Methane emissions in Mediterranean rice fields: Ebro Delta Case

M. Martínez-Eixarch[1], C. Alcaraz[1], C. Ibáñez[1], J. Antonio Saldaña- De la Vega[1], J. Noguerol2, M. Viñas[2], X. Aranda[1],

[1]IRTA- Ecosistemas Acuáticos, St. Carles de la Ràpita (Tarragona); [2]IRTA-GIRO, [3]IRTA-Horticultura Ambiental (Caldes de Montbuí, Barcelona)

Workshop Guido Berluchhi

Borgonato di Corte Franca, December 5th, 2017

Study site:The Ebro Delta (S. Catalonia)





The Ebro Delta is one of the most important wetland complexes in the Mediterranean with 65% of its area covered by rice fields

Rice fields are crucial for preserving biodiversity of the surrounding natural wetlands and the local economy.

Paddy rice fields, considered as semi-natural wetlands, are the leading source of anthropogenic CH_4 emissions.

- ➔ Paddy rice cultivation represents 47 % of anthropogenic CH_4 emissions
- ➔ After harvest, straw is incorporated into the soil: soil accretion, carbon sequestration>> what is the C budget??

Projects conducted in IRTA for GHG mitigation

Main objectives:

1) To estimate GHG emissions in rice fields: temporal pattern and cumulative emissions.
2) To provide guidelines to rice farm sector to implement agronomic measure to reduce GHG emissions without yield penalties.

- Agronomic and environmental factors:
  - LIFE EBRO-ADMICLIM
- Water management-based mitigation measures: Alternate wetting and drying systems (AWD)
  - GreenRice. Partners: UK (Universidad de Aberdeen), Francia (CIRAD, CFR), Italy (Universidad de Torino y Entecra), España (CRAG, IRTA)
  - INIA Cambio climático en arrozales (València), IFAPA (Sevilla), IRTA

www.greenrice.eu

Project Life EBRO-ADMICLIM

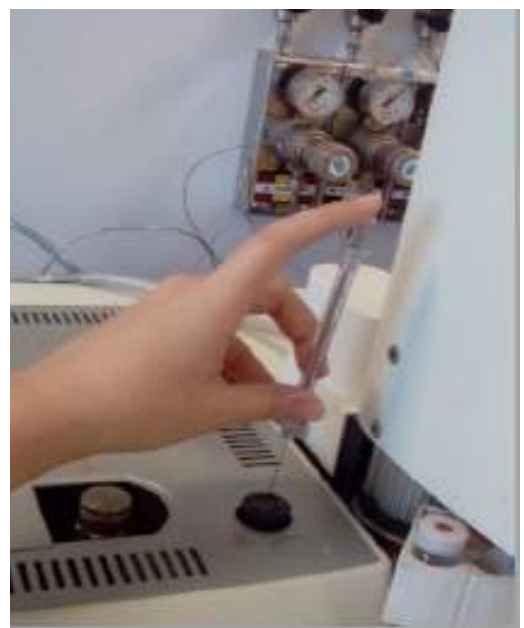
Life Ebro-Admiclim (2015-2018)- GHG emissions in rice.

- To estimate cumulative CH4 emissions and termporal pattern in rice fields.
- To determine main agronomic and environmental drivers of CH4 emissions.
- To provide agronomic mitigation measures to rice farm sector.

Material and Methods (2015-2016)

- **Monthly sampling in 22 commercial fields in Ebre Delta**
  - ➔ Rice fields are flooded from May to September (harvest) and left to progressively dry out over post-harvest period
  - ➔ After harvest, straw is incorporated
- **Data collection:**
  - o CH_4: non-steady closed chambers
  - o Physicochemical: Soil temperature Eh, pH, conductivity
  - o Agronomic traits

