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Development of an automatic prototype to measure soil GHG emissions within the project LIFE AGRESTIC

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Introduction. *Mitigation of N_2O emissions from soil could be achieved by the optimization of N inputs to soil, as emissions mainly occur when there is a N surplus in soil respect to crop's demand (Snyder et al., 2014). Model-based Decision Support Systems (DSS) and the design of efficient and low input cropping systems can improve N management. The introduction of legumes in the crop rotation may lower the N emissions (Jensen et al., 2012). Legumes may be also a source of N_2O emissions due both to N2-fixation and to the incorporation in the soil of N rich residues (Volpi et al., 2018). High quality measures of soil emission are crucial for assessing the effectiveness of mitigation practices. The most suitable and accessible way to measure GHG emissions from soil, comparing different treatments is the chamber technique (Livingston and Hutchinson, 1995). The development of GHG measurement systems, based on automatic chambers and accurate analysers, can improve the quality of soil flux data and the estimation of seasonal GHG emission.*

Oblective. Within the project AGRESTIC a prototype for continuous measurement of soil GHG was developed to measure soil N_2O and CO_2 emissions. This is aimed at assessing the potential GHG mitigation of Efficient Cropping Systems (ECS) based on the inclusion of legumes in crop rotations, both as pulses or intercropping species, and on the use of DSS, compared to a Conventional Cropping Systems (CCS), representing the business as usual of the farmers in the sites.

1 The field experiments are carried out at two sites: Ravenna (Cà Bosco farm) and Foggia (Caione farm), both characterized by a silty-clay-loam soil with an organic matter content equal to 1.4% and 2%, respectively. The ECS is managed according the Horta DSS.

RAVENNA

Year	CCS	ECS
Year 0	Common wheat	Common wheat
Year 1	CCS1 Maize	ECS1 Pea
Year 2	CCS1 Durum wheat	ECS1 Durum wheat + catch crop
Year 3	CCS1 Tomato	ECS1 Tomato
Year 3+1	CCS1 Durum wheat	ECS1 Durum wheat + catch crop

FOGGIA

Year	CCS	ECS
Year 0	Common wheat	Common wheat
Year 1	CCS1 Sunflower	ECS1 lentil
Year 2	CCS2 Durum wheat	ECS2 Durum wheat + catch crop
Year 3	CCS3 Barley	ECS3 Sunflower
Year 3+1	CCS4 Durum wheat	ECS4 Barley + intercropping catch crop

2 Emissions of CO_2 and N_2O from soil are measured by 8 flow-through non-steady-state automatic chambers (four per cropping system). Each automatic chamber is in aluminium alloy and it has an internal radius of 15 cm. A PVC collar 10 cm height is inserted for about 6 cm in the soil and the chamber is closing and opening on top of the collar. The chamber is equipped with a gasket to avoid air leakage during the closing time, a pressure controller, an air-mixing tube which guaranteed the homogeneity of gases concentrations within the chamber and a dust filter. An anti-radiation cover is placed on top of the chamber to avoid heating within the chamber.

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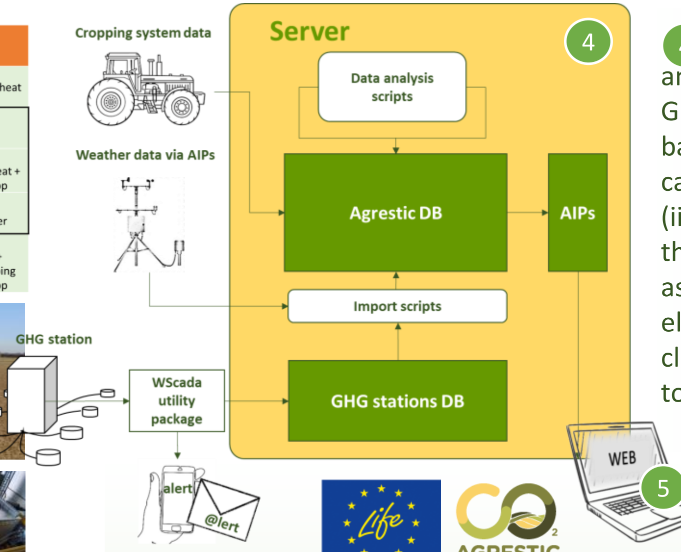

3 Other measured variables are: air pressure and temperature within the chamber, soil water content and temperature using probes beside each chamber. An air-conditioned shelter contains: the analysers for N_2O (Teledyne GFC-7002TU) and CO_2 (LI-COR LI-850), a multiplexer and a local processing unit which operate the measurement cycles of the eight chambers. Measurement time of each chamber lasts for 10 minutes. Chambers are connected to the shelter by a double pipe (inlet and outlet) of 15 m long.

4 The IT infrastructure is based on a SQL database and Python routines to collect the data from the two GHG stations. The system is implemented with a R-based algorithm to: (i) select the best interval to calculate fluxes over the entire chamber closing time, (ii) calculate fluxes with different models, (iii) select the best model and (iv) check the quality of fluxes and assign flags according to quality levels. Raw, elaborated data and plots of GHG emissions and climate data are organized in a web interface together with farmer operations schedule

5 The prototype will measure soil GHG emissions with an automatic and standardized procedure, allowing to:(i) collect and analyse data with high temporal resolution; (ii) assess the GHG mitigation of the Efficient Cropping Systems designed within the project AGRESTIC; (iii) evaluate the effectiveness of process-based models to improve the prediction of GHG emissions.

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