

Le attività ed i risultati del progetto LIFE ARIMEDA in Spagna

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Life ENV - ES 00400 ARIMEDA

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Fertigation with pig slurry in Aragon (Spain) at full-scale

AMMONIA EMISSION reduction based on:

- Lower NH_4^+ concentration in the irrigation
- N dose adjusted to crop demands
- Splitting side dressing in several events
- Low air-liquid contact surface application techniques





Subsurface Drip irrigation

Max. particle size: 50-100 µm

Simple emitters (no membrane and large filtering surface)



Pivot

Max. particle size: 150-500 µm

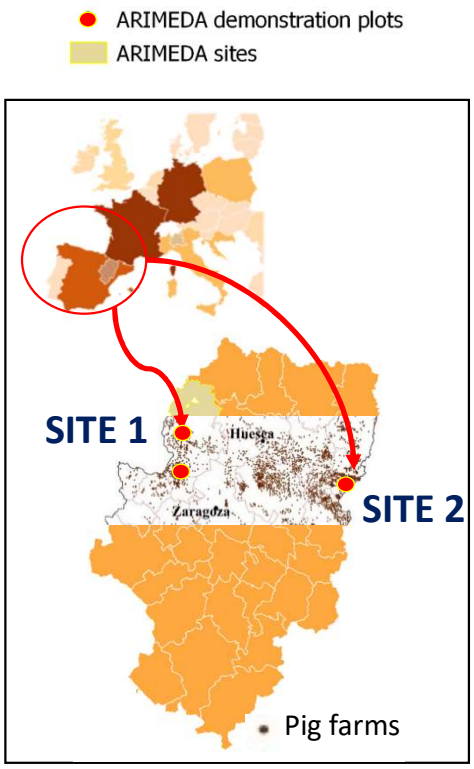
Low-pressure irrigation

Lower drift losses

Nozzles bellow crop canopy



Fertigation with pig slurry in Aragon (Spain) at full-scale



CASE-CONTROL APPROACH

3 YEARS: 2018-2019-2020

Demonstration plots	REFERENCE	DRIP IRRIGATION	PIVOT
SITE 1 Cinco Villas Soil: Shallow and stony *64.8% sand* *23.7% lime* *11.5% clay*			
SITE 2 La Melusa Soil: Deep and clayey *59.2% sand* *20.3% lime* *20.6% clay*			

BASE DRESSING	170 NFU ha^{-1} *pig slurry*	vs.	100 PFU ha^{-1} *mineral P*
SIDE DRESSING	205 NFU ha^{-1} *synthetic N*	vs.	220-270 NFU ha^{-1} $LF_{pig\ slurry}$
	Traditional practices: 2 fertilizing events		Splitted fertilization >10 fertigation events

How do we fertigate? Preparatory actions



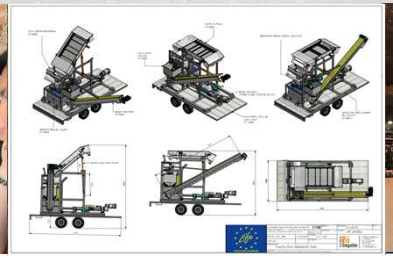
1. Farm selection

- Representative scale (size)
- Logistic restrictions
- Monitoring requirements
- Farmers willingness to participate



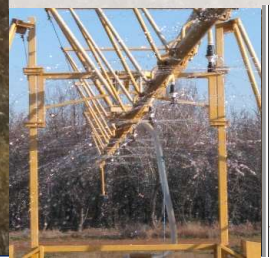
2. Separation prototype *Design, building and start up*

