	Co-inoculation + DAP
T7	Co-inoculation + MO
T8	Co-inoculation + RP

Torres et al., 2023. Microorganisms

TriEstimul biofertilizer to improve kikuyo grass productivity and phosphorus availability - Methodology

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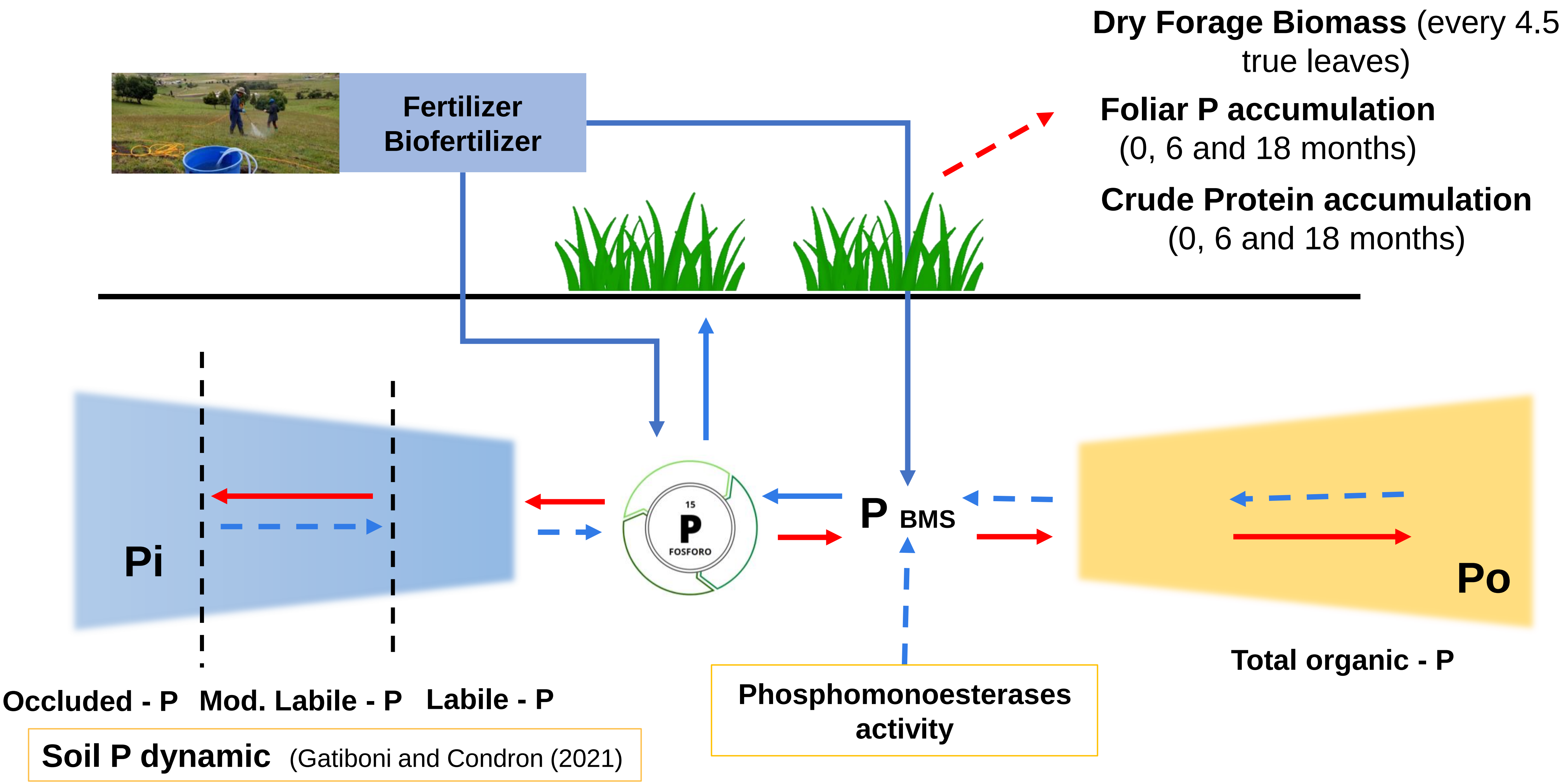

