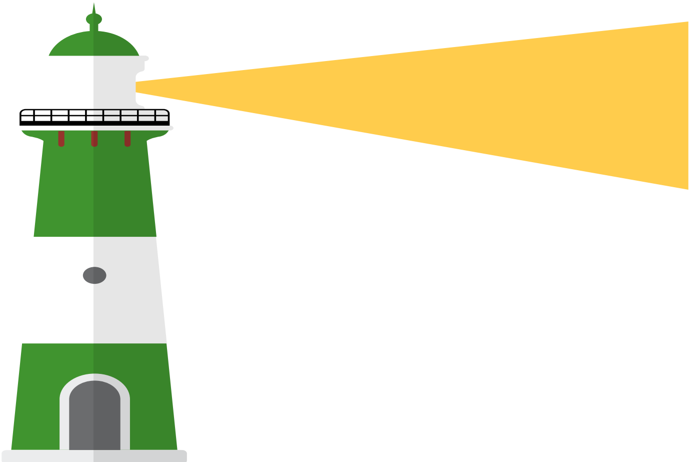
Nutri2Cycle

Transition towards a more carbon and nutrient efficient agriculture in Europe



Use of poultry manure compost and pig slurry to replace mineral fertilizers used as basal fertilization in maize crop

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 773682.

Description of the solution

A field experiment was set-up to assess the potential of **pig slurry** and **poultry manure compost (chicken or turkey)** to replace mineral fertilizers **as basal N fertilization** in maize crop.

The total N applied using the organic materials can be calculated, and mineral N fertilization can be supplemented later (during sowing, weeding, or irrigation), to level the total N applied to the crop – **Precision agriculture tools.**

The experiment was performed in a commercial farm "*Quinta da Cholda*" (Azinhaga, Portugal), one of the most important maize farms in Portugal (over 500 hectares) – João Coimbra, considered a "Model maize producer", uses precision agriculture practices.

Público

I Liga
Benfica vence em Braga (0-2) e passa para o terceiro lugar
Desporto, 35

Televisão
Um ano de covid-19 paralisou as produtoras e deixou milhares de profissionais sem rendimento
Cultura, 28/29

Van Gogh
Pintor viveu pobre, mas quadros que deu à irmã pagaram-lhe os cuidados médicos
Cultura, 30

Governo quer reforçar poderes para encerrar fundações privadas

Proposta de lei em curso prevê mais acesso a informações e penas até 10 mil euros para fundações falsas

Dia da Água Na Quinta da Cholda só há rega quando os computadores decidem

Especialistas avisam
Máscaras podem causar atrasos no desenvolvimento dos bebés

Grupo Wagner
O braço armado da Rússia não pára de crescer em África

Autárquicas 2021
Partidos em acção entre incertezas e muitos desafios

https://www.youtube.com/watch?v=0Qkv1cNyWgM

Experimental design

Three different experimental sites were selected:

Site 1) Sandy soil ("*Pessegueiro*"), lower OM content (1.96%), application of organic amendments in a yearly basis, and conventional agriculture practices;
Site 2) Loamy soil ("*Melhorada*"), medium soil OM content (2.32%), no history of application of organic materials, using conventional agriculture practices;
Site 3) Sandy loam ("*Vinha*"), with direct seeding over the last 15 years, higher OM content (2.9%), no history of application of organic materials.

At each site, three sub-plots of approximately one hectare each (18 m x 500 m) were selected to test our treatments.

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Experimental design (Cont.)