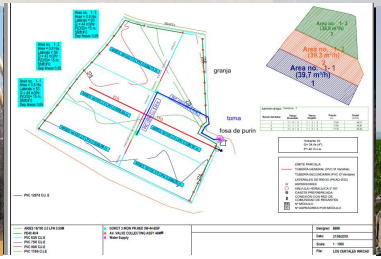






3. Fertigation system *Design, installation and start up*







How do we fertigate? STEP 1 Liquid/fraction separation

PROTOTYPE FOR PIVOT

$Ø_p$: 500-250 µm
Q: 7-12 m^3/h
$Consumo_e$: 0,310 kWh/m^3

PROTOTYPE FOR DRIP IRRIGATION

$Ø_p$: 100-80 µm
Q: 4-8 m^3/h
$Consumo_e$: 0,180 kWh/m^3

REMOTE CONTROL GSM SYSTEM

Start and stop / Alarm system

Real-time flow rate and energy monitoring

Camera control





















How do we fertigate? STEP 2 Transport + Storage nearby the plot











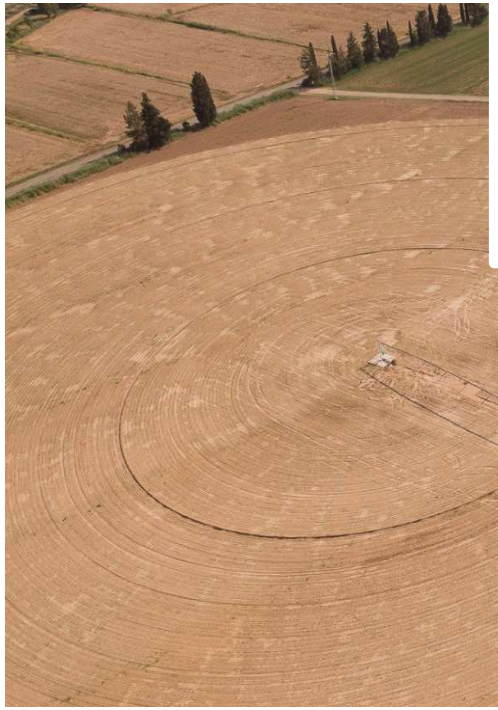
How do we fertigate? STEP 3 *Dose control and liquid fraction injection*















How do we fertigate… in pivot?

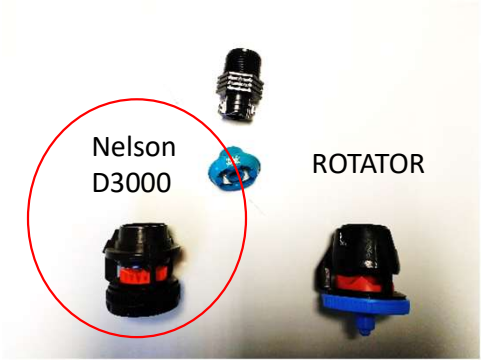
CINCO VILLAS (Biota)

- 10,4 ha - 6,3 mm in 10 hours
- H: 2,8 m above the floor
- Distance between nozzles 3 m





LIFE ARIMEDA
Nozzles NELSON D3000
6 PSI (0,4 bar)





LA LITERA (La Melusa)

- 6,4 has - 7,6 mm in 10 hours
- H: 0,4 m above the floor
- Distance between nozzles 1,4 m

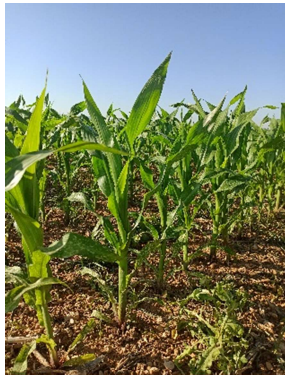




How do we fertigate…in drip irrigation?

CINCO VILLAS (Torremira)

2 ha - 30 cm depth
50 cm between emitters - 75 cm between lines







Drippers
Netafim Dripnet PC
Pressure complensated

Dripper: 1,6 l/h - Pluviometry: 4.7 mm/h
With membrane – Large filtering surface

LA LITERA (La Melusa)

2 ha - 30 cm depth
50 cm between emitters - 75 cm between lines





Dripper: 2,0 l/h - Pluviometry: 5.3 mm/h
Without membrane – Large filtering surface