Gas sampling and analyses methodology



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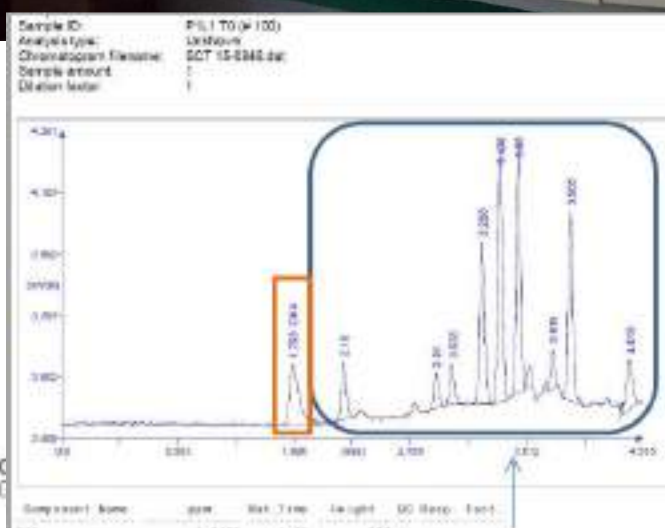
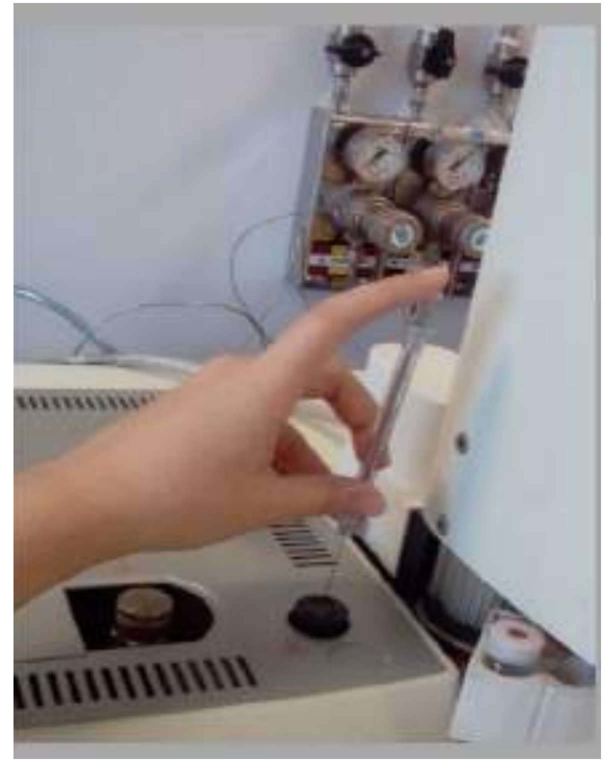
Análisis gases en el laboratorio: CROMATOGRAFIA DE GASES

Laboratorios IRTA/GIRO (Torre Marimón, Caldes de Montbui)





Rice cultivation in Ebro Delta

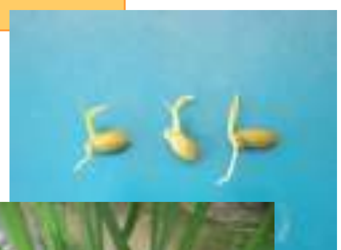
Jan	Feb	March	Apr	May	June	Jul	Aug	Sept	Oct	Nov	Dec

Soil preparation labouring

Permanent flooding

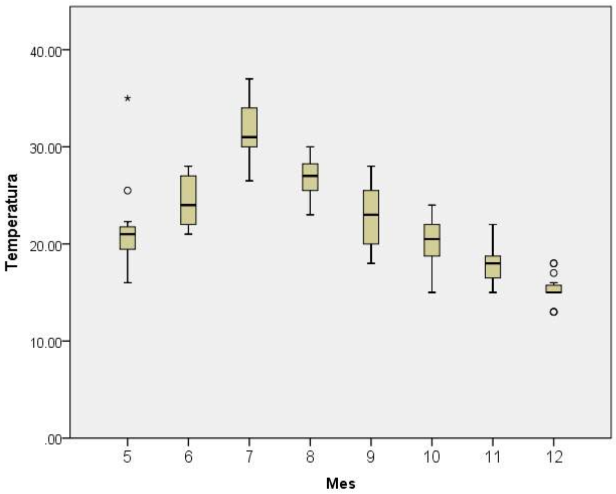
Harvest

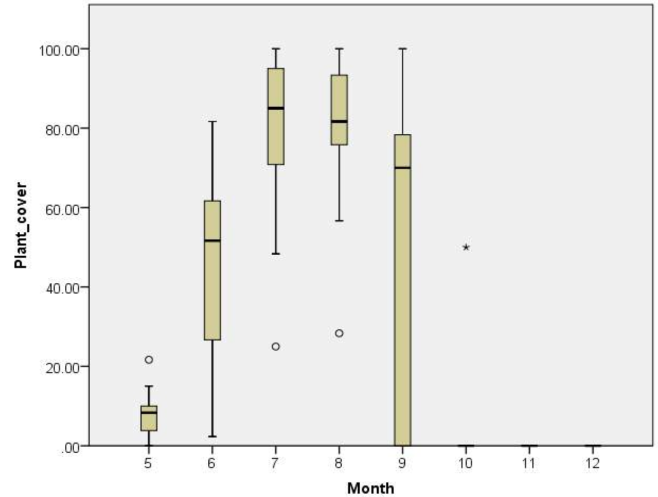
- Straw incorporation into the soil (October)
- Progressinve drainage of fields