Each sub-plot received a different **basal fertilization** with:

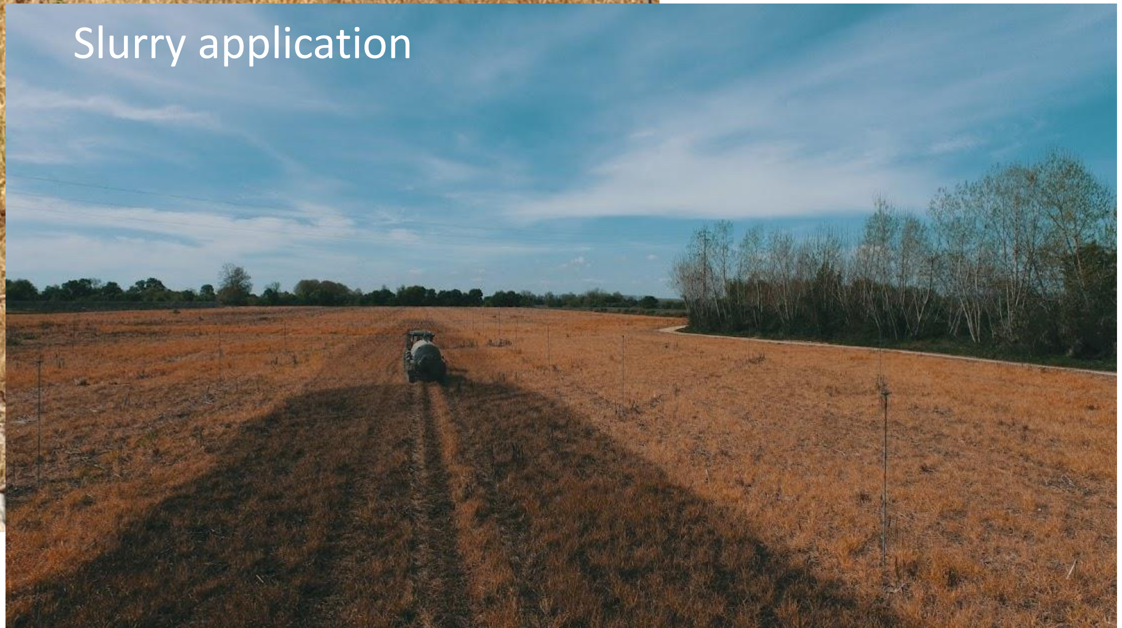
(i) **pig slurry** (approximately 32 m^3 ha^{-1}) , equivalent to 90 kg N ha^{-1};

(ii) **poultry manure compost** (approximately 10 t fresh compost ha^{-1}), equivalent to 90 kg N ha^{-1};

(iii) **mineral fertilizer** (acting as the control), equivalent to 60 kg N ha^{-1} in site 1 and 2 (conventional tillage) and to 160 kg N ha^{-1} in site 3 (no-tillage).

Basal N fertilization was complemented with **top dressing fertilization** and fertigation in order to supply 300 kg N ha^{-1} in all treatments.

All other operations (e.g., P and K fertilization, herbicides application, irrigation, etc.) were equally applied to the three plots.



Slurry application

Demo on the application logistics

One important interest of these experimental sites were to evidence how the application of both materials, solid (manure compost) or liquid (slurry), are possible.
A **“Demo day” to local producers** was prepared.

Evidencing materials safety use – Heavy metals content

Other important interest of the Field Experiment was to evidence the safety use of these materials, considering the existing Legislation.

Portugal has just released new Legislation (3/February/2022), on the agricultural valorization of animal manures and slurries (livestock effluents) and derived materials (e.g., compost, digestate) – more precautionary regarding HM content.

	Turkey manure compost	Chicken manure compost	Pig slurry	Legal limit value (*)
Heavy-metals	mg/kg DM	mg/kg DM	mg/kg DM	mg/kg
Cu	107.9	120	30.2	400
Zn	544	775	96.1	1000
Cd	0.06	0.08	n.a.	3
Pb	0.09	0.13	n.a.	300
Cr	2.64	4.02	n.a.	300
Ni	2.38	3.68	n.a.	200
Hg	0.00065	0.00026	n.a.	3

Diário da República, 1.ª série

N.º 24 3 de fevereiro de 2022

AMBIENTE E AÇÃO CLIMÁTICA E AGRICULTURA

Portaria n.º 79/2022

de 3 de fevereiro

Sumário: Define o regime aplicável à gestão de efluentes pecuários, revogand
n.os 631/2009, de 9 de junho, e 114-A/2011, de 23 de março.