Drippers
Netafim Aries16100

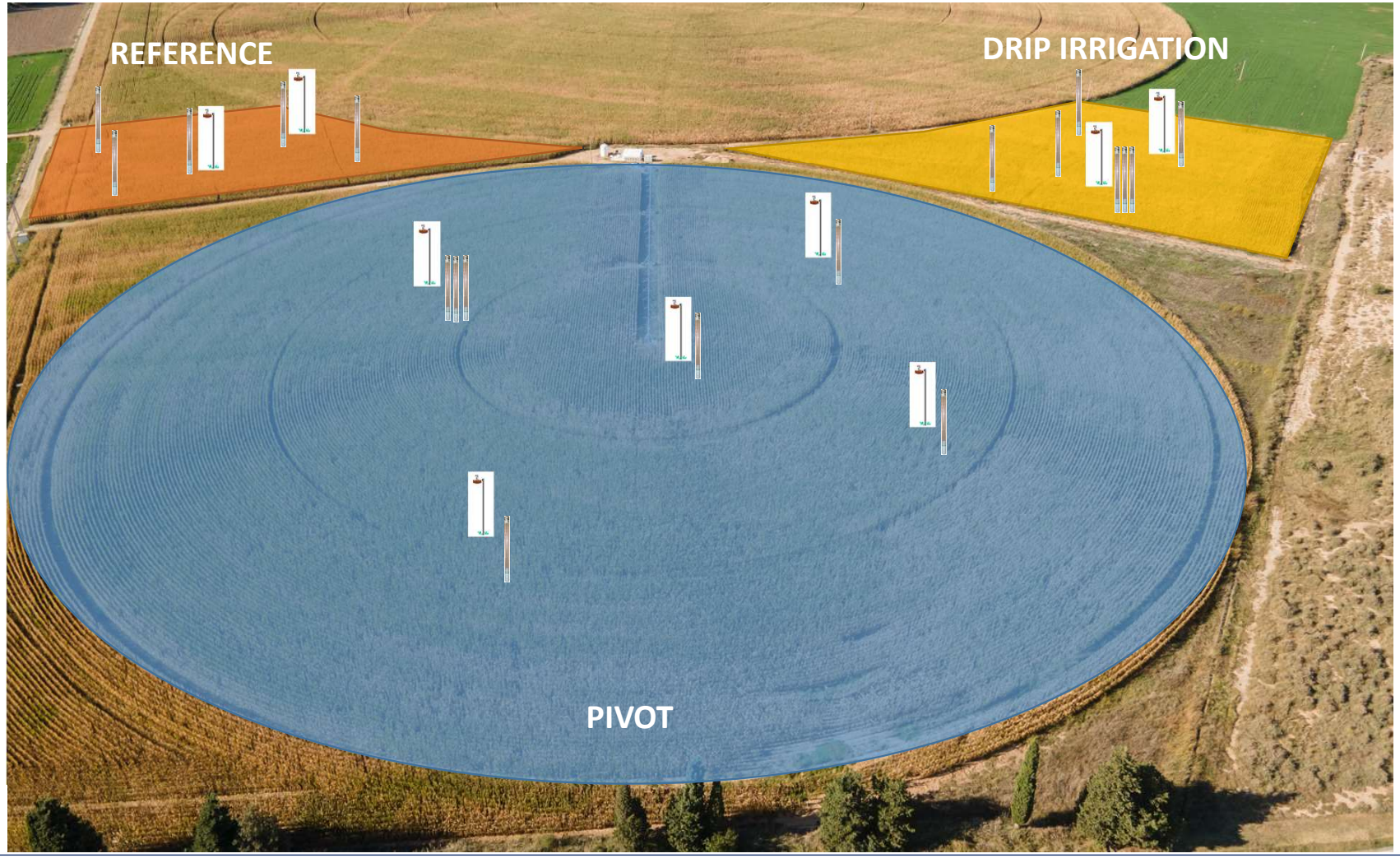


What do we have measured?

1. NH_3 EMISSIONS
2. RISK OF NITRATE LEACHING
3. CROP YIELD AND NUE







What do we have measured? Ammonia emissions

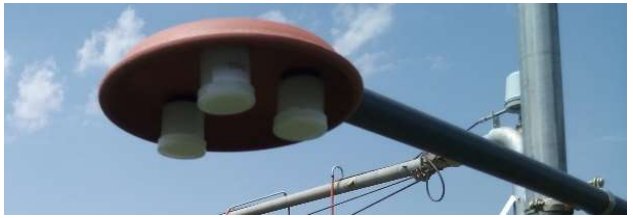
FIELD MONITORING

Average $[NH_3]_{air}$

- ALPHA® samplers (12 % (m/v) citric acid in methanol)
- 3 ALPHA®/mast - 1,2 m above crop canopy - 2-4 masts/plot
- Daily sampling during fertigation – ↓frequent in other periods

