TECHNICAL SPECIFICATIONS

FOR THE SUPPLY OF
A '<u>GHG MONITORING STATIONS</u>'
FOR
SCUOLA SUPERIORE SANT'ANNA

PROGETTO LIFE+ AGRESTIC

CUP: J56C17000130006

CIG: 770713402E

Summary

1. Introduction

Scuola Superiore Sant'Anna (SSSA), Pisa, Italy, is a public university specialized in applied sciences aimed at paving innovative pathways in education and research, responding to the modernization and innovation of society itself. The Institute of Life Sciences (ISV) of SSSA is requiring the services of this tender.

The Institute of Life Sciences is partner of the project LIFE+ AGRESTIC "Reduction of Agricultural GReenhouse gases EmiSsions Through Innovative Cropping systems", funded by the European LIFE programme 2017 (LIFE17CCM/IT/000062)[*], starting in January 2019. The project AGRESTIC aims at fostering the adoption by EU farmers of innovative and efficient cropping systems with a high climate-change mitigation potential and spreading innovative views and tools for climate-ready and resource efficient agriculture. Project activities include the design and the implementation of N- and C-Efficient Cropping Systems (ECSs) with higher potential of carbon storage and nitrogen efficiency and lower GHG emission rates compared to Conventional Cropping Systems (CCSs) on three demonstration sites.

SSSA is responsible to develop and use a prototype for automated and continuous monitoring of soil GHG fluxes, composed by: i) two GHG monitoring stations and ii) an IT infrastructure for data management and elaboration. The prototype will be used to collect data on soil GHG flux for the computation of GHG emissions by different cropping systems and for the adaptation of process-based biogeochemical models that will allow the up-scaling GHG emissions mitigation potential of ECS adoption at regional level.

2. Service requirements

This call for tender answers to the need of the project AGRESTIC of developing two GHG stations for automatic and continuous soil GHG emissions monitoring. The tender includes the engineering design, the purchase of all the components, the assembly, the testing and the maintenance of the two soil GHG monitoring stations (minimum requirements are reported in section 5.2). Tender must include a system for data access by remote and data transmission to SSSA.

The two GHG stations will be developed by the selected Provider in close co-operation with the Institute of Life Science during all the phases of the project and in co-operation with the contractor that will develop the IT infrastructure to manage and elaborate the collected data.

3. General conditions

The two GHG monitoring stations must be assembled, tested and maintained in two demonstration farms hosting the comparison between the two cropping systems, sited in two Italian regions: Emilia Romagna and Apulia. Details on the two sites are reported below. Electricity will be available in the two sites with a voltage of 220 V. No LAN connection will be available on field.

The service of this tender will start with the contract signature (about June 2019) and it will last until the end of the AGRESTIC project, for the moment fixed at 30 June 2023, unless extended.

The Provider must guarantee the design, the installation of the two GHG stations, their connection to the electrical grid and the operational tests in field by 4 months from the signature of the contract.

[*] http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=6720

Site in Emilia Romagna

The field site in Emilia Romagna region is in Ravenna, Località Cà Bosco - San Romualdo. The field dimension is 240 m x 300 m (Figure 1 and 2). The long-term climatic data (meteorological station Ravenna-Punta Marina) are reported in Table 1.

Table 1: Long-term climatic data in Ravenna.

Ravenna			
Month	T min (°C)	T max (°C)	Rainfall (mm)
January	0	5	44
February	2	8	37
March	5	12	53
April	9	16	48
May	13	21	45
June	16	25	46
July	19	28	45
August	19	27	61
September	16	24	61
October	11	19	51
November	6	12	68
December	2	7	47
Average annual T	13.4		
Total annual rainfall			606

Fig. 1: Site 1 in Emilia Romagna, Ravenna.

Fig. 2: Field and access to field where will be placed the GHG station in Ravenna.