Balance to total N applied

Treatment	Application	N_{total} concentration in the fertilizer (g/kg)	N_{total} basal application (kg N/ha)	N_{total} application at sowing (kg N/ha)	N_{total} application at hoeing (kg N/ha)	N_{total} application (kg N/ha)
N mineral fertilizer	150 kg/ha	400	60.0	22.5	78	160.5
Pig slurry	32 m^3/ha (4 tanks of 8 m^3)	2.92*	93.4	22.5	44	159.9
Poultry manure compost	10 t/ha (fresh material)	8.74*	87.4	22.5	50	159.9

≅ 30% total N applied using manures (30% savings in N mineral fertilizers)

Total N basal application was higher when using the manure-derived materials, but:

$N_{total} \neq N_{available}$

Total N application was leveled in all treatments during weeding

After weeding, N was applied in all the treatments in fertigation (total 300 kg N/ha)

Experimental measurements

Soil sampling: at each site and plots at the beginning and at the end of the experiment.

Soil analysis: pH, EC, OM content, total N, extractable P and K (Olsen), cation exchange capacity, total S, total metals (Cu, Cd, Cr, Ni, Pb, Zn), C fractionation, and sequential P extraction.

In analysis

Crop: Maize yield, SPAD, and nutrient use efficiency.

Greenhouse gases emissions (CH_4, CO_2, N_2O): measured during the whole experiment using the static chamber technique (Fangueiro et al., 2018). Three times per week during the first week and then on a weekly basis until the end of the experiment – total emissions were calculated.

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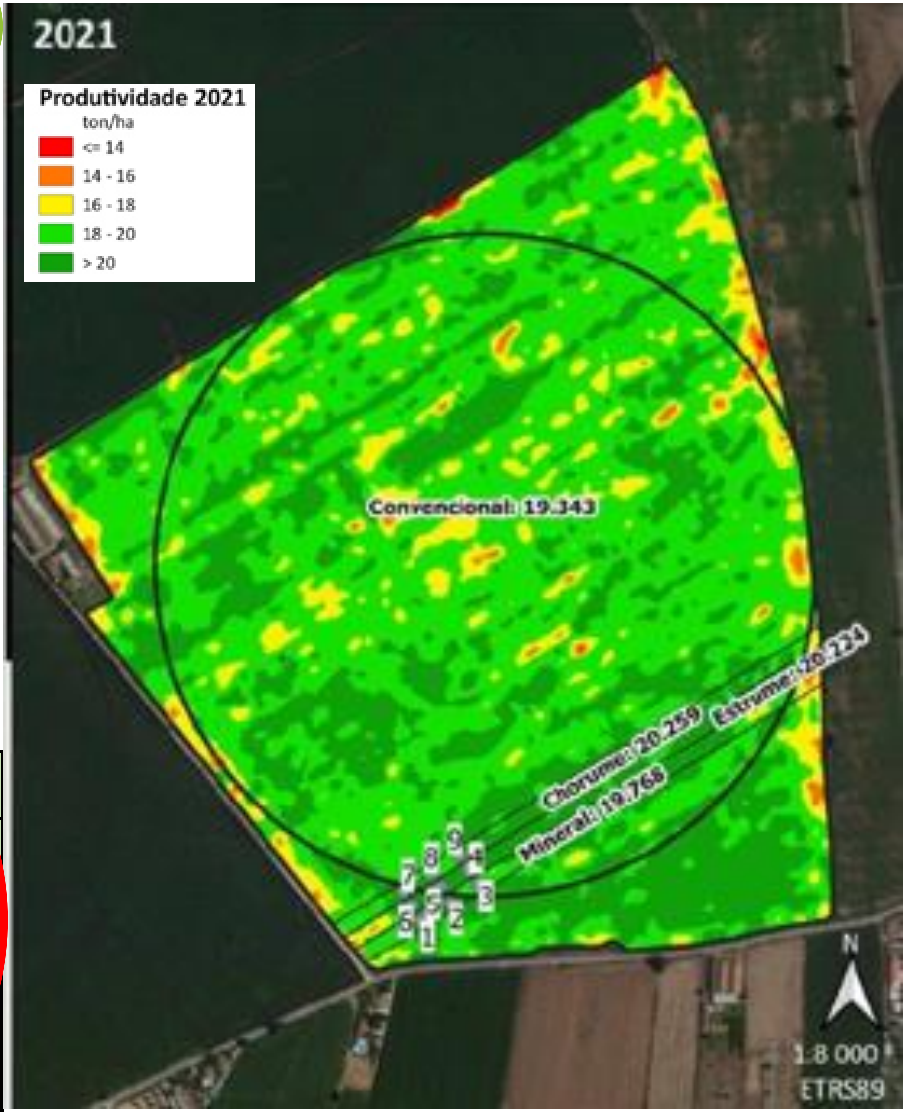
Preliminary results – *Melhorada* (loamy soil)