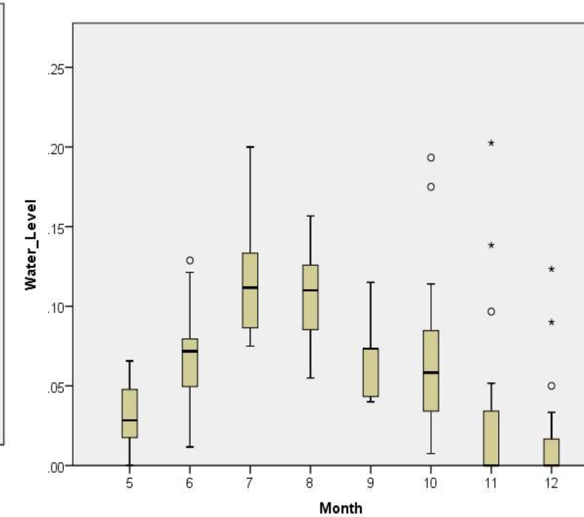


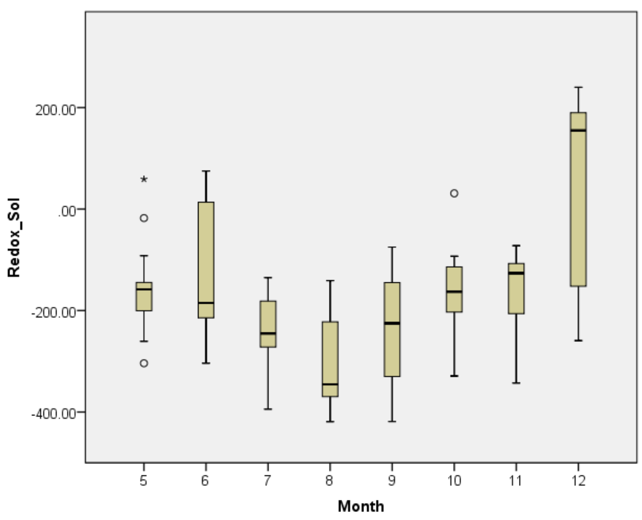
Main results

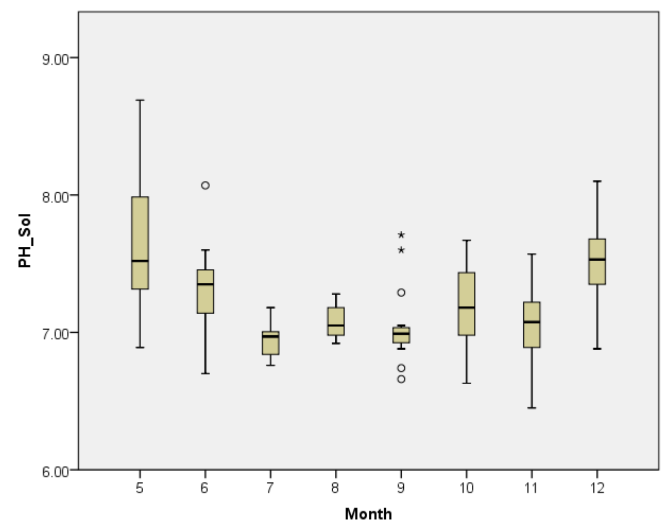
Temporal pattern of agronomic and environmental variables