Site in Apulia

The field site in Apulia region is close to Foggia, Locality San Giuseppe. The field dimension is 340 m x 250 m, the connection to electrical grid is at 50 m (Figure 3, 4, 5). The long-term climatic data (meteorological station Foggia-Amendola) are reported in Table 2.

Table 2: Table 1: Long-term climatic data in Foggia.

Foggia			
Month	T min (°C)	T max (°C)	Rainfall (mm)
January	3	12	42
February	3	13	41
March	5	15	43
April	7	19	36
May	11	24	37
June	15	28	36
July	18	32	26
August	18	31	27
September	15	28	46
October	11	22	53
November	7	1	53
December	4	13	57
Average annual T	14.8		
Total annual rainfall			497

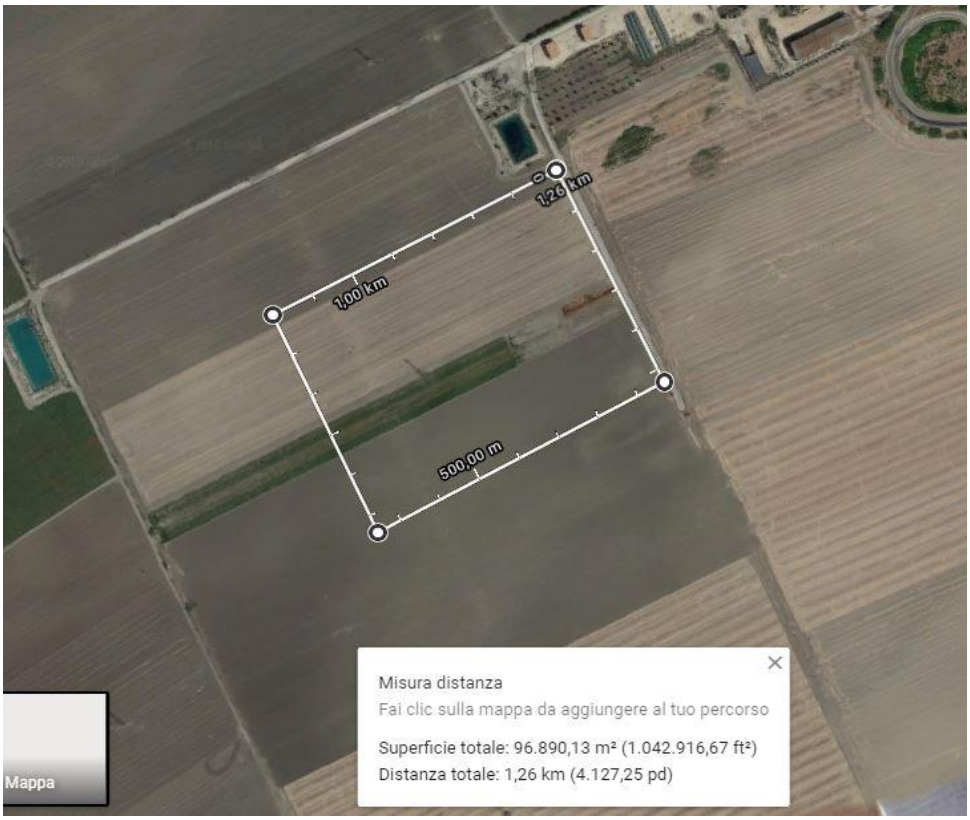

Fig. 3: Site 2 in Foggia.

Fig. 4: Access to field trials in Foggia.

Fig. 5: Field where will be placed the GHG station in Foggia.

In each site, one GHG station will be placed between the fields hosting the two cropping systems tested in the AGRESTIC project, to monitor soil flux continuously both from CCS and ECS, as reported below in Figure 6 A and B.