SPAD measurements indicated no significant differences in chlorophyl content between treatments (16/06/2021)

	SPAD
Mineral Fertilizer	49.4±3.4 a
Poultry manure compost	49.4±2.3 a
Pig slurry	48.6±1.2 a

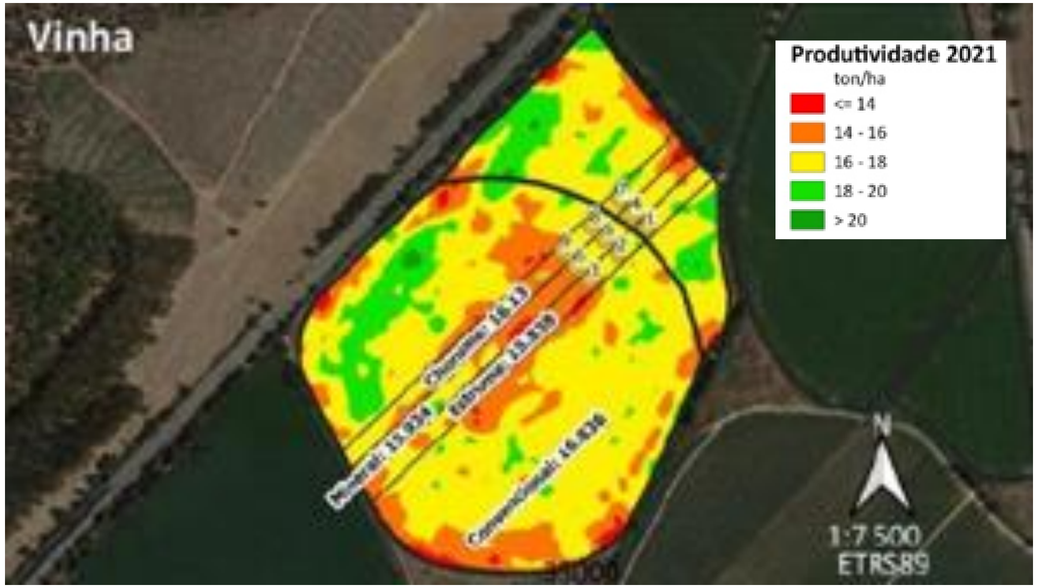


Maize yield (2021 *versus* 2020)

Melhorada (Sandy loam soil)		Productivity ($t\ ha^{-1}$)		
	Area (ha)	2020	2021	Variation (%)
Conventional	51.16	18.031	19.343	7.27
Mineral Fertilizer	1.05	18.319	19.768	7.91
Poultry manure compost	1.07	18.017	20.224	12.25
Pig slurry	1.09	17.932	20.259	12.98

Maize yield (2021 *versus* 2020)