TriEstimul biofertilizer to improve kikuyo grass productivity and phosphorus availability - Results

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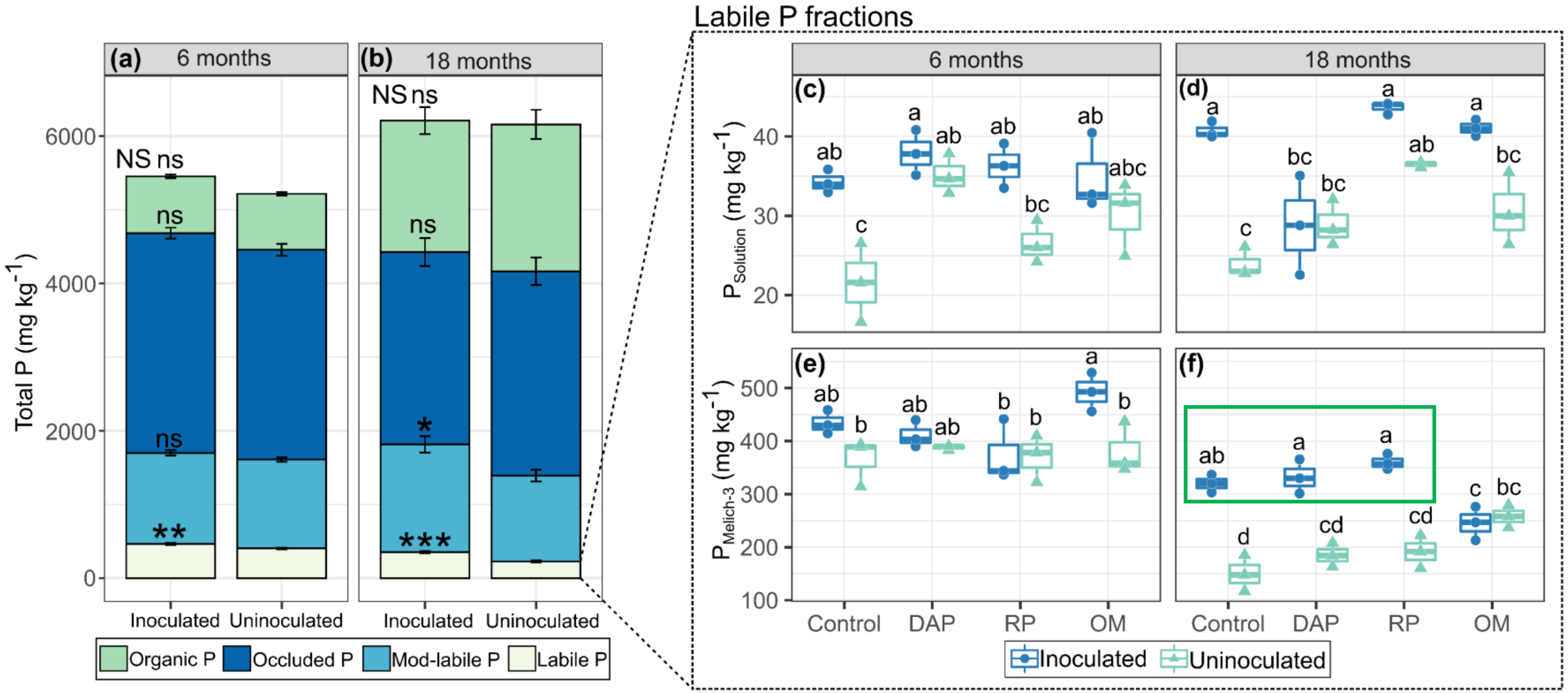
Soil Phosphorus dynamic



- The inoculation improves soil phosphorus availability.
- The main effect observed 18 months after implementation.