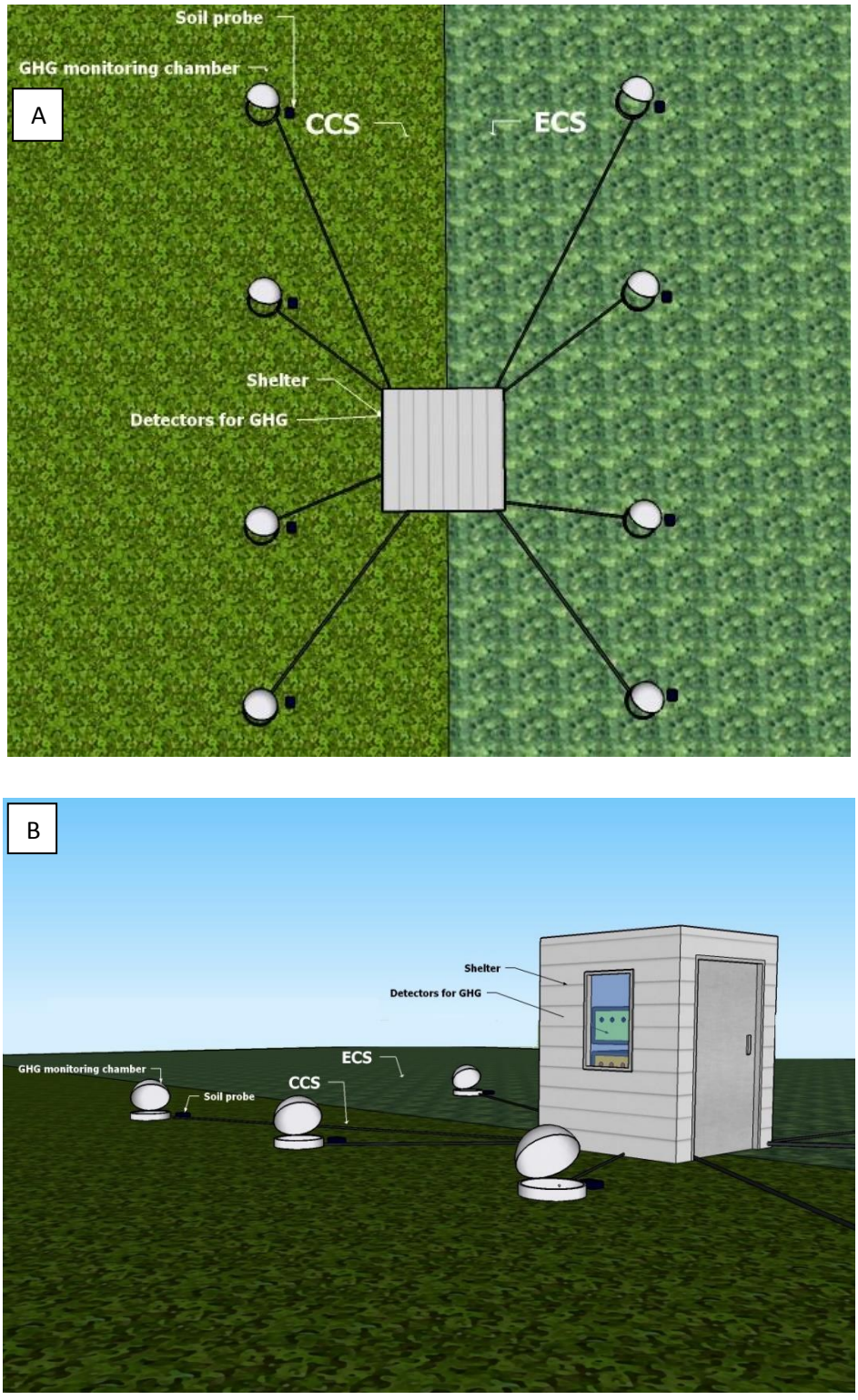

Fig. 6 A and B: Scheme of the GHG monitoring station set up to measure soil N_2O and CO_2 emissions, soil temperature and soil water content in both CCS and ECS.