Weather station: wind speed and direction + T





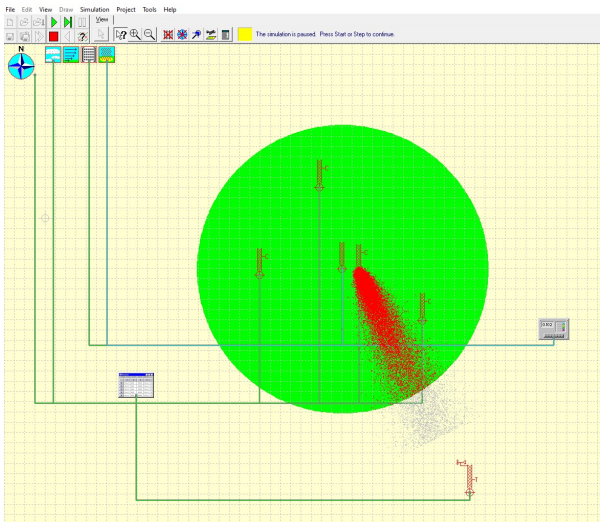


EMISSION ESTIMATION

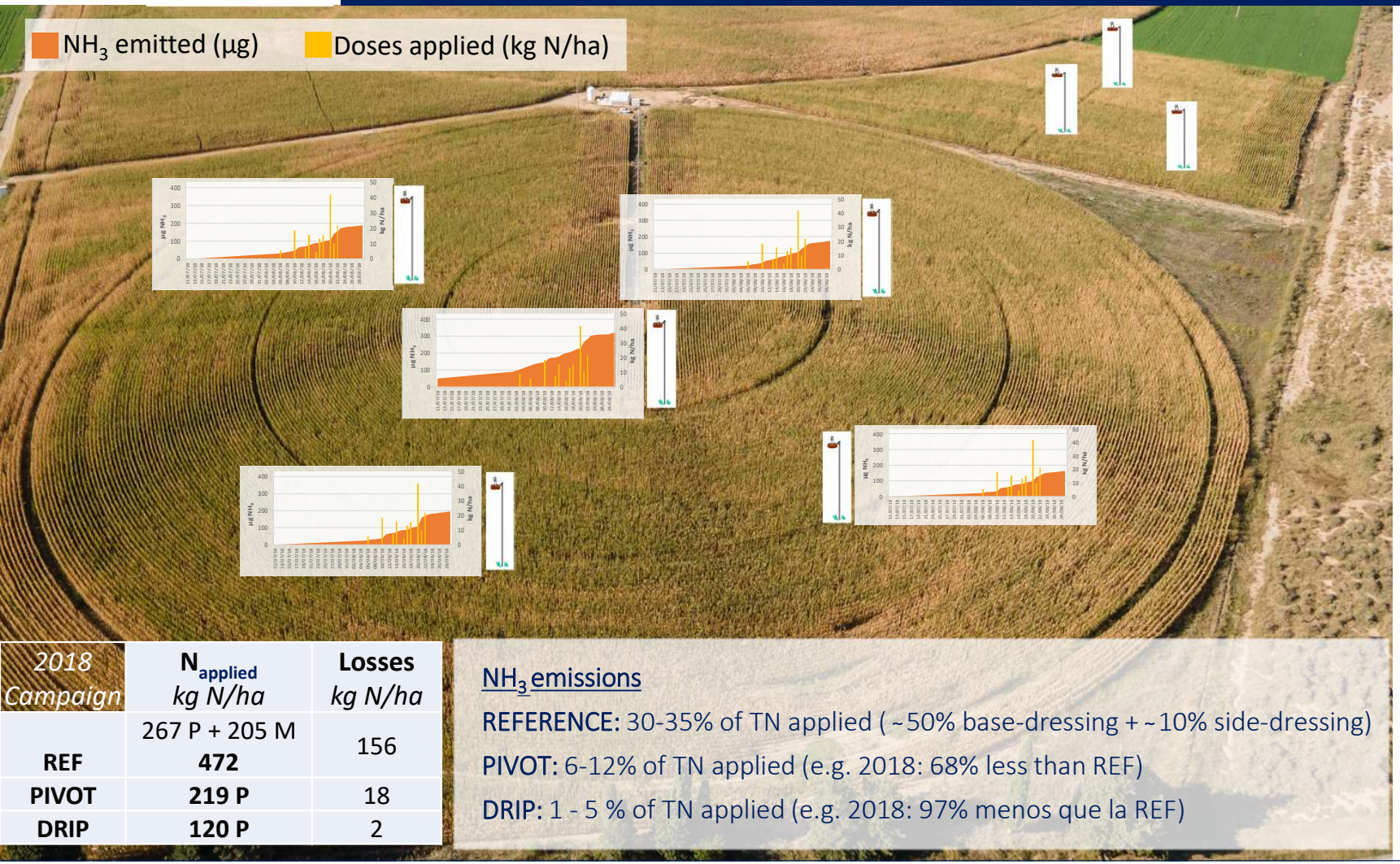
Windtrax (Thunder Beach Scientific) – bLS Inverse dispersion model