Torres et al., 2023. Microorganisms

TriEstimul biofertilizer to improve kikuyo grass productivity and phosphorus availability - Results

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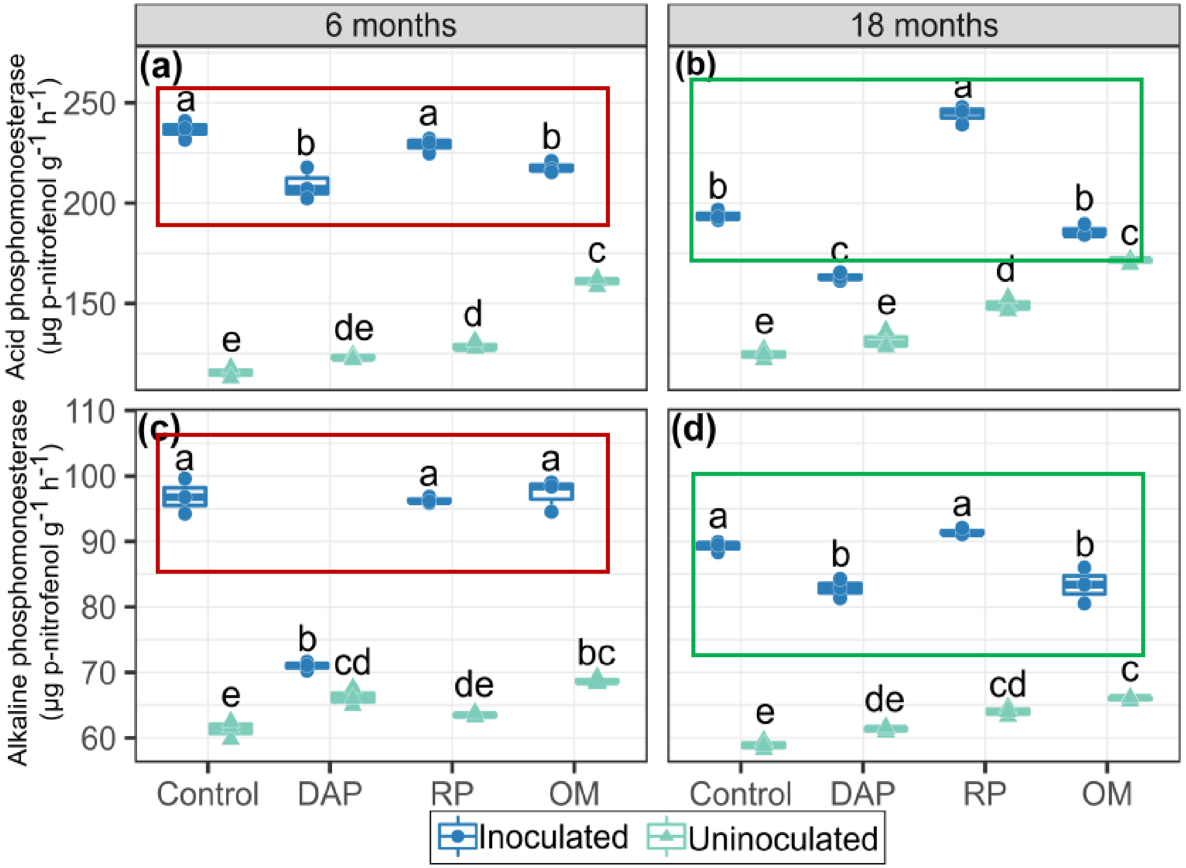
Enzyme activity