4. Technical specifications: minimum requirements

Tenderers must present in the technical offer the documentation to guarantee the respect of the minimum requirements listed in the technical specifications:

- curriculum vitae of the working team;
- experience in inherent projects/topics;
- detailed design of the two GHG stations;
- technical sheets of components;
- certificates of conformity of components.

4.1 Definitions

GHG station: ensemble of instrumentation, analysers, automatic closed dynamic chambers, soil sensors, tubes and pumps, local processing unit, completely assembled, calibrated, tested and perfectly working for the automated and continuous monitoring of CO_2 and N_2O emissions from soil.

4.2 GHG monitoring stations description

Each GHG monitoring station is aimed at the automated and continuous monitoring of CO_2 and N_2O emissions from soil with the method of the dynamic closed chamber for long periods. The overall arrangement of the GHG stations must respond to the specific needs of the project AGRESTIC, thus the GHG station will be developed together with the SSSA team based on the technical specifications given below.

The minimum technical requirements are described in the eight paragraphs listed below:

1. CO_2 and N_2O analysers (4.2.1);
2. automatic closed chambers (4.2.2);
3. multiplexer (4.2.3);
4. soil sensors (4.2.4);
5. local processing unit (4.2.5);
6. shelter (4.2.6);
7. other components (4.2.7);
8. design criteria of the GHG station (4.2.8);
9. services (4.2.9).

4.2.1 CO_2 and N_2O analysers

- Each GHG station will be able to measure N_2O and CO_2 concentrations in gas flux using two different analysers, one for each gas (or a unique analyser if available). The analysers must be able to measure gas concentration within the chamber headspace during chamber deployment to allow a subsequent calculation of N_2O and CO_2 fluxes from soil;
- The analysers can operate according to the following technologies: Infrared based technologies, quantum cascade laser spectrometry, Off-Axis Integrated Cavity Output Spectroscopy (OA-ICOS), Cavity Ring-Down Spectroscopy, Gas filter correlation technology;

- The analysers must be robust and adaptable for field conditions;
- The analysers must be both battery and AC compatible; if they are not AC compatible then a DC AC inverter must be provided;
- The analysers must be suited to be easily integrated and connected to a multiplexer system (4.2.3) for continuous monitoring of soil fluxes with automated chambers (4.2.2);
- The output rate must be at least 0.1 Hz (10 sec) or higher frequency;
- To prevent the interaction of water vapour on the GHG measuring, the measurement of the analysers should be or non-significantly influenced by the water vapour, or at least one of the two analysers must be able to measure water vapour concentration to apply the correction of the measured GHG to obtain the dry mole fraction directly without drying;
- The measurements from the two analysers must be non-significantly influenced by the broadening effects, otherwise it should be possible to apply a correction on the measurements for the absorption line broadening effects;
- The analysers must be capable of Parts-Per-Billion (ppb) precision;
- For CO_2 analyser the measurement range must be at least 0 - 3000 ppm of CO_2;
- For N_2O analyser the measurement range must be at least 0 – 3 ppm of N_2O;
- The analysers must provide data outputs through one or more of the following: Local storage, internet, RS232, analog output, Ethernet, USB (or equivalent);

4.2.2 Automatic closed dynamic chambers

- Eight automatic closed chambers per GHG station must be provided and each chamber must allow the gas measurement by both CO_2 and N_2O analysers;
- The automatic chambers must be closed dynamic; it means that they will operate in a closed circuit and therefore in accumulation;
- The opening and the closing of the chambers must be automatable and manageable through the multiplexer (4.2.3) and local processing unit (4.2.5); the opening and the closing of each chamber will be registered by a sensor and communicated to local processing unit;
- The material of the chambers must be stainless steel and they must be opaque for the sun's rays;
- The chambers must be insulated to inhibit energy exchange with the atmosphere and minimize temperature variations in the headspace during deployment, for example: reflective foil, foam or chamber surface painted with a light colour;
- The chambers must be tested against water and dust damages due to the on-field placement and the exposition to the weathering;
- The basis each chamber must be circular. Its diameter must be in a range between 20 cm and 50 cm and the height of the chamber must be in a range between 10 cm and 30 cm;
- One collar for each chamber must be provided to allow the measurement of the gas flux from soil;
- The collars must be of the same diameter of the chamber and the height must be in the range of 5-15 cm, to be inserted few cm into the soil (≤ 5 cm);
- The chambers must guarantee:
  - the homogeneity of the gas concentration in the headspace volume;
  - the pressure equilibration between chamber headspace and atmosphere;
  - the avoidance of the air leaks from the chamber/collar headspace through a sealing system.