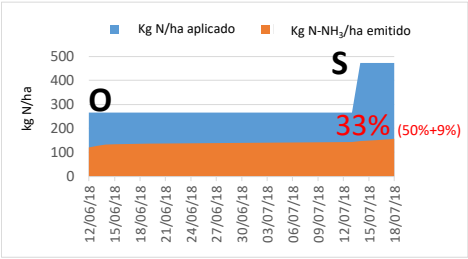




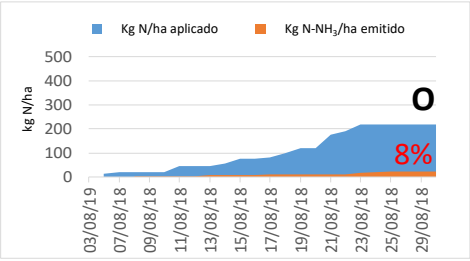
What do we have measured? Ammonia emissions



REFERENCE



PIVOT



2018 Campaign	**$N_{applied}$** *kg N/ha*	**Losses** *kg N/ha*
REF	267 P + 205 M **472**	156
PIVOT	**219 P**	18
DRIP	**120 P**	2

NH_3 emissions

REFERENCE: 30-35% of TN applied (~50% base-dressing + ~10% side-dressing)

PIVOT: 6-12% of TN applied (e.g. 2018: 68% less than REF)

DRIP: 1 - 5 % of TN applied (e.g. 2018: 97% menos que la REF)

FERTIGATION

Reductions due to:

+ Less emissions per N applied

+ Less N applied

What do we have measured? Risk of nitrate leaching





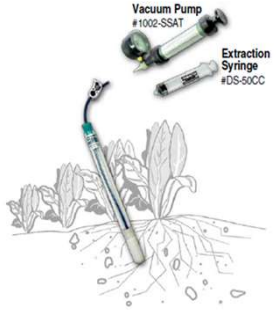


FIELD MONITORING

[NO_3^-] in subsurface water (below root zone)

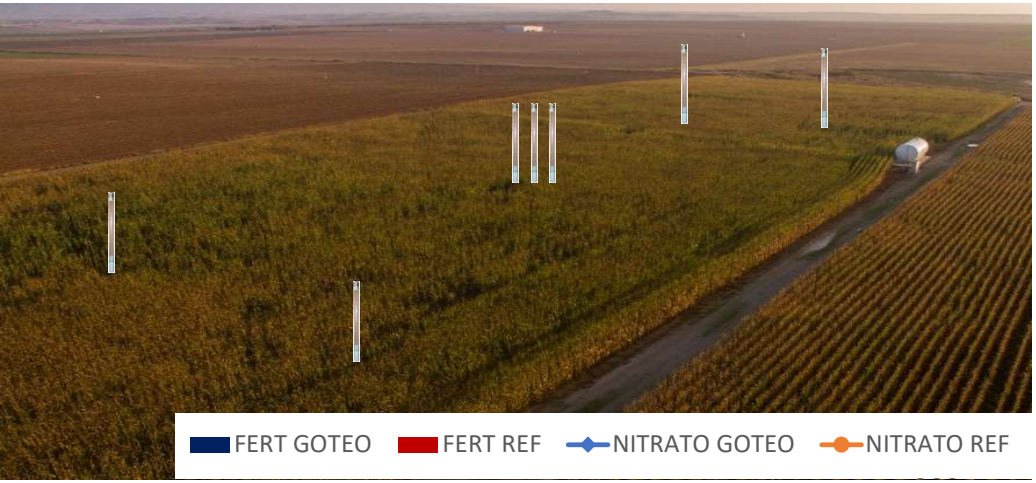
- 7 suction cups/plot - Irrometer®
- Shallow soils: 45 cm - Deep soils: 100-120 cm
- 1 weekly sampling (vacuum/sampling 24h)