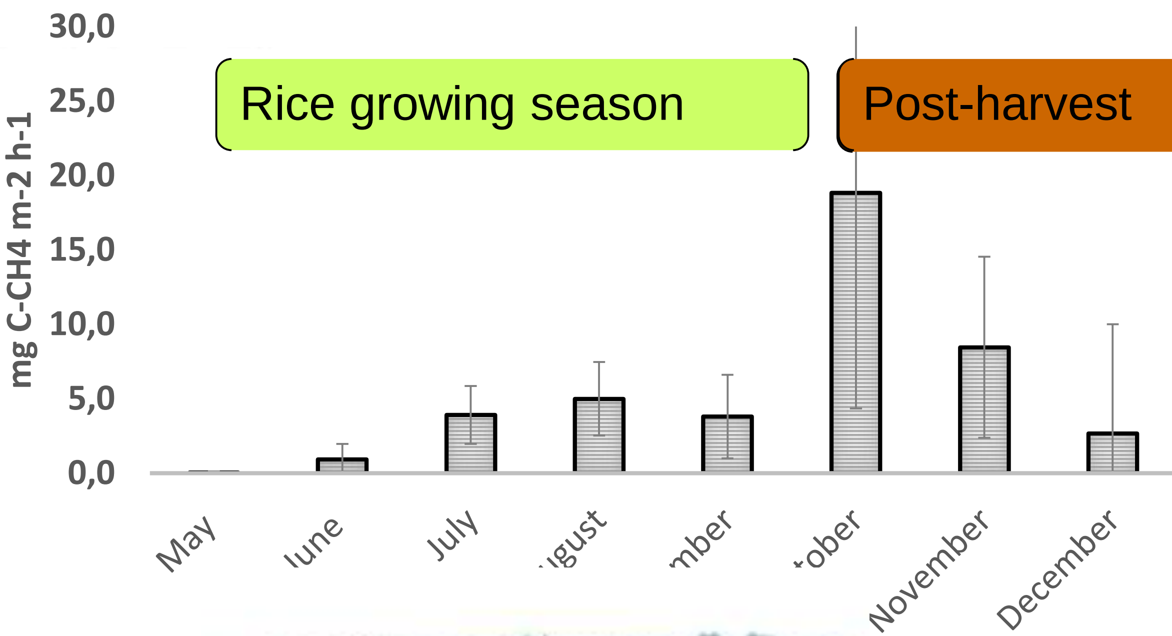








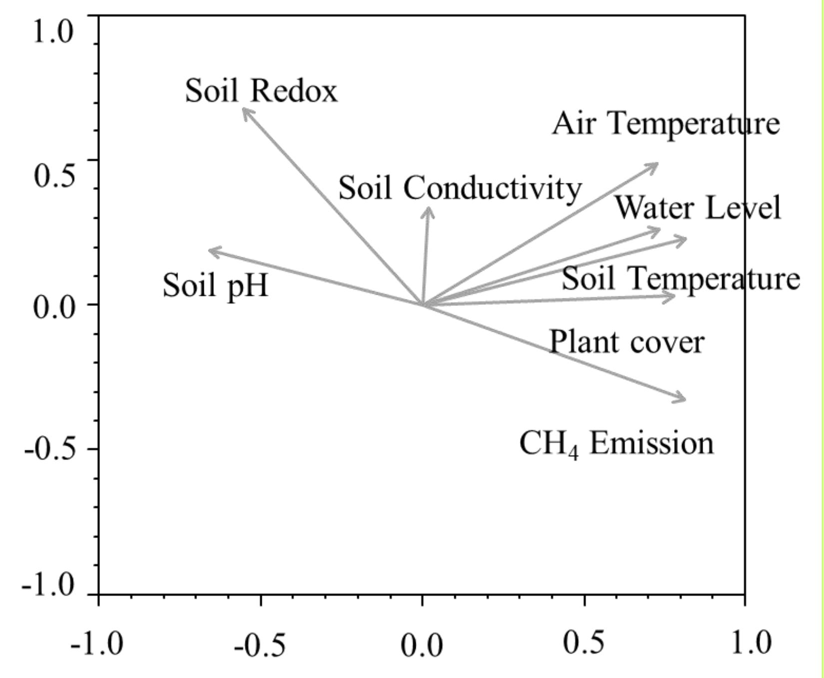
2015.Temporal pattern of CH_4 emissions

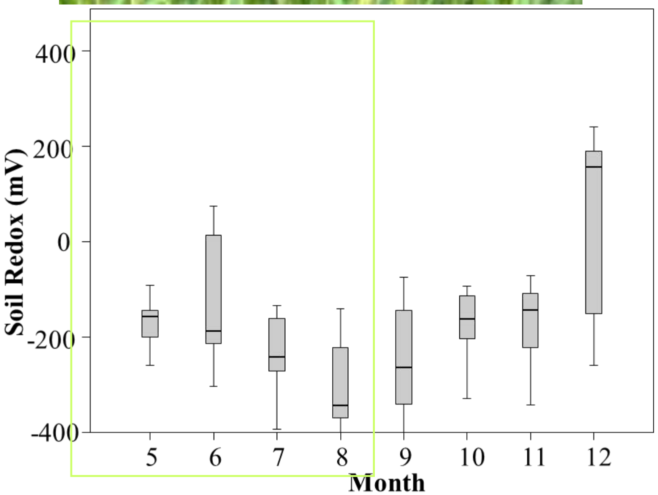


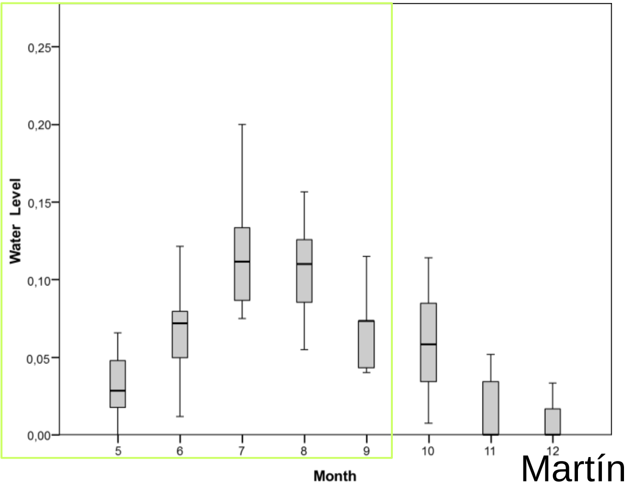
70 % of CH4 emitted during post-harvest

Correlation among all the variables