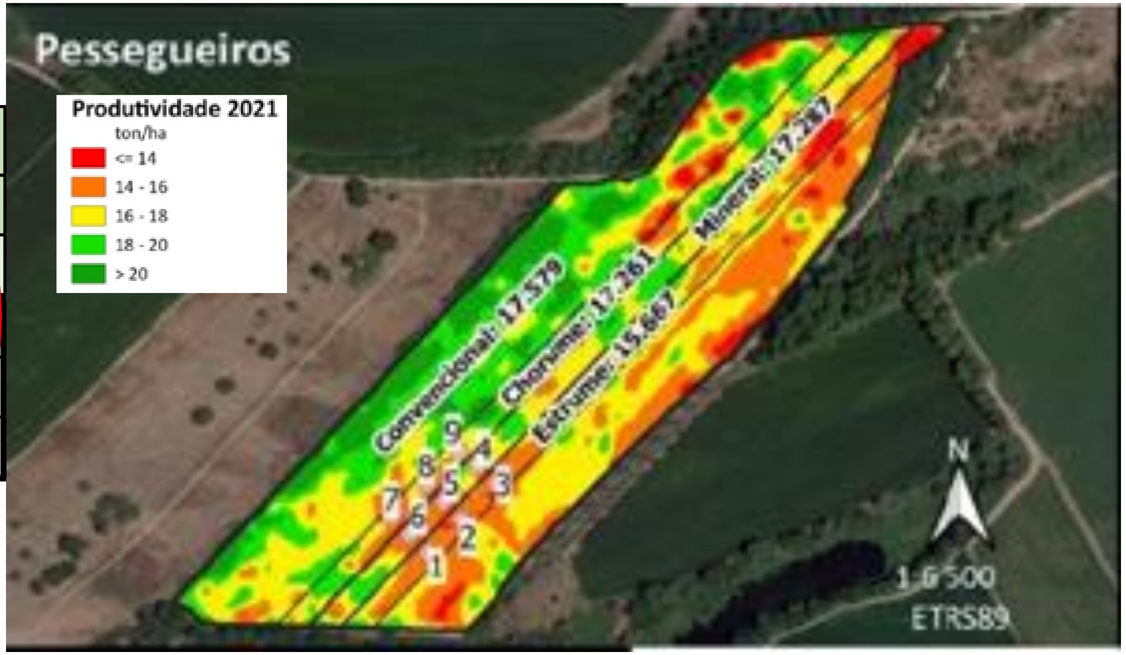
Vinha (Direct seeding)		Productivity (t ha^{-1})		
	Area (ha)	2020	2021	Variation (%)
Conventional	10.9	14.990	16.836	12.31
Mineral Fertilizer	0.79	14.259	15.934	11.75
Poultry manure compost	0.80	14.492	15.838	9.29
Pig slurry	0.78	14.091	16.130	14.47



- Overall lower maize yields in direct seeding.
- Yield increased in all plots from 2020 to 2021.
- The higher variation was obtained after **pig slurry** application, with higher yield, relatively to the other plots.

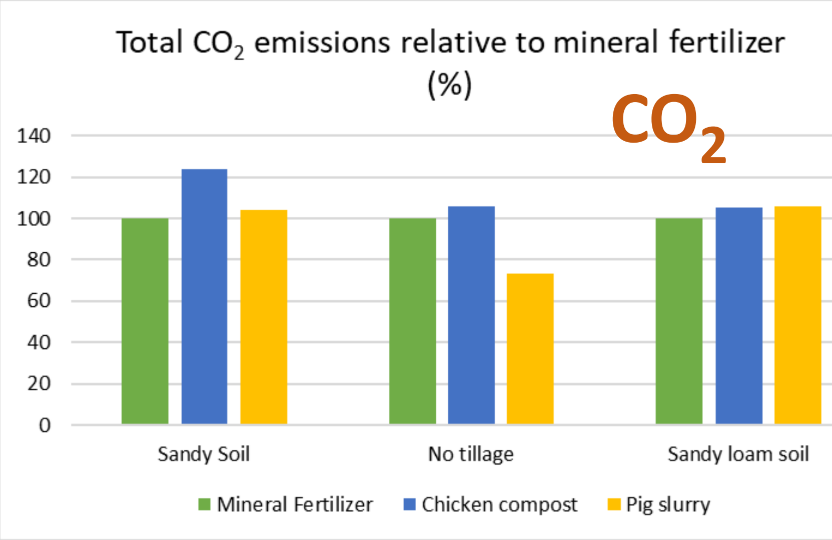
Maize yield (2021 *versus* 2020)