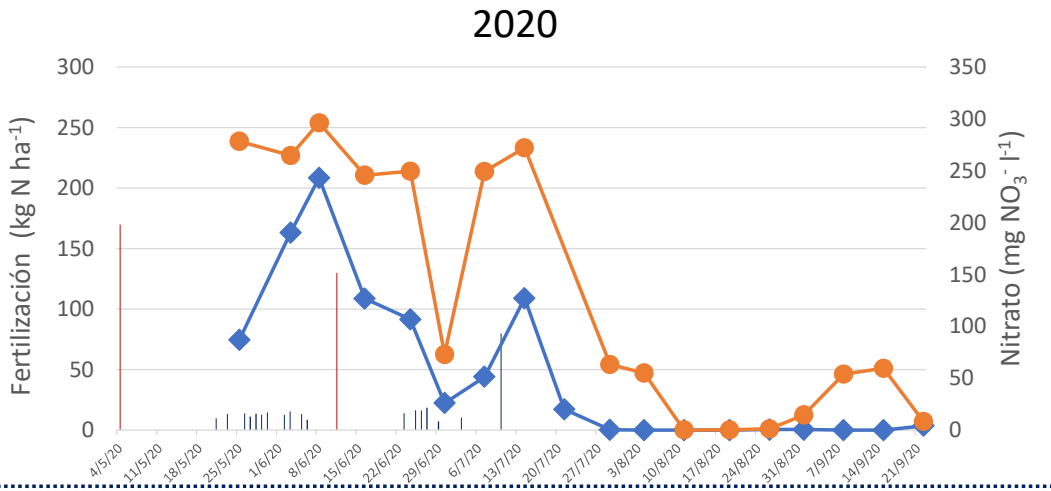


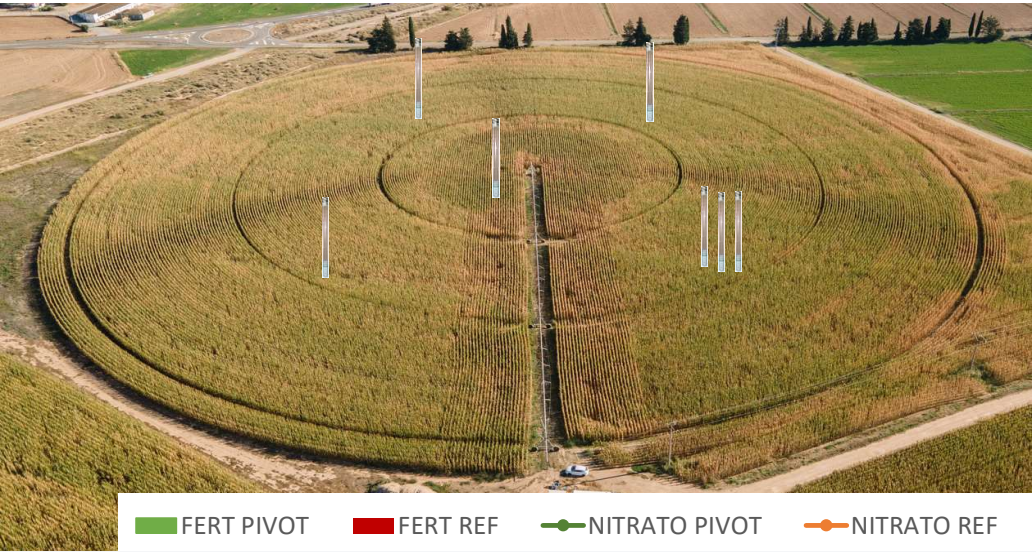


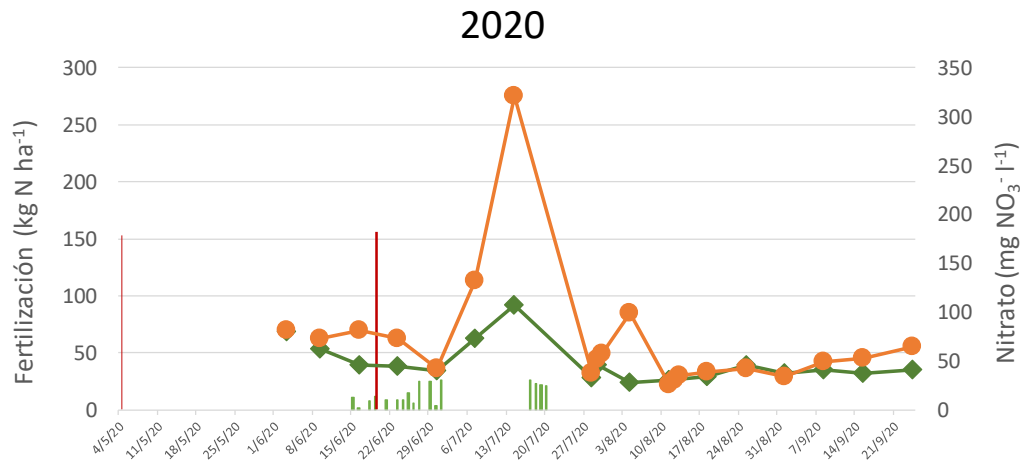
COMPARATIVE ASSESSMENT: REFERENCE vs. DEMONSTRATIVE PLOT

What do we have measured? Risk of nitrate leaching









What do we have measured? NUE

FIELD MONITORING

N applied

- V_{LF} and V_{water} applied (m^3/ha): Flowmeters and storage level sensors
- $[TAN]_{LF}$: laboratory and Quantofix

Grain yield, humidity and N content

- Manual control: 5 control points/plot - 2 maize lines x 3 m (4.5 m^2)
  - ✓ Grain yield and humidity, above ground biomass
  - ✓ Total N by combustion (LECO FP-528 analyzer)
- Harvest: yield control of the whole plot

AGRONOMIC NUE

$$\text{NUE} = \frac{N_{uptake}\ (aerial\ biomass)}{N\ applied}$$











What do we have measured? *NUE*



Cinco Villas		N applied *kg/ha*	Doses (kg N/ha)	Yield 14% *(t/ha)*	NUE *(std. dev.)*
2020	Ref.	172 P + 130 S	---	---	---
	Drip	204 P + 84 S	13.4	7.2	0.33 (0.03)
	Pívot	186 S + 83 P	10.4	13.6	0.56 (0.04)