Rice growing season







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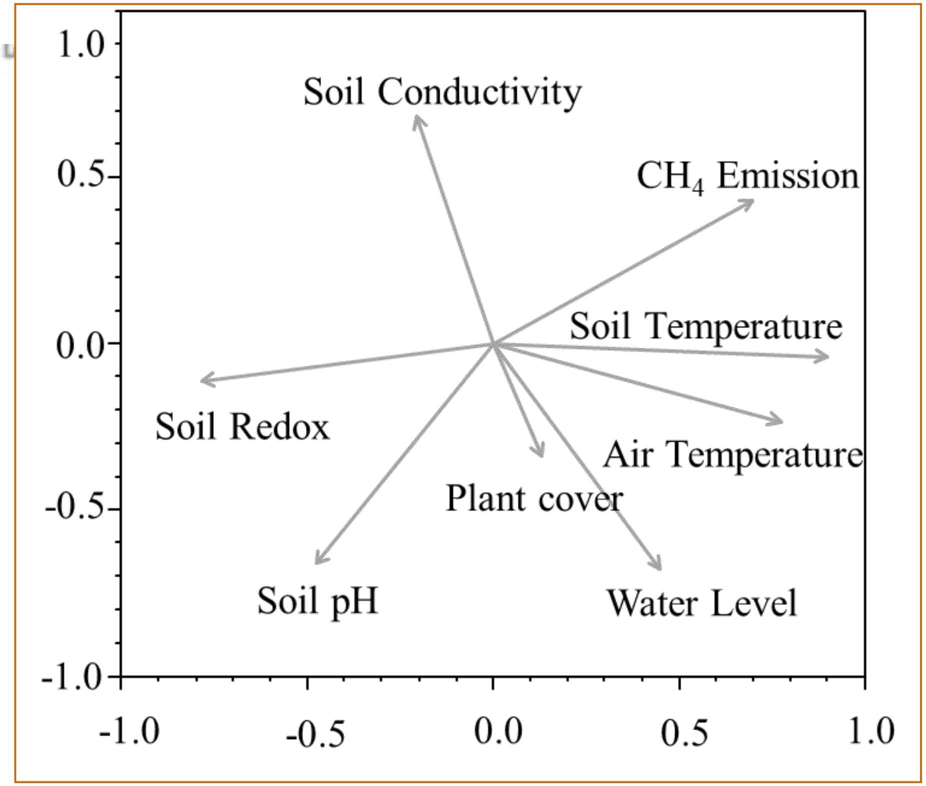
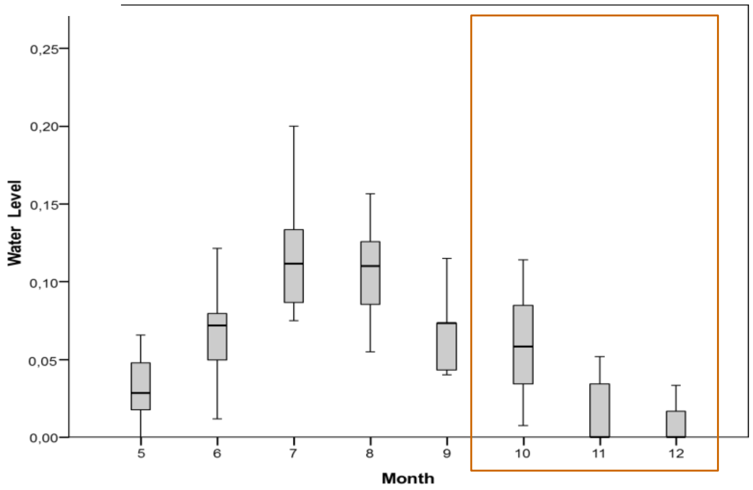
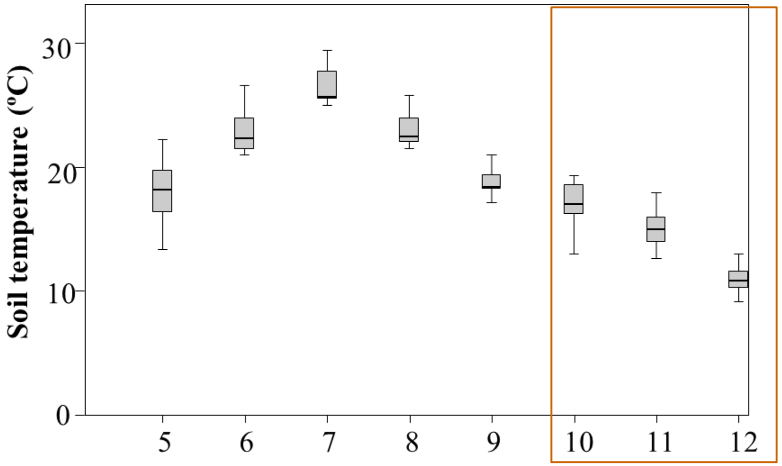
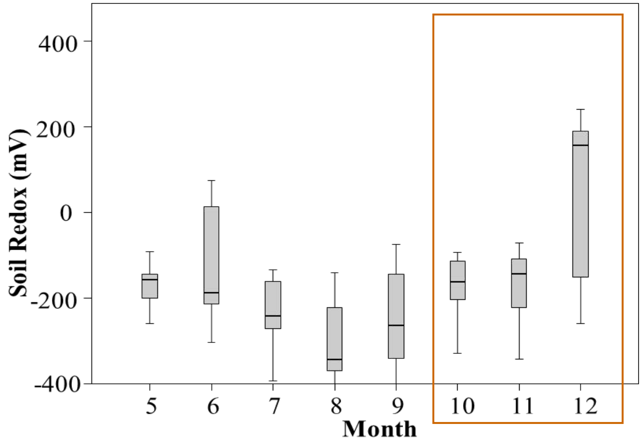
Correlation among all the variables