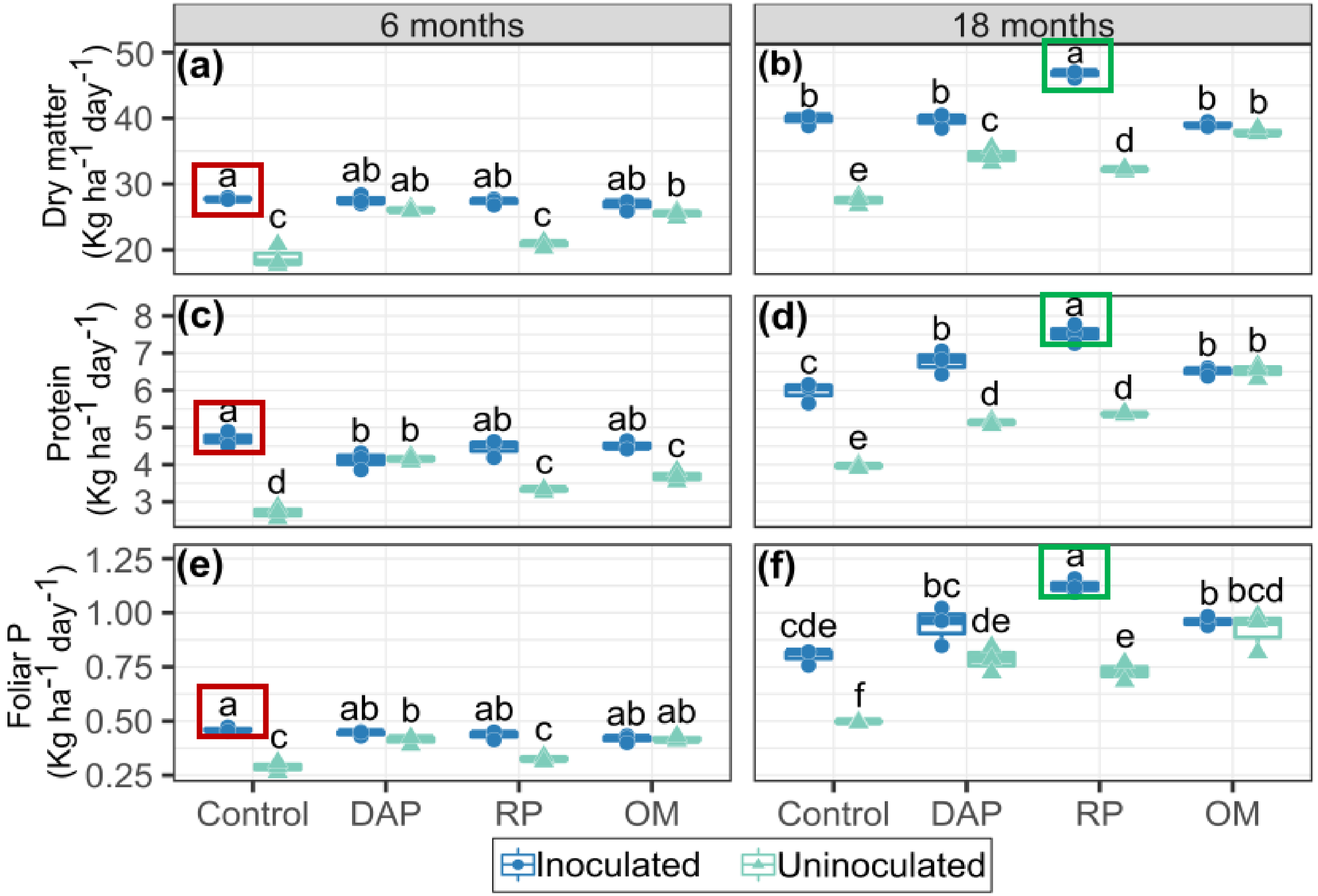


- The effect is observed 6 months after implementation, regardless of the phosphorus source