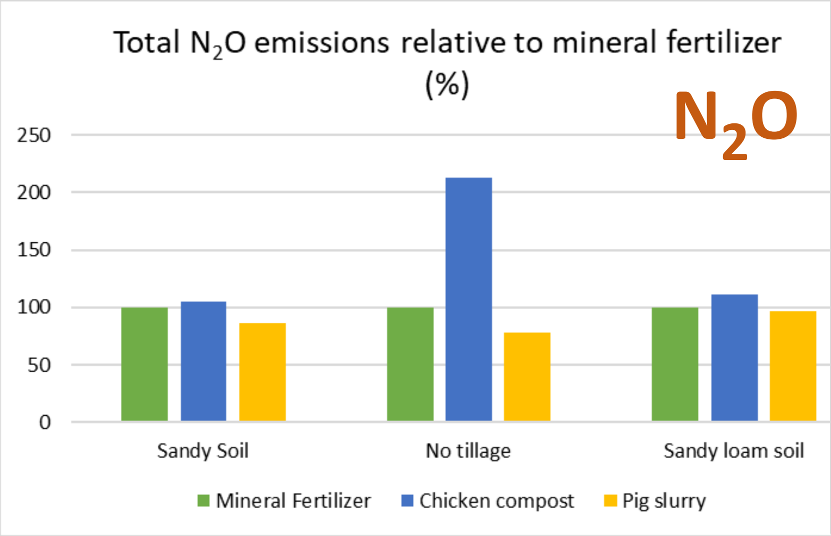
Pessegueiros (Sandy soil)		Productivity ($t\ ha^{-1}$)		
	Area (ha)	2020	2021	Variation (%)
Conventional	6.26	16.997	17.579	3.43
Mineral Fertilizer	1.13	17.289	17.287	-0.01
Chicken compost	1.13	17.204	15.667	-8.93
Pig slurry	1.12	16.967	17.261	1.73

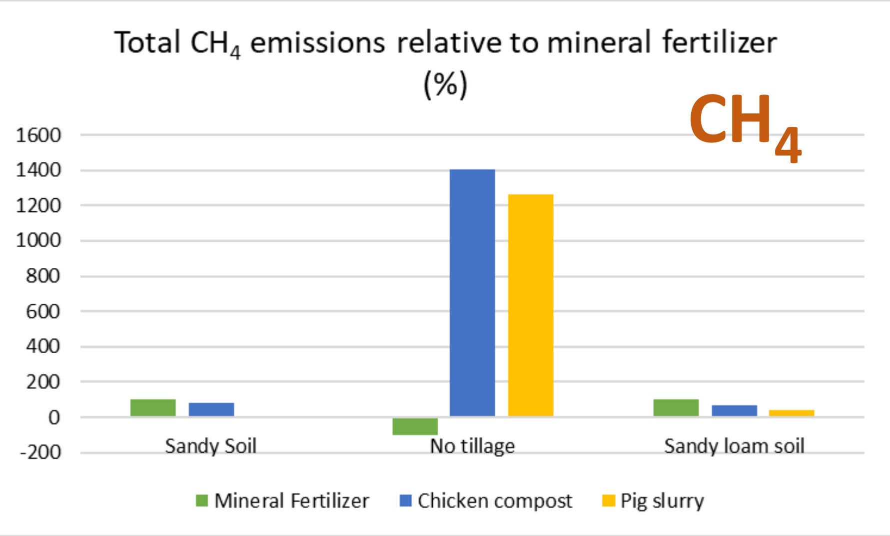


- Higher productivities than in direct seeding, but the results were not so promising here;
- This experimental site is very heterogeneous, was the first to be sowed, and it rained in the following week;
- The yield only increased from 2020 to 2021 after **pig slurry** application, but with lower values than in the rest of the field.