Post-harvest









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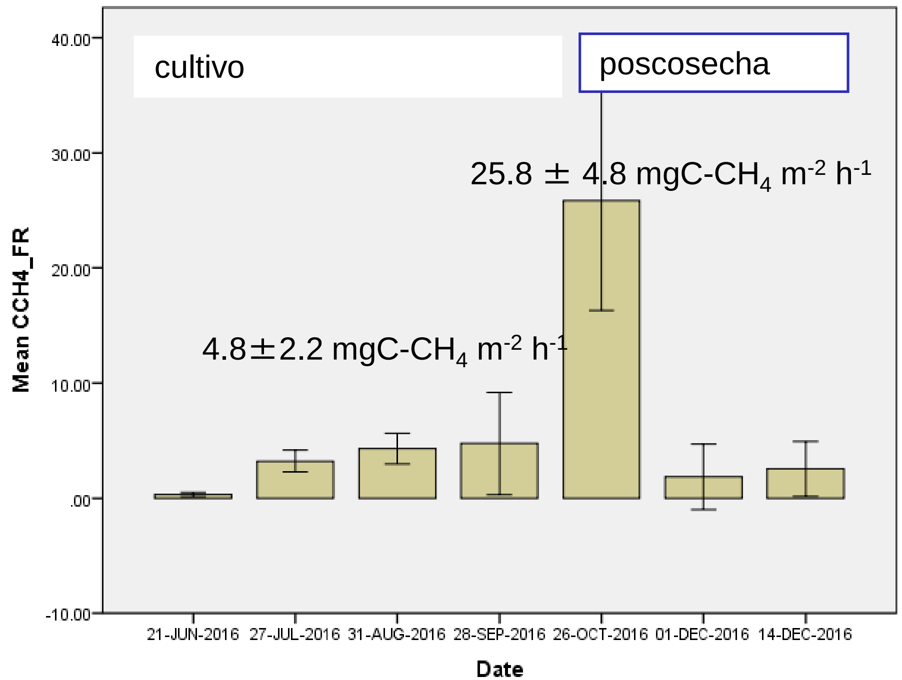
Cumulative emissions of methane and seasonal pattern: 2016



2015 Mean CH_4 emission rate (mg C-CH_4 m^{-2} ha^{-1})	Mean ± SE
Growing-season	2.71 ± 0.25
Post-harvest	9.71 ± 1.60
Annual	5.2 ± 0.62

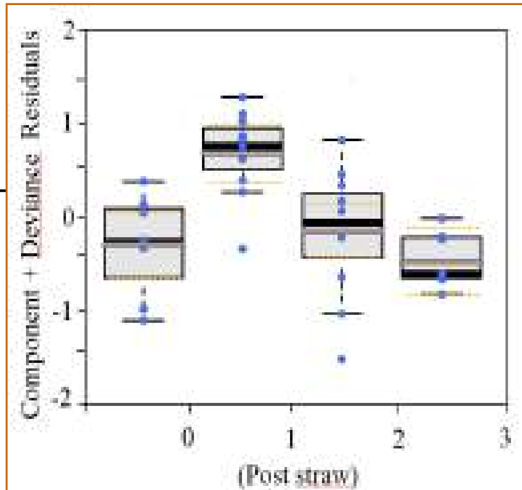
2016 Mean CH_4 emission rate (mg C-CH_4 m^{-2} ha^{-1})	Mean ± SE
Growing-season	3.2 ± 0.61
Post-harvest	10.1 ± 2.14
Annual	6.1 ± 1.0

Straw incorporation

Generalized Linear Model (GLMz)

model parameter	RICE GROWING SEASON N=20 SP	ß	Bias	POST-HARVEST N=26 SP	ß	Bias
(Intercept)	1.000	3.670	-0.191	1.000	-6.918	-0.115
Soil Redox	1.000	-3.798	0.026	0.453	-1.551	-1.142
Soil Temperature	0.288	0.208	-2.977	1.000	4.771	-0.263
Soil pH	0.335	-0.766	-1.776	0.135	0.009	-218.89
Soil conductivity	0.379	-0.214	-1.400	0.230	0.221	-2.331
Plant cover	0.956	0.050	0.021	0.240	0.021	-3.820
Water level	1.000	3.884	0.103	0.985	-5.240	0.044
Air temperature	0.225	0.000	1721.8	0.203	-0.360	-3.823
… 1 month prior to CH4 sampling				0.993	0.788	-0.156
…2 months prior to CH4 sampling				0.993	-0.001	2.457
… 3 months prior to CH4 sampling				0.993	-0.556	0.703

Straw incorporated...



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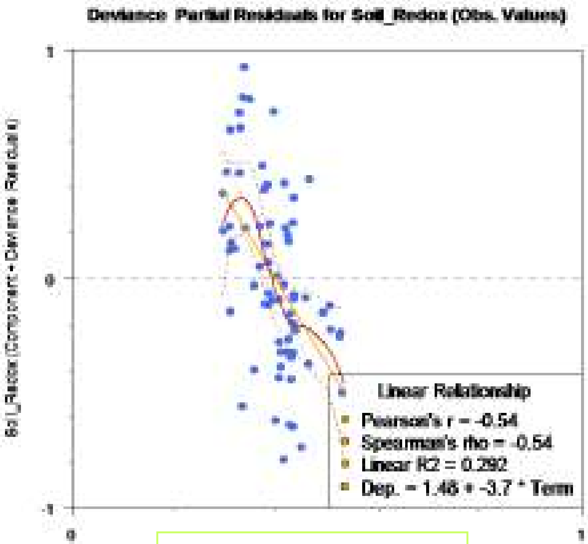
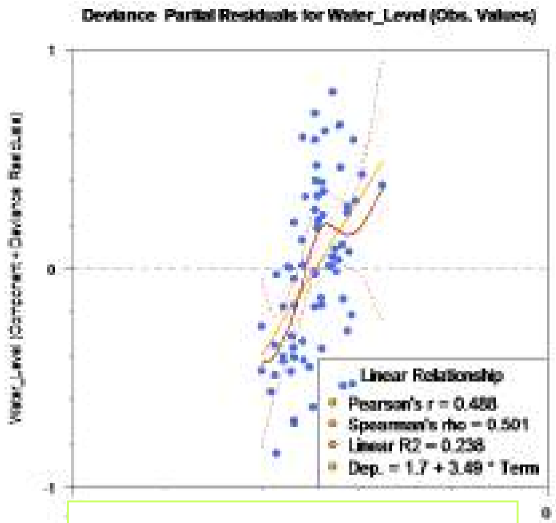
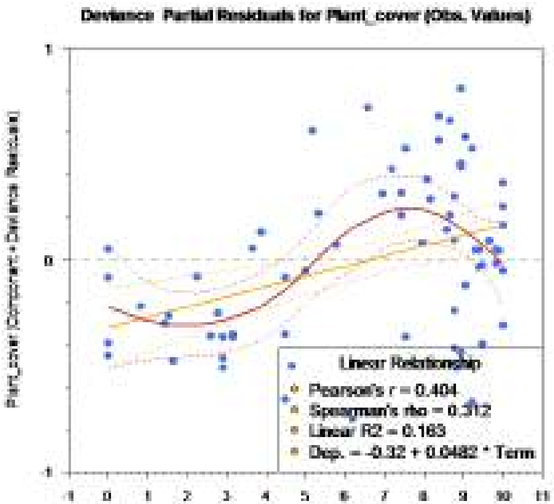
Growing season: Linear relationship between main drivers and CH4 emissions



Soil redox



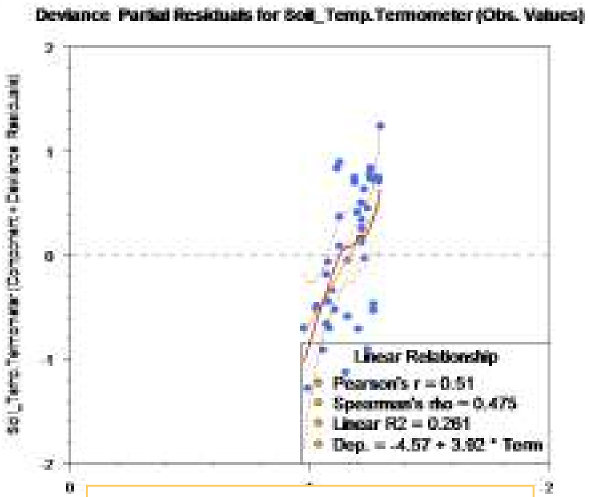
Water layer depth



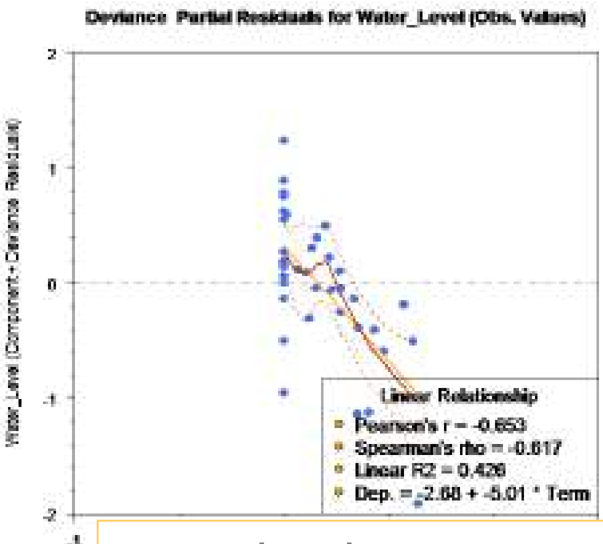
Plant cover

Soil redox, water layer depth and plant cover are the main drivers.

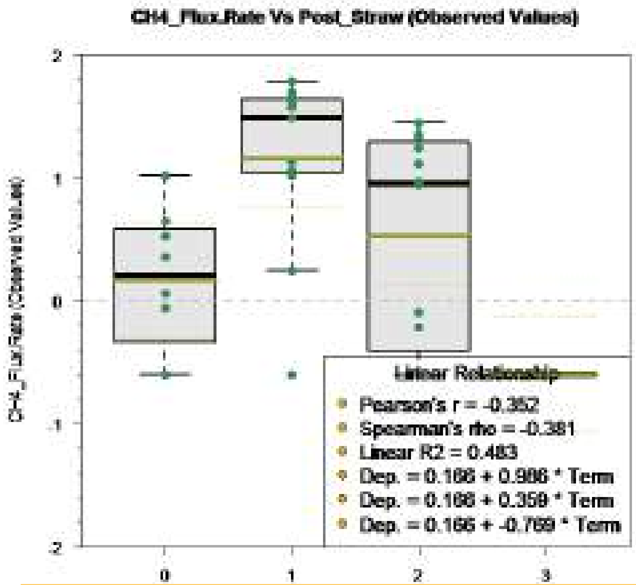
Post-harvest: Linear relationship between main drivers and CH4 emissions



Soil temperature



Water level



Timing of straw incorporation

SUMMARY

- ✓ Temporal pattern of CH4 emission in Ebro Delta rice field follow a bi-modal distribution, with two peaks: in July/August and in October.
- ✓ En 2015, rice fields emitted *ca.* 6.600 Tm of CH_4 (*ca.* 0.2 Tg CO2-eq), **70% of which during the post-harvest**. >> need of more studies on straw management strategies.

- ✓ Main drivers of CH4 emissions differ in the growing and post-harvest seasons:
  - → Growing season : soil redox, wáter layer depth (positively) and plant cover.
  - → Post-harvest: soil temperature, wáter layer depth (negatively) and Straw incorporation.


Thank you!