2019	Ref.	167 P + 176 S	---	9.9	0.47 (0.05)
	Drip	357 P	12.5	12.5	0.56 (0.08)
	Pívot	136 S +192 P	12.6	14.4	0.52 (0.06)
2018	Ref.	181 P + 150 S	---	4.9	0.34 (0.07)
	Drip	191 P	14.6	6.6	0.47 (0.10)
	Pívot	213 P + 107 S	16.1	13.6	0.59 (0.06)

La Melusa		N applied *kg/ha*	Doses (kg N/ha)	Yield 14% *(t/ha)*	NUE *(std. dev.)*
2020	Ref.	153 P + 156 S	---	17.6	0.45 (0.03)
	Drip	242 P	10.8	12.6	0.73 (0.13)
	Pívot	195 S + 55 P	12.2	15.7	0.68 (0.17)
2019	Ref.	218 P + 148 S	---	13.9	0.64 (0.10)
	Drip	299 P	22.4	4.2	0.45 (0.04)
	Pívot	263 P	7.5	13.9	0.88 (0.09)
2018	Ref.	267 P + 148 S	---	10.7	0.45 (0.03)
	Drip	170 P +27 S	26.0	8.1	0.73 (0.13)
	Pívot	262 P	14.9	10.9	0.68 (0.17)

COMMUNICATION, DISSEMINATION, NETWORKING, TRANSFERENCE

SEMINARS AND STUDY VISITS…

2019 2 Workshops (>100 attendants) and 4 study visits

2020 3 study visits in small groups (safety reasons)

+

5 scientific congresses and workshops
10 technical workshops
Agricultural fairs
Networking with other projects
Regional media apperances



