Greenhouse gases emissions







Total CH_4, CO_2, and N_2O emissions were calculated in the three experimental fields.
Mineral fertilizer (green) emissions were considered as 100%, and the CO_2, N_2O, and CH_4 emissions with **poultry manure (blue)** or **pig slurry (yellow)** application were compared with those with mineral fertilizer application;
Statistical treatment of the data is needed, but:

- In most cases, **poultry manure compost** emitted more gases (CO_2, N_2O, and CH_4 in the direct seeding);
- **Pig slurry N_2O emissions** were always lower than when using the mineral fertilizer;
- Both organic materials led to a high **increase in CH_4 emissions in the direct seeding** plot.

Final remarks (ongoing work…)

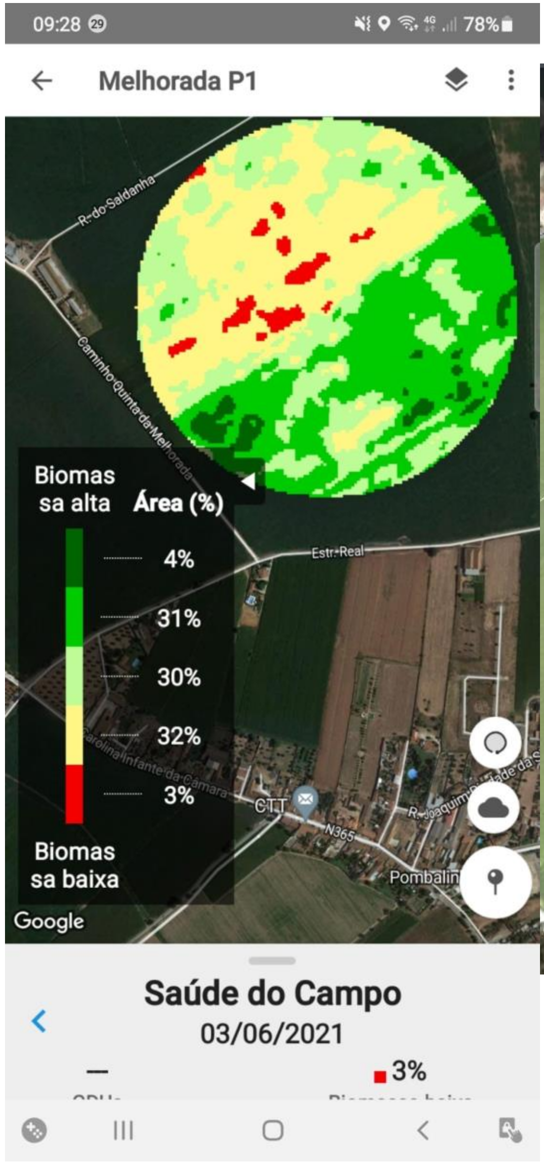
The present experiment evidenced some benefits and limitations related to the use of organic fertilizers for maize fertilization.

The practice contributes to **close the N, C, P loops**:

- **N:** ≅ 30% of the mineral N fertilizer can be replaced by an organic N source, closing the loop of the slurry and compost N, by producing some cereals that can be used to feed pigs and poultry.

- **C**: Both compost and slurry contain a significant amount of OM that will enrich the soil - positive effect, allowing an expected increase in soil fertility and overall soil health (in evaluation).

- **P**: Organic fertilizers will also provide P to the soil, ensuring the closure of the slurry and compost P cycles, reducing the inputs of mineral P fertilizer – **this needs to be quantified in future experiments.**



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