4.2.3 Multiplexer

- A multiplexer per each GHG station will carry out the switching for the opening and the closing of the chambers, selecting the sampling line and the corresponding chamber; it also acquires soil temperature and moisture data from soil sensors (4.2.4) and controls the gas flow in the sampling line;
- The time of chambers closing and opening must be easily programmable;
- The multiplexer must be able to connect and manage at least 8 automatic chambers operating in sequence with the two gas analysers and the pump (if needed). It must be equipped with several sampling ports for gas measurements, in adequate number to support the connection and functioning of at least 8 flow-through non-steady state automatic chambers (4.2.2);
- It must be able to manage measurement from more than one trace gas analysers (even if produced by different companies);
- The multiplexed system should be adequately dimensioned to operate at its best considering the operating pressure and flow rate of each analyser, and consequently connect the analysers in series or in parallel and designing it accordingly to the maximum flow rate allowed by the multiplexer equipped with pump or separate pump.

4.2.4 Soil sensors

- Soil sensors for soil temperature and water content at a depth <15 cm must be placed close to each chamber;
- Both a unique soil sensor to measure soil temperature and water content or two different soil sensors to measure each variable could be suitable;
- The measurement range of soil moisture sensor must be between 0% VWC to saturation;
- The soil temperature sensor must measure in a range between -10°C to +55°C.

4.2.5 Local processing unit

- It will control the automation and the timing of the measurements, sending the signal to the multiplexer
- The control unit must also acquire, store the data and manage their transmission, including data from GHG analysers and soil sensors (4.2.4);
- Data collected by the GHG station must be available and transmitted to the SSSA team at least at the end of measurement of an entire cycle (8 chambers). Data must be provided in one or more datasets containing the time series for all the measured variables in common data exchange format;
- The local unit must be the access point for remotely controlling the functioning of automatic chambers, multiplexer and analysers and to visualize the measured data;
- The local processing unit must be equipped with a software to manage the overall functioning and management of the GHG station.

4.2.6 Shelter

- In each GHG station the instrumentation will be mounted on a rack structure inside a shelter;
- The shelter shall be air-conditioned, insulated and painted in a light colour;
- The door of the shelter must be lockable;
- A light must be installed inside the shelter;
- Each shelter must be equipped with a cam, web-cam or equivalent to allow the control of the conditions of the GHG station and the surrounding field;

- The shelter must be solidly anchored on a levelled ground, and it shall be raised from the ground;
- The shelter must be tested for water ingress and dust penetration to avoid any damages for the instrumentation due to the on-field placement and to the exposition to the weathering.

4.2.7 Other components

- Mass flow meter to measure and check the flow rate inside the circuit (analysers, multiplexer, chambers);
- Tubes and connection adequately dimensioned to maintain the correct gas flow rate along the whole circuit without pressure loss;
- Pumps (if needed);
- Filters where needed (chambers, analysers) to protect the circuit from dust and/or water vapour.

4.2.8 Design criteria of the GHG stations

- Each GHG station (i.e. chamber dimensions, analyser precision, tubes length, pump etc.) must:
    - be designed to guarantee an adequate precision of gas measurement (ppb) with a short closing time of the chambers (< 20 min);
    - guarantee continuous functioning;
- Each GHG station will be powered through the connection with the electrical grid but must be also provided with an uninterruptible power supply to guarantee functioning in case of power failure;
- The executive design of the GHG stations must be provided according to the minimal technical requirements specified above, considering all the aspects of the planning (electronic, pneumatic, mechanic etc.).
- The executive design must be finalized with the SSSA team, thus two technical meeting between SSSA team and the Provider will be organized to check the progress of the GHG station implementation before the operational test.

4.2.9 Installation, set up in field and documents

The supplier will provide:

- Purchase and assembly of all the components, set-up and lab checking of the correct functioning of the two GHG stations;
- On-field installation of the two GHG stations and connection to the electrical grid;
- Operational test in field to evaluate the correct functioning of the two GHG stations, checking at least:
    - The air tightness of the chambers;
    - Opening and closing of the chambers in a fixed sequence;
    - Connection of the GHG analysers and soil sensors to the local process unit;
    - Data quality and reliability of the measured flux and soil variables (temperature and moisture);
    - The correct calibration of the sensors (GHG analysers and soil sensors);
    - The sensitivity and the limit of detection of the two GHG analysers in the field;
    - The robustness of the two GHG stations under field conditions.
- A legal warranty of conformity on the CO_2 analyser, N_2O analyser and multiplexer of each GHG station for at least 36 months;
- Technical specification for all devices and analysers and a brief technical report on the functioning of the GHG station (EN and/or IT);

- Declaration of conformity for the CE marking of all the component of the GHG station;
- Certifications necessary by law for the development of the assignment.

4.2.10 Training

- The technical offer must include a short training (2 days, one day of training in each site) for expert users for the GHG station use to learn how to carry out ordinary maintenance of the stations and to control the correct functioning of the instrumentation. The training will be carried out together with the conclusion of the operational test.

4.2.11 Maintenance services

The supplier will provide:

- Guaranteed remote assistance in case of malfunctioning of any components and for answering to the queries of the users, from the GHG stations operational test to the end of the contract;
- At least 8 interventions of maintenance in field from the GHG stations operational test to the end of the contract. Each intervention of maintenance in field includes per diem and travel and the presence of one technician in field for one day.

Assistance service	Response time
Assistance by remote	Response time for remote assistance request after a received call/request: ≤ 1 working day Resolution time for a remote assistance request: ≤ 3 working days for any interruptions of the GHG stations functioning; ≤ 5 working days for failures that not stop the GHG stations functioning;
Assistance on field	Intervention in field after a received call/request for on demand maintenance: ≤ 7 working days

5. Summary table of evaluable features

The compliance of the equipment to the technical specification assessable as improvements must be evident in the documentation (see Section 4).

Summary Evaluable Features (evaluation)			
Item	Criteria	Evaluation system	Max points
A.1	Overall experience on GHG monitoring systems	A.1.1 CV of contractor team	3
		A.1.2 Proved experience in inherent projects/topics	3
A.2	Quality of the overall GHG station design	Completeness of the project considering all aspects, including overall dimensioning and easy monitoring by remote control of the overall station.	15
A.3	Quality of the automatic chambers	Automatic chambers: proved functioning in relation to the scope, robustness, adequateness of the dimensions, and presence of an internal air temperature thermistor/sensor.	12
A.4	Quality of soil sensors	Soil sensors: measurement range, resolution and accuracy for soil temperature and soil moisture.	12
A.5	Quality of the Analysers	Quality of measurement: measurement range, precision, lower detection limit, RMS noise or similar. Robustness: operating temperature and humidity range.	12
A.6	Quality of the multiplexer	Easy setup of the time of chambers closing and opening, adequate pump volume (if needed).	12
A.7	Data management	Easy access, visualization and exchange of data, software for GHG station management and data recording.	9
A.8	Quality of assistance	A.8.1 Organization of the assistance, timing of intervention by remote and in field.	9
		A.8.2 Additional maintenance in field: number of interventions Each additional one offered by supplier (a) is considered through the formula: P(a) = Offer(a) / Offer max * max points	3
Max Technical points			**90**