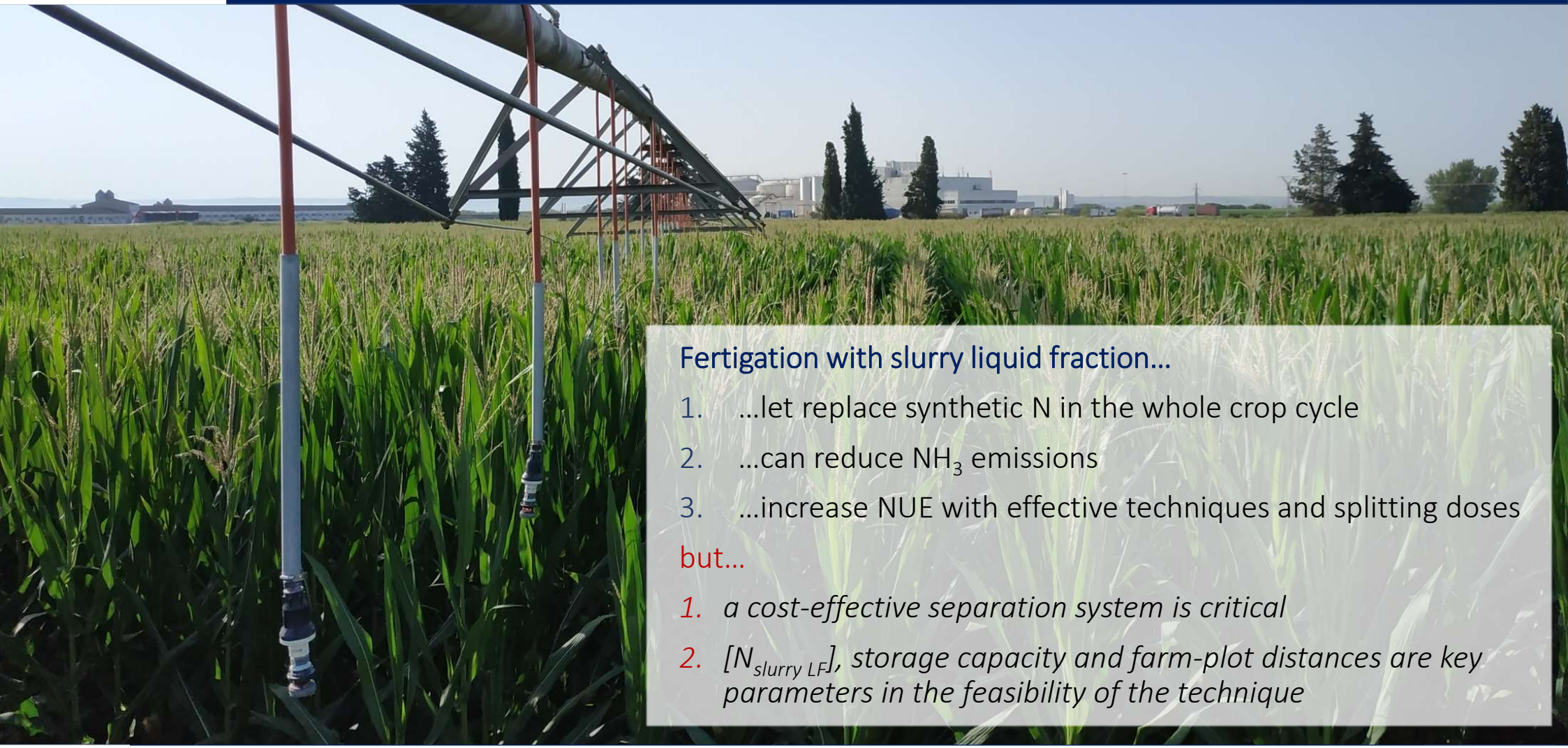








Main conclusions in Aragón



Fertigation with slurry liquid fraction…

1. …let replace synthetic N in the whole crop cycle
2. …can reduce NH_3 emissions
3. …increase NUE with effective techniques and splitting doses

but…

1. *a cost-effective separation system is critical*
2. *[$N_{slurry\ LF}$], storage capacity and farm-plot distances are key parameters in the feasibility of the technique*



MUCHAS GRACIAS

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