Torres et al., 2023. Microorganisms

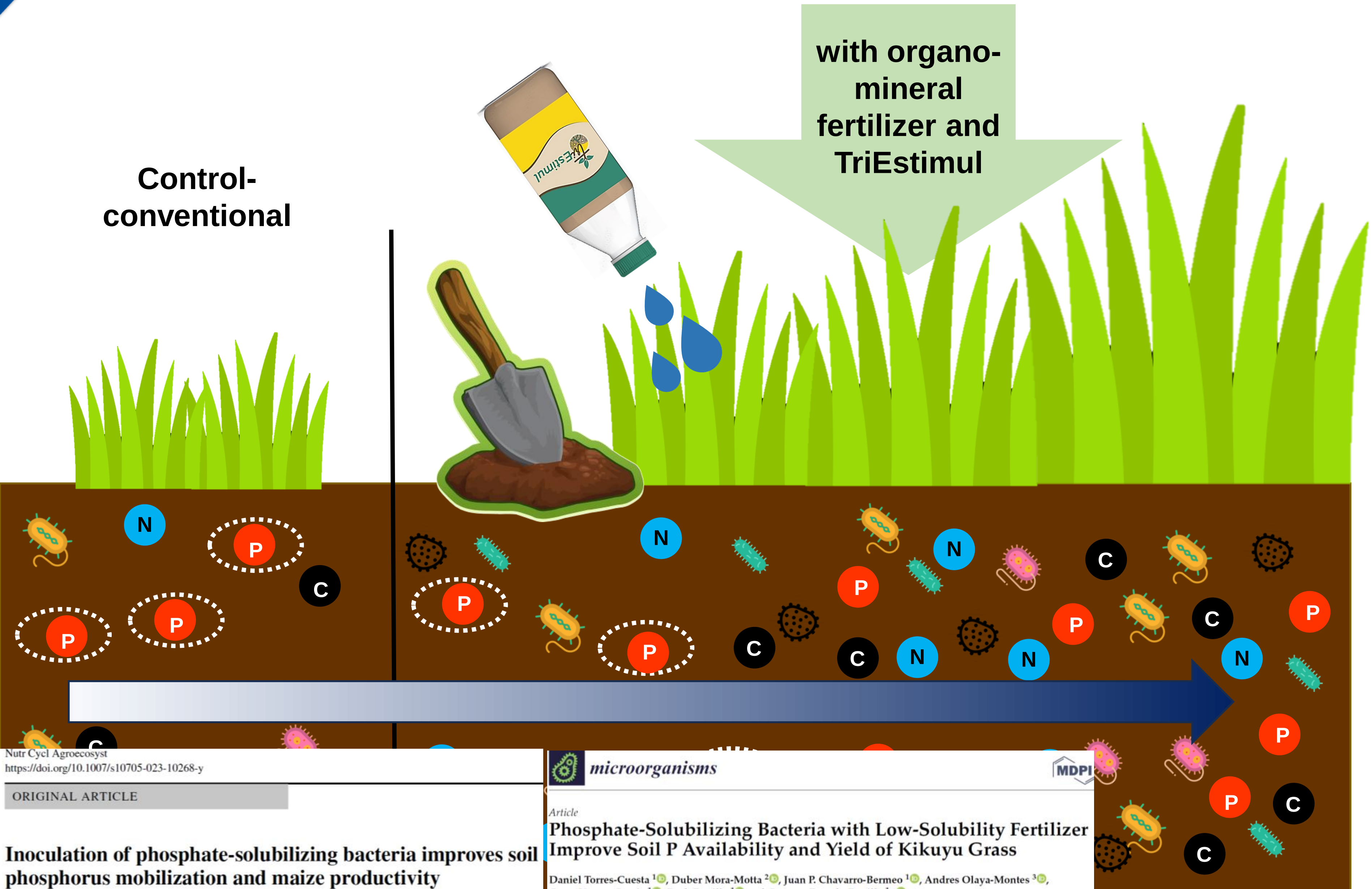
TriEstimul biofertilizer to improve kikuyo grass productivity and phosphorus availability - Results

Forage production and quality



Torres et al., 2023. Microorganisms

Assessment of soil health and nutrient dynamics in crops of interest



Nutr Cycl Agroecosyst
https://doi.org/10.1007/s10705-023-10268-y

ORIGINAL ARTICLE

Inoculation of phosphate-solubilizing bacteria improves soil phosphorus mobilization and maize productivity

microorganisms MDPI

Article

Phosphate-Solubilizing Bacteria with Low-Solubility Fertilizer Improve Soil P Availability and Yield of Kikuyu Grass

Daniel Torres-Cuesta [1], Duber Mora-Motta [2], Juan P. Chavarro-Bermeo [1], Andres Olaya-Montes [3],

Increase in crop productivity

Higher nutritional quality

Legacy of organic fertilizer and TriEstimul inoculation

Greater availability of nutrients

Thank you for your attention…

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SISTEMAS AGROPECUARIOS SOSTENIBLES