AgriCaptureCO_2

Regenerating soils for climate and farmers

[30 April 2021]

D3.1 End-user needs analysis

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101004282.

Document control page

Project	AgriCaptureCO2
Project, full title	Developing EO-powered services to promote soil carbon sequestration through regenerative agriculture
Project number	101004282
Project start	January 1st 2021
Deliverable	
Work Package	WP3 - DEVELOP: Co-creation of the AgriCapture platform
Document title	D3.1 End-user needs analysis
Version	1
Responsible author	Dragutin Protic
Contributors	Bojana Obrenovic, Milan Kilibarda, Jelena Kilibarda, Luka Glusica, Andrew Bowen
Date of delivery	30.4.2021.
Due date of deliverable	30.4.2021.
Type	Report
Language	English
Rights	Copyright "AgriCapture consortium"
Status	( ) In progress ( ) For review ( ) Approved
Dissemination level	Public

Version history

Version	Implemented by	Date	Description
V0.1	Gilab	15.4.2021.	First draft for internal review
V1	Gilab	30.4.2021.	For submission

Executive summary

The end-user needs analysis is aimed to be the bases to direct development of AgriCapture products and services. The process included analysis of the current knowledge (reports, scientific papers), methodologies, functioning, rules and philosophy of both Regenerative Agriculture and Carbon markets and the future perspective of the paradigms, and collecting feedback from the stakeholders through the surveys and workshops. It is resulted in 1) understanding of the AgriCapture operational ecosystem and stakeholders, 2) definition of AgriCapture users and the understanding why and how would they use AgriCapture products and services and 3) definition of the User requirements describing what the users want to accomplish by using AgriCapture products and services.

1 Introduction

1.1 Scope

AgriCapture seizes upon Earth Observation (EO) – free and open Copernicus data in particular – to deliver a highly innovative, flexible, and scalable solution for soil carbon (C) capture projects/initiatives, targeting one of the two only potential mass C sinks (i.e. soil) through proven and increasingly popular agricultural practices (i.e. regenerative agriculture – Reg Agri).

AgriCapture will develop a systematic, robust and flexible platform for quantifying, verifying, and promoting soil C capture, allowing (i) farmers and other landowners to become "carbon farmers", (ii) food companies to offset their carbon foot print and offer "zero carbon" products, and (iii) certifying organizations to scale up and automatise their processes. The digital, web-based platform will provide four services, namely: Quantify, Explore, Support and Verify, that will run on EO data.

AgriCapture services' descriptions:

Quantify	Provides high resolution maps of SOC content on an agricultural field level: 1) before applying RegAgri practice to serve as a benchmark for measuring carbon sequestration and 2) for monitoring of SOC changes (carbon sequestration as the result from RegAgri practice). Provides maps of optimal locations for soil sampling on an agricultural field level to minimize the costs of monitoring of SOC sequestration.
Explore	Provides: 1) an estimation of potential annual SOC sequestration for the next few years (in t/ha units) and 2) an estimation of the potential effect on farm economics (applies to a farm if certain RegAgri practices are implemented).
Support	Web/mobile application which provides farmers with a set of data layers, maps and analytical functionalities (e.g., yield estimation, field productivity maps/management zones, near real time monitoring of crop vigor, meteorological data and forecast, integration of soil moisture sensors, comparison of data, farm management tool, soil properties management tool, etc.). The app will also provide farmers with a guideline of how to use the service in the context of RegAgri and how to optimize the production.

Verify	Remote automated checking if certain RegAgri practice was applied on a certain field (e.g., no-till, cover crop, mulching, agroforestry, etc..) based on EO satellite data.

To iteratively develop AgriCapture services that effectively deliver value to end-users it is essential to collect and assess the needs and work processes of the various end-user groups for AgriCapture. This document is aimed at defining clear requirements deduced from end-user needs to guide development on which basis the function and operation of AgriCapture services will be defined in D3.2 AgriCapture service specifications & system architecture.

1.2 Methodology

To maximize market potential and applicability of AgriCapture products and services, a co-creation methodology has been adopted. This means that AgriCapture stakeholders were identified and involved in the beginning of the development process. Co-creation of products and services fully involves stakeholders in the technical development process through a guided dialog. In this case, they are a partner in the process of developing products and services:

a. they provide the information through dialogue;

b. they participate in the solution design;

c. they participate in solution development;

d. they design the experience as they interact with it (proactive).

The involvement of the end users will be accomplished through 5 diverse use cases located across Europe, namely in the UK, Serbia, Poland and Greece, and a use-case in Kenya.

Besides, a number of the relevant documents, surveys and reports in the domain of Regenerative Agriculture, SOC sequestration and Carbon markets were studied in order to gain in-depth knowledge of the current and future contexts in which the AgriCapture solutions will operate.

The process of defining user requirements consisted of the following steps:

1. Identification of AgriCapture stakeholders together with consortium partners OCW, LEAF, GWCT, representative of the sectors of carbon markets and Regenerative Agriculture, and pilot partners ELGO, FrOils, UPOR and SatAgro which represent

farmers' sector and are the managers of the use cases. The aim was to define business/operational profile and the area(s) of intervention and interaction with the AgriCapture products and services.

2. Analysis of current knowledge (reports, scientific papers), methodologies, functioning, rules and philosophy of both Regenerative Agriculture and Carbon markets and the future perspective of the paradigms.

3. Co-design process involved the following activities:

- Initial questionnaire sent to the consortium partners aimed at collecting the information on their vision of the stakeholders benefits from AgriCapture services.
- Workshop conducted to detailly explain the idea of the AgriCapture products and services to the project partners
- Online survey aimed at collecting feedback from broader range of AgriCapture end-users was launched.
- Special questionnaire related to Support service aimed at collecting feedback from farmers.

Based on the information collected in various stages of the process, the following outcomes from the user requirements analysis were created:

- Understanding of the AgriCapture operational ecosystem and stakeholders
- Definition of AgriCapture users and the understanding why and how would they use AgriCapture products and services
- Definition of the User requirements describing what the user want to accomplish by using AgriCapture products and services

2 AgriCapture ecosystem

AgriCapture will operate in the domains of Carbon markets and Regenerative Agriculture. The following sub-chapters will provide more details on the contexts of the two domains.

2.1 Carbon markets

Carbon markets are financial markets for carbon credits. A carbon credit is a tradable credit granted to a country, company, etc., for reducing emissions of carbon dioxide or other greenhouse gases by one metric ton below a specified quota[1].

Carbon market instruments fall essentially into two categories: cap-and-trade (C-T) and baseline-and-credit (B-C) instruments. Under the former, units are issued to installations or entities included under the cap by an administrator, and entities are meant to surrender a specified quantity of units to offset/compensate their emissions. Units represent therefore an "allowance" to emit that is usually denominated in metric tons of carbon-dioxide equivalent (CO_2e). In a B-C scheme, units are earned from a calculation of the difference of emissions between a baseline scenario (that is, that which would have occurred in the absence of the scheme itself) and the actual prevailing (or "project") scenario. If that calculation yields a reduction between baseline scenario emissions and project emissions, these emission reductions accrue to the entity responsible for the action. They represent therefore a "credit."[2]

Carbon credits are certified by Carbon Offset Programmes, the organizations that manages the standards by approving the methodologies for carbon offset projects. A carbon offset methodology is a framework document that defines the quantification and parameters that are required to generate carbon offsets throughout the life of a project. It establishes the project's baseline, identifies qualifying practice changes to reduce carbon, and defines the monitoring requirements necessary to ensure that the reductions are real, quantifiable, verifiable, and additional to what would have happened in the absence of the project.[3]

The carbon offset certification process (Figure 1.) starts with project design phase when project developer submits project description to a Carbon Offset Programme. The Programme creates project record in the registry. The project developer submits a project description (PDD) to a Validation/Verification body (VVB) which assesses the project in accordance with the Programme rules (standard methodology) and provides validation report and validation representation.

[1] https://www.merriam-webster.com/dictionary/carbon%20credit

[2] World Bank. 2016. "Carbon Credits and Additionality: Past, Present, and Future." PMR Technical Note 13. Partnership for Market Readiness, World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

[3] https://climeco.com/creating-carbon-offsets-it-starts-with-a-methodology/

The next phase is the project implementation. Project Developer monitors project according to the approved monitoring plan and submits monitoring report and any accompanying documentation to the VVB. Validation/verification body assesses GHG emission reductions or removals in accordance with the Programme rules and provides a verification report and verification representation. The Programme registry carbon credit records on the Programme's project database and deposits carbon credits in project developer's accounts.

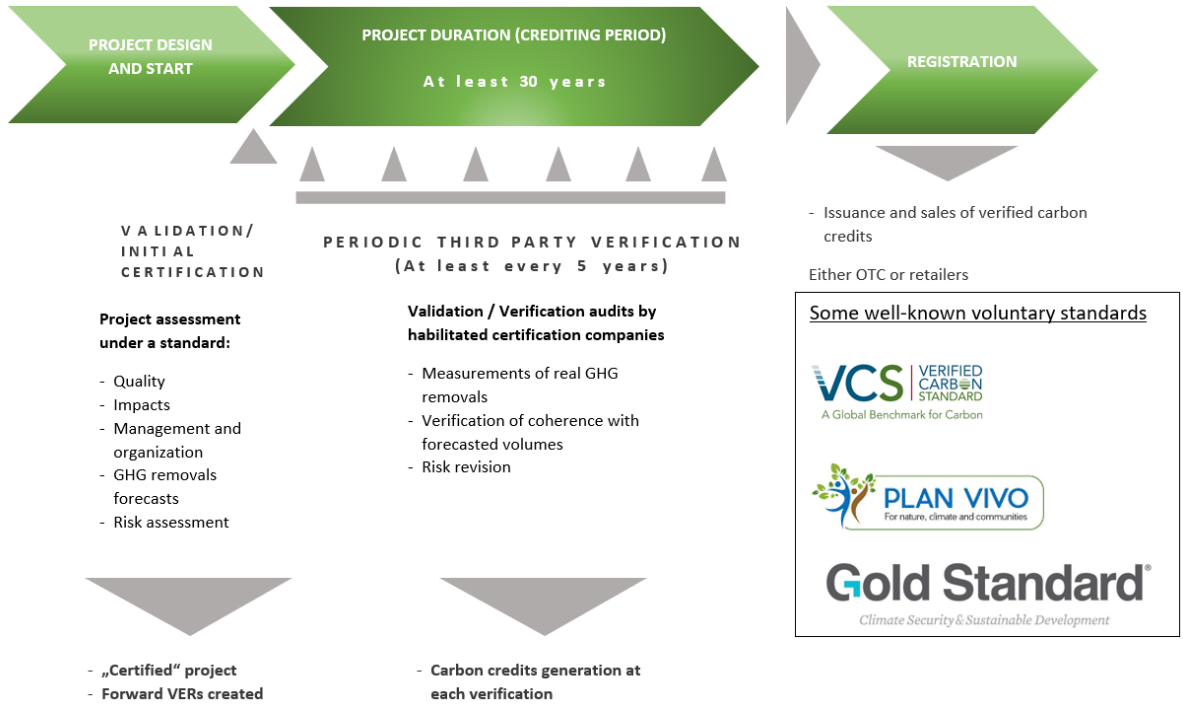


Figure 1. The carbon certification process (adapted)

There are a number of Carbon Offset Standards regulating carbon credits certification in the voluntary carbon market. In this document, three of them, namely Verified Carbon Standard (VCS), Gold Standard and Plan Vivo, with high market share (in terms of registered projects and issued carbon credits), and with methodologies supporting generating carbon credits from agriculture are analysed.

The following table provides relevant information on each of them.

Carbon Offset Programme/ Standard	Description	Certification	Validation and Verification (VVB)
Gold Standard	Gold Standard was established in 2003 by WWF and other international NGOs to ensure projects that reduced carbon emissions featured the highest levels of environmental integrity and also contributed to sustainable development. With the adoption of the Paris Climate Agreement and the Sustainable Development Goals, we launched a best practice standard for climate and sustainable development interventions, Gold Standard for the Global Goals, to maximise impact, creating	Certified Emissions Reduction: a carbon credit, issued by another third-party standard (typically UNFCCC CDM) for use in the compliance carbon markets. A Gold Standard labelled CER is known as a **GS-CER** Gold Standard Verified Emissions Reduction (**GS-VER**): A Gold Standard issued Verified Emissions Reduction: a single unit (one tonne) of CO2 equivalent reduction captured as a carbon credit for use as a commodity within the voluntary carbon market	Gold Standard Validation & Verification Body: A Gold Standard approved audit organisation appointed by and on behalf of the Project Developer to carry out an audit and assessment in order to provide a Validation or Verification Report to Gold Standard in order to ultimately support Certification or rejection. VVBs: https://www.goldstandard.org/project-developers/standard-documents https://cdm.unfccc.int/DOE/list/index.html

	value for people around the world and the planet we share.		
VCS	The VCS Program managed by VERRA allows certified projects to turn their greenhouse gas (GHG) emission reductions and removals into tradable carbon credits. Since its launch in 2006, the VCS Program has grown into the world's largest voluntary GHG program. VCS projects include dozens of technologies and measures which result in GHG emission reductions and removals, including forest and wetland conservation and restoration, agricultural land management, transport	Emission reductions certified by VCS program are eligible to be issued as **VCU**s, with one VCU representing one metric tonne of greenhouse gas emissions reduced or removed from the atmosphere. VCUs can be labelled with certifications awarded by other, non-GHG programs that have been approved by VCS. These additional certifications typically represent community and biodiversity benefits achieved by projects, in addition to the climate benefits inherent in a VCU. https://verra.org/project/linked-standards-programs/	All VCS projects are subject to desk and field audits by both qualified independent third parties and Verra staff to ensure that standards are met and methodologies are properly applied. VVBs: https://verra.org/project/vcs-program/validation-verification/

	efficiency improvements, and many others.		
PlanVivo	The Plan Vivo Foundation is a Charity, registered in Scotland, that applies the Plan Vivo concept and upholds projects to the Plan Vivo Standard– a tried and tested framework for community land use and forestry projects that strive to make a difference. By doing so, we help projects provide benefits to communities and the environment, and provide assurances to buyers of Plan Vivo certificates that emission reductions represent real, additional and verifiable environmental benefits.	**Plan Vivo Certificates (PVCs)** represent real, additional and verifiable emission reductions, whereby 1 PVC equates to 1 tonne of CO2 sequestered or mitigated. All Plan Vivo Certificates (PVCs) are issued, transacted and retired on the Markit Registry. By using this third-party registry, PVCs are allocated unique serial numbers, ensuring that there is no double-counting or double-selling of PVCs.	Have appropriate experience and expertise in community-based Payments for Ecosystem Service projects; Have documented experience in verifying GHG reductions and using sustainability metrics; Are accredited to an appropriate land-use scope by an appropriate authority such as the CDM, FSC, or by an IAF member to ISO14065 (not applicable for local validators) VVBs: https://www.planvivo.org/validation-verification

2.2 Regenerative agriculture

The term "regenerative agriculture" was first coined by Robert Rodale (1983)[4]. The name highlighted how more intensive industrialised agriculture methods more severely reduce the natural resource base on which agriculture depends, and that without stewardship of this natural resource base, "sustainable agriculture" and "conservation agriculture" were insufficient for supporting the food and natural resource needs of a growing human population. Regenerative agricultural systems increase soil health and promote biodiversity while producing nutritious food profitably.[5] Regenerative agriculture uses holistic farming practices with the overall purpose of improving the soil (increase the microbial populations) which in turn has the ability to sequester carbon dioxide, improve water retention, and contribute to biodiversity.[6]

Ethan Soloviev and Gregory Landua write in 'Levels of Regenerative Agriculture' that the aim of Regenerative Agriculture is to regenerate the health, vitality, and evolutionary capability of whole living systems.[7]

A number of benefits are attributed to Regenerative Agriculture[8]:

> **Ecological**: Farmers experience improvements in soil health and fertility, evidenced by healthier crops and improved yields. Biodiversity on land, air, and water followed improved biodiversity in the soil. Regenerative farming also benefits water quality and quantity. Significant outcome of the practices is Carbon sequestration as the soil is the greatest Earth's carbon sink. Furthermore, regenerative agriculture is a path toward climate resiliency and adaptation.

[4] Rodale R: Breaking new ground: the search for a sustainable agriculture. *The Futurist.* 1983; **17**(1): 15–20.

[5] Fenster TLD, LaCanne CE, Pecenka JR et al. Defining and validating regenerative farm systems using a composite of ranked agricultural practices [version 1; peer review: 2 approved]. F1000Research 2021, 10:115

[6] https://blogs.bard.edu/mba/2019/04/23/regenerative-agriculture-increases-profits-and-benefits-the-planet/

[7] http://www.terra-genesis.com/wp-content/uploads/2017/03/Levels-of-Regenerative-Agriculture-1.pdf

[8] https://www.nrdc.org/experts/arohi-sharma/regenerative-agriculture-part-4-benefits

Economic: Cost-savings from reduced use of fuel, chemicals, including fertilizers, herbicides and pesticides, and antibiotics, has a positive impact on farm profitability.

Recognising differences in soil types, water availability, climate, natural surroundings, and biodiversity, regenerative growers develop tailored, site-specific blends of regenerative practices to improve soil health and their resilience to climate change. There is a number of practices assumed to be regenerative, for example[9]:

Cover cropping: This is the practice of planting cover crops, which are plants that cover your soil in order to reduce soil erosion, increase water retention, improve soil health, increase biodiversity and more. Cover crops can be planted around the time of harvesting cash crops or in between rows of permanent crops.

No-till: A technique that leaves the soil intact when planting rather than disturbing the soil through ploughing.

Diversified Crops: Growing a variety of crops protects against pests and diseases, provides a diversified income stream and habitats for more pollinators, and improves soil health.

Perennial plants: Perennials are plants that do not need to be replanted every year. Perennials also exhibit long root systems that can retain water, improve soil's porosity, sequester and store more carbon, and improve soil health.

Agroforestry: Practice wherein growers integrate trees and shrubs into crop and animal systems. This practice, which mimics forest systems, helps multiple species benefit from one another.

However, not all regenerative farmers use or can use all these practices. They should rather be designed to suite best the local conditions (e.g. soil, climate, crops...).

In the context of carbon credits certification by Carbon offset standards, Regenerative Agriculture projects can be registered if designed in accordance to a number of the existing methodologies. The methodologies approved by the popular Standards are presented in the following table.

[9] https://www.nrdc.org/experts/arohi-sharma/regenerative-agriculture-part-3-practices

Standard	Methodology	Description
Gold Standard	Gold Standard Approved Methodology: The specific Activity/Outcome requirements and procedures used to calculate, monitor and report on a given Outcome that may lead to the issuance of Gold Standard Certified SDG Impact Statements or Products. Soil organic carbon methodology: Soil organic carbon framework methodology https://globalgoals.goldstandard.org/402-luf-agr-fm-soil-organic-carbon-framework-methodolgy/	The methodology presents requirements to quantify changes in greenhouse gas (GHG) emissions and soil organic carbon (SOC) stocks through the adoption of improved agricultural practices. Activities can achieve avoidance of emissions as well as sequestration of carbon in the soil, both which result in increased SOC content.
	This Soil Organic Carbon (SOC) Activity Module https://globalgoals.goldstandard.org/402-1-luf-agr-am-soc-module-improved-tillage/	This Soil Organic Carbon (SOC) Activity Module presents the requirements and guidance to quantify greenhouse gas (GHG) emissions from agriculture by changing soil tillage practices within agricultural systems. This SOC Activity Module is based on and replaces the Gold Standard Agriculture Methodology for Increasing Soil Carbon Through Improved Tillage Practices V0.9.
VCS	VM0017 Adoption of Sustainable Agricultural Land Management	The methodology quantifies the GHG emission reductions of sustainable land management practice activities that enhance

	https://verra.org/wp-content/uploads/2018/03/VM0017-SALM-Methodolgy-v1.0.pdf	aboveground, belowground and soil-based carbon stocks of agricultural areas. The methodology applies input parameters to analytic, peer-reviewed models to estimate the organic soil carbon density at equilibrium in each of the identified management practices in each land use category.
	VM0042 Methodology for Improved Agricultural Land Management https://verra.org/wp-content/uploads/2020/10/VM0042_Methodology-for-Improved-Agricultural-Land-Management_v1.0.pdf	This methodology is applicable to projects that introduce sustainable management practices to an agricultural landscape where the soil organic carbon would have remained constant or decreased in time without the intervention of the project.
	VM0021 Soil Carbon Quantification Methodology https://verra.org/wp-content/uploads/2018/03/VM0021-	This methodology quantifies the greenhouse gas (GHG) emission reductions and soil organic carbon (SOC) removals resulting from the

	Soil-Carbon-Quantification-Methodology-v1.0.pdf	adoption of improved agricultural land management (ALM) practices. Such practices include, but are not limited to, reductions in fertilizer application and tillage, and improvements in water/residue management, cash crop and cover crop planting and harvest, and grazing practices. This modular methodology is designed to be applicable to ALM projects, including changes to agricultural practices, grassland and rangeland restorations, soil carbon protection and accrual benefits from reductions in erosion, grassland protection projects and treatments designed to improve diversity and productivity of grassland and savanna plant communities. The associated modules provide methods for quantifying and monitoring changes in carbon accrual in, and emissions from, soils as well as from other GHG pools and sources that may be affected by AFOLU projects.
PlanVivo	Small-Holder Agriculture Monitoring and Baseline Assessment (SHAMBA) methodology https://www.planvivo.org/Handlers/Download.ashx?IDMF=5b30948b-26f3-4d7a-803f-0fcce593acbd	Estimation of emissions and removals (Baseline scenario; Project intervention) Applicable project types: Afforestation; Reforestation;

		Agroforestry; Agricultural land management

2.3 Stakeholders

The stakeholders in the AgriCapture ecosystem (domains of Carbon markets and Regenerative Agriculture) that can potentially benefit from AgriCapture are:

Stakeholders	**Description**
Farmers (SOC sequestration and/or Regenerative Agriculture project owner)	The operator and owner of the physical installation where the GHG emission reduction and removals project takes place can be any private person, company or other organization. Farmer who applies practices of Reg Agri in order to be certified.
Auditors (Validation & Verification Body - VVB)	Auditors known as validation/verification bodies (VVBs) are tasked with assessing projects against the Carbon offset Program rules and the requirements of the applied methodology. VVBs are qualified, independent third parties which are approved by Carbon offset standard organization to perform validation and verification.
Project develops (Advisers with experience in Carbon offset regulations and markets)	Provides e.g. help in planning the timber conservation project so it generates the maximum amount of credits possible. Derives a fee for advising clients and developing projects, and, sometimes, also takes a cut of revenues generated in the sale of credits.

Carbon Offset Programme/Standard Organisations	Defines the methodologies (rules and protocols) for Carbon offset projects. The organizations behind the standards generate fees from managing the certifications of projects as well as handling the logistics of issuing and retiring credits.
For-profit carbon credit brokers	They buy credits in the wholesale market from a Project developer, packages them into bite-sized portions, and offers them to consumers at a mark-up.
NGOs	Carrying out environmental and climate change projects. Raising awareness of Regenerative Agriculture.
Regenerative/Sustainable Agriculture certification bodies	Provides assurance that a farmer produces farm products in accordance to the certification standard.
Public authorities	Create legislation that regulates matters related to carbon offsetting, climate change mitigation and agriculture. Creating and managing projects related to carbon offsetting, climate change mitigation and agriculture.

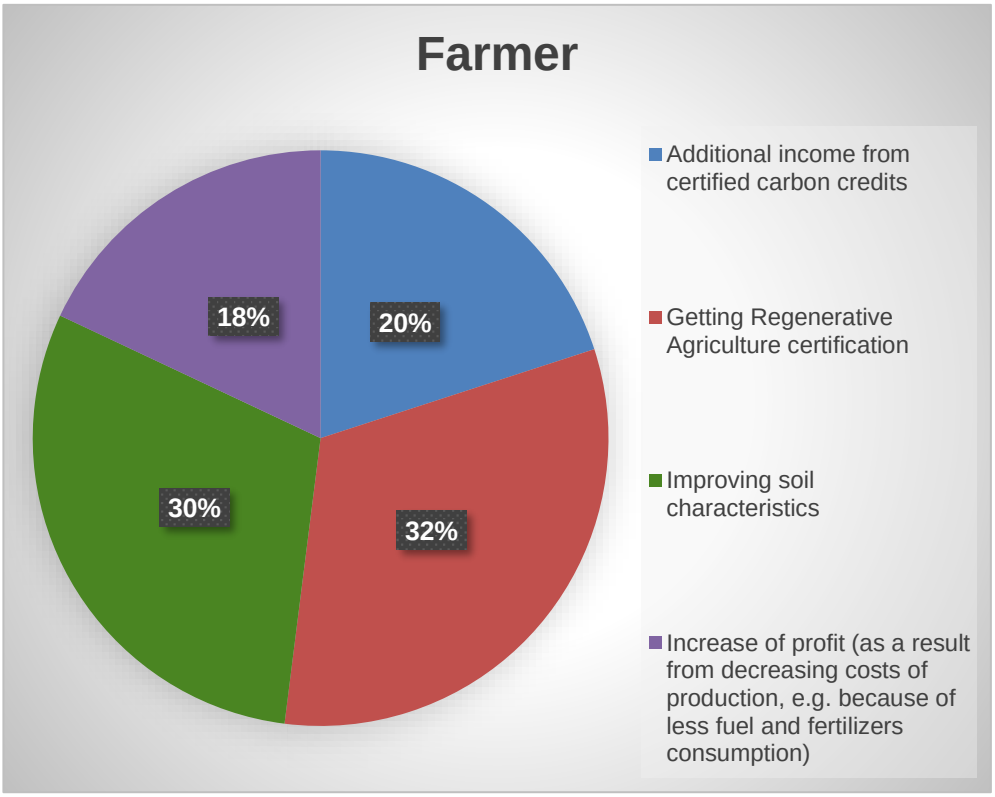
3 Survey analysis

As described in the Methodology section, two surveys were conducted during the user feedback collection process, one dedicated to collect feedback on all AgriCapture services from wide range of potential users, and the other focusing on the Support services for farmers.

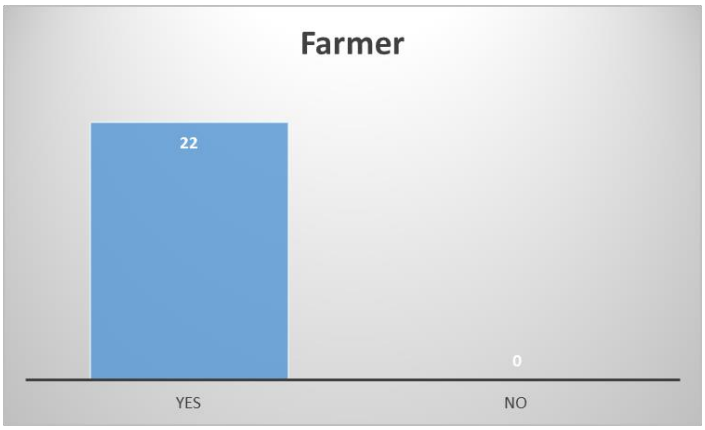
3.1 General survey

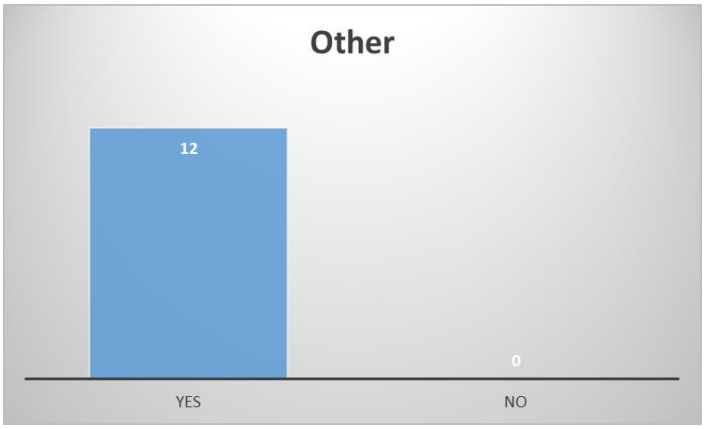
In this survey, 35 participants provided feedback. 22 of them are farmers or farmers associations and the rest are other stakeholders (certification bodies, NGOs, researchers…).

GENERAL QUESTIONS
Question 1: What are your reasons to be involved in Regenerative Agriculture?



Question 2: Are you interested in Soil Organic Carbon (SOC) data?





Question 3: Why? (follow up from Q2)

FARMER:

- improvement of soil characteristics, nutrient and water capacity
- Desire to improve soil conditions.
- I have been looking at it for over 20 years and believe it is one of the key indicators of overall soil health
- Water storage potential, nutrient holding capacity, better structure for soil and carbon sequestration
- I believe that if we can measure carbon in a legitimate way, it can be used as a driver for "Payment for performance" rather than payment for activity. I want my clients to be rewarded for doing a better job than simply the minimum necessary to pass a set of activity criteria. I also believe that building soil carbon

will benefit a wide range of other Natural Capital items that may be much harder / more expensive to measure (Retailer)

- Quantifying, verifying and promoting carbon capture in soils is of great interest and very necessary to the regeneration of those soils, but we must say that from our point of view it is not enough of an indicator to show or prove the aims and practices (such as use of cattle and its appropriate management on the land) that Regenerative Agriculture establishes as essential to recover soil fertility, biodiversity and agricultural and rural ecosystems. (Farmer association)
- We carry out carbon fixation studies in the projects we work with
- To enrich the land, for easier work
- I am interested in changing the way of cultivating agricultural land from conventional to sustainable regenerative way
- My goal is to increase humus
- Intensive tillage, in our country with a plow, leads to increased decomposition of humus, which is not renewed by the introduction of manure, green manure or some other measure of humus preservation. Loss in the last 60 years is 2-2.5%
- To check if I'm on the right track with the processing method of land.
- considering the climate change all issues related to organic carbon sequestration are important
- organic carbon sequestration in the soil is an important factor for the climate
- This is very important information
- carbon sequestration is a very important action to mitigate climate changes
- improvement of soil characteristics. increase of profits reduction of production costs

RESEARCH:

- To track KPIs
- Because it provides a basis for robust monitoring, reporting and verification (MRV) for certification and for monitoring impacts of policies

- Many areas of Crete face serious issues with water availability, low amounts of SOC, and saltwater intrusion
- For research purposes
- To inform policy discussions

NGO:

- It is one of the best metrics for measuring the impact of regenerative farming and grazing practices. Also, will be essential to the establishment of carbon credit markets and will enable farmers to sell the ecosystem services they are providing.
- Currently developing a results-based payment scheme where carbon storage in soils is discussed
- Opportunity to develop a baseline to work from and encourages awareness and the want to improve.

BUSINESS:

- To check fertility of the soil, try to improve it and possibly also generate carbon credits.

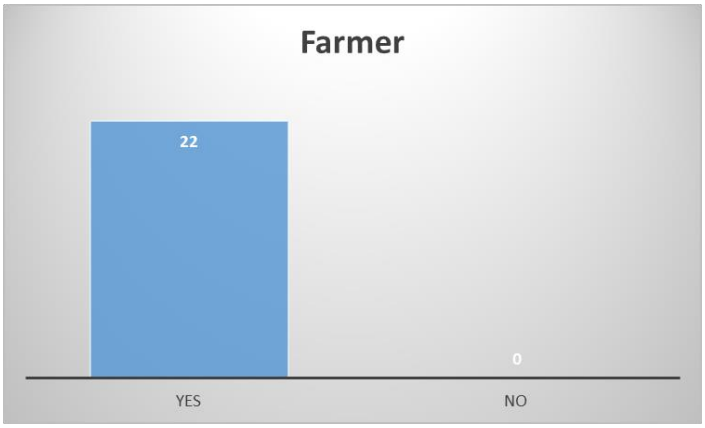
PUBLIC AUTHORITY:

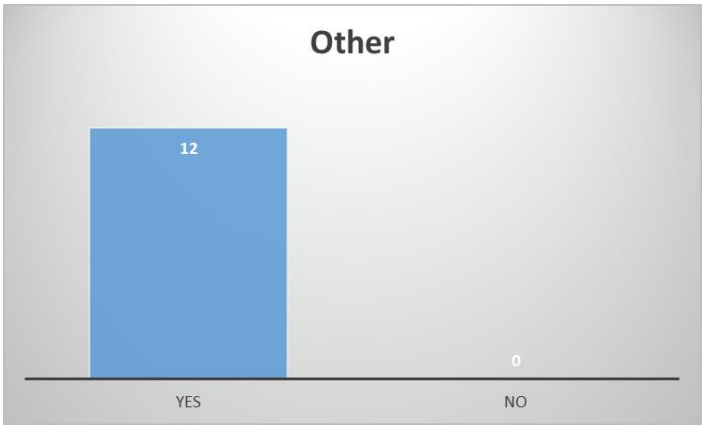
- To enable the SOC actual/potential to be given for a particular geography

CERTIFICATION BODY:

- This will help measure carbon footprint baselines and re-measurements to understand the difference in carbon sequestration.

Question 4: Are you interested in Carbon sequestration in soil (increase of SOC content)?





Question 5: Why? (follow up on Q4)

FARMER:

- improvement of soil characteristics, nutrient and water capacity
- Mitigation of climate change, adaptation to climate change, stop the loss of diversity, better water management (infiltration, cleaning, storage), increased aggregate stability, higher profit, more resilient system, …
- as one of the many benefits of regenerative practices, which are environmental, social and economic (Farmer association)
- Perhaps long term but initial priority is soil improvements. Wish to investigate how suitable some of our clay/loam over peaty soils might sequestrate.

- This is the means of reducing greenhouse gas emissions in the atmosphere and will eventually lead to an extra form of income for farms that can prove sequestration
- Help address climate change, opportunity for land managers
- There is plenty of science to show why SOC is important for soil function and equally plenty of evidence of how we have degraded and lost soil in recent years (Retailer)
- It is important to improve soil health
- I do not have much knowledge on this topic, but from what I have read it seems to me closely related to regenerative agriculture, so in that sense I am interested
- My goal is to increase humus
- this is a way to improve the production, physical, chemical and biological properties of the soil
- To check if I'm on the right track with the processing method of land.
- For the same reason i mentioned above
- this is an important information
- This is very important information for soil characteristics
- carbon protected products

RESEARCHER:

- To help reduce GHG emissions provide robust system for combating global warming
- Maintenance and enhancement of SOC is a key action for adaptation in agriculture, with benefits for mitigation.
- A main agronomic practice for climate change mitigation in olive cultivation could be a higher soil water retention capacity through boosting SOC.
- For research purposes
- Key contributor to mitigate climate change and GHG emissions

NGO:

- Important why to mitigate climate change, prevent soil erosion, in increase biodiversity below and above the soil.
- Opportunity to evidence that good farmers are doing. Public money for public goods.

BUSINESS:

- To increase fertility soil and in the future get access to the emission certification market.

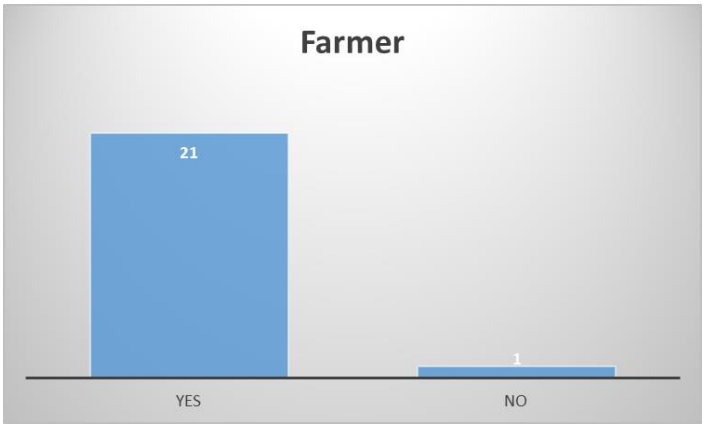
PUBLIC AUTHORITY:

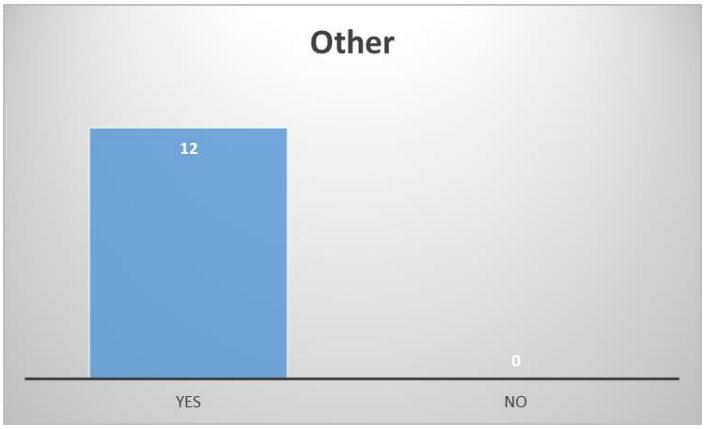
- The County Council, 12 district and 2 unitary councils wish to investigate the opportunities for soil carbon sequestration to help us meet to meet our commitment to achieve carbon neutrality. This could either be through the improved management of land in public ownership, or by the establishment of a local carbon market that will assist us to offset Carbon and support our rural communities and businesses.

CERTIFICATION BODY:

- As above (i.e. Q3)

Question 6: Are you interested in Regenerative of Conservation Agriculture?





Question 7: Why?

FARMER:

- improvement of soil characteristics, nutrient and water capacity
- Because it is the future of agriculture and ... see above ;-)!!
- We are interested in and dedicated to Regenerative Agriculture, which we understand to be very different to Conservation Agriculture. There seems to be a mistake in terminology or in the understanding of the terminology, and we would really like to converse with you about this. (Farmer association)
- I have been practicing and learning from this for over 20 years
- To reverse declines in SOC leading to improved ecosystem services and wider benefits to biodiversity, climate, etc (Retailer)
- We are developing more than 40 regenerative agriculture projects in Spain in places with different soils, climates and precipitation
- I inherited the farm from my parents and grandparents and I have been cultivating it in the same way as those before me for a couple of years, but the conventional method of cultivation seems increasingly unsustainable due to the large and irrational use of fertilizers and pesticides, as well as high fuel consumption. It is conventionally insisted on the bare surface of the land where all plants except the cultivated crop were destroyed - thus replacing every natural process with artificial ones (loosening of plant weeds - frequent machining, less moisture retention - irrigation, lack of useful minerals - application of artificial fertilizers, etc. .)
- It is future.

- We have been applying it on the PSS experimental field for more than 40 years, on individual crops
- I already work that way
- very important
- I think this is necessary

RESEARCHER:

- To help reduce GHG emissions provide robust system for combating global warming
- It's the basis for SOC maintenance and enhancement.
- ELGO supported agri-cooperatives in Crete to increase water efficiency in olive production with Regenerative Agriculture. Also, ELGO has longer term data from Regenerative Agriculture implementation
- For research purposes
- The ability of these approaches to store carbon in soil

NGO:

- Interested in regenerative agriculture as a means of increasing soil health and biodiversity
- Because it is needed to protect and restore natural resources
- There is a clear case for climate action; rising temperatures are driving natural disasters, weather extremes, environmental degradation, food and water insecurity, economic disruption, terrorism, and conflict. With sea levels rising, the Arctic melting, coral reefs dying, forests burning, and oceans acidifying, it is clear that "business as usual" is not going to cut it. Now is the time to act. Agriculture has a unique opportunity to act as a carbon sink and contribute to the global collective action for change, with the goal not just being sustainability but positive redress of issues including net emissions, biodiversity loss and social inequality. Regen Ag offers an opportunity to achieve these solutions.

BUSINESS:

- Since a few years we have propagated biological farming, which comprises activities are very close to regenerative and conservation agriculture. Our main purpose is to improve quality of food produced, and of the soil, and to gain competitive advantage through a high-quality produce.

PUBLIC AUTHORITY:

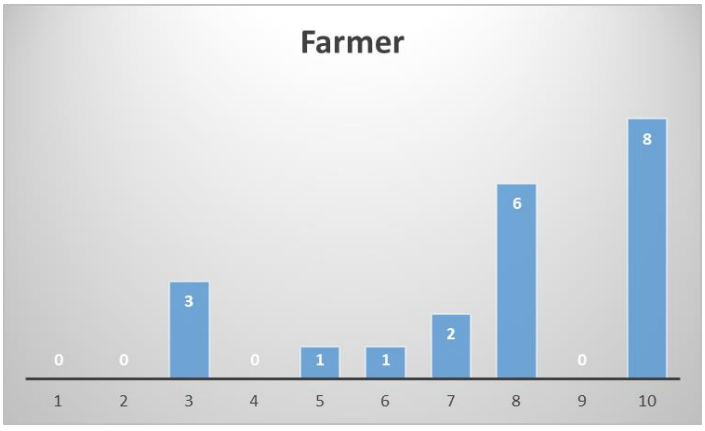
- As part of our work to achieve carbon neutrality the County Council, 12 district and 2 unitary councils, working with other partners in Lancashire, wish to investigate the opportunities to apply the principals of regenerative agriculture to the management of land in public ownership in a manner that will enhance longer-term carbon capture. It will also help us to address our commitment to the conservation and restoration of biodiversity in the face of a changing climate

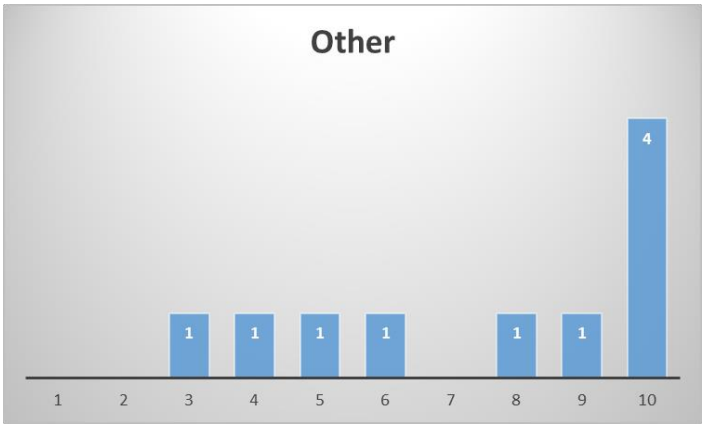
CERTIFICATION BODY:

- OCW would like to further understand the regenerative practices (interventions) used to increase carbon in soil.

SOIL ORGANIC CARBON (SOC) QUANTIFY

Question 8: How valuable would Pan-European map of SOC stock in kg/ha at high spatial resolution (30 m) for standard soil depths 0-30, 30-60 and 60-100 cm would be to you? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 9: Please describe any modifications of the proposed Pan-European map that would make it more valuable to you

FARMER:

- Only that from a farmer's perspective 60-100 is not that interesting, except for water movement in soil.
- For a farmer it is interesting to see what the status is, but the next step is to increase SOC stock in the soil. So it would be more beneficial to have recommendation how to do so at the same spatial resolution.
- Data specific to farm location.
- A system to ground truth any satellite imagery.
- The map will be a complete source of important information at a pan-European level. Of course, the elements that will relate about my farm i consider that they are valuable (Greece)
- They are valuable if they concern my farm (Greece)
- I don't know what exact information the map will include but it is great source of information and if they concern my farm, they are valuable (Greece)
- This analytical map could be a valuable source of information especially for Olive calculation and for my own farm. (Greece)
- We are concerned that an initiative to certify regenerative practices is being launched based on this one very limited indicator. That one single indicator could serve to develop a certification about "carbon sequestration" or "carbon farming", for example, but not about "regenerative agriculture", which as we are sure you

must be aware of, includes social, environmental and economic factors at farm level, and also nutritional quality improvement at final product level. (Farmers association)

RESEARCH:

- We are making this map so we hope it will be useful! (ENMX)
- I have doubts whether such a map is feasible - i.e. whether it can provide the level of accuracy that you would need to set up payments for SOC sequestration. As I am not a soil scientists I can't say what type of sampling would be minimal to set up sufficient accuracy, but I don't see how 30m spatial resolution could be accurate enough. It is beneficial that you are looking at different soil depths and not just 0.30cm. (Ecologic Institute)
- It would make it much easier for farmers to calculate the amount of carbon in their soils accurately. (GWTC)

NGO:

- I would like to know more about the map, its accuracy, how it works, who is funding it and who manages it. (EIT FOOD)

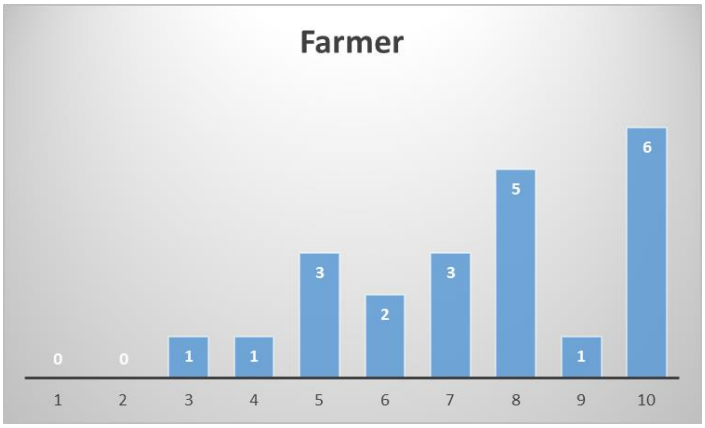
BUSINESS:

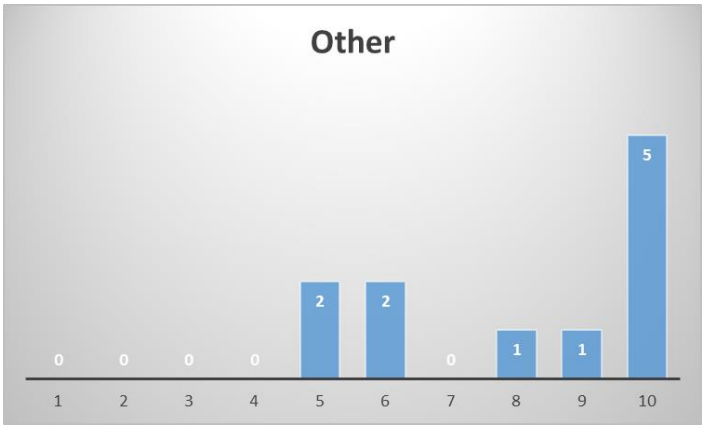
- We are mainly interested in mapping carbon stocks at the local scale.

PUBLIC AUTHORITY:

- Former landfill sites and reclaimed former industrial sites are likely to have very shallow soils.

Question 10: How valuable would it be to you to receive a limited number of optimal locations in the field where to take soil samples in order to create a highly accurate SOC stock map for the field?





Question 11: Please provide us any comment you have regarding the soil sampling optimal locations for SOC estimation

FARMER:

- The most important question I have on this method is, what logarithms are you using to define this spot (which information is going into this model?).
- Having a defined methodology for how to do this would be very useful, eg geo-position, depth and time of year to take samples
- Provided this enables the farmer to get a reasonable idea of his SOC stocks and the method used proves to be accurate and scalable then it is useful.
- It would make sampling easier for me and speed up the sampling process;

- A very small number of soil samples taken at optimal locations can replace the traditional system of taking a very large number of soil samples across the field to create an accurate map of organic carbon in the soil, which significantly reduces the cost of measuring carbon in the soil. (SRB)
- I have submitted a list of parcels and I expect to determine the locations (SRB)
- It is important (SRB)
- This process is a very important for assessment of carbon sequestration facilitating the accuracy of the final map (Greece)
- Soil sampling helps to create an accuracy map for soil sampling (Greece)
- Soil sampling helps to create an accuracy map (Greece)
- It is very important to depict the optimal soil sampling positions (Greece)
- We do not understand well what this means, how these points would be decided and which would be the participation of people in the field. (Farmers association)

RESEARCH:

- If you can ensure comparable level of accuracy, then taking fewer samples would of course be very beneficial to reduce costs of monitoring. But how would you ensure that the optimal locations are really optimal? (Ecologic Institute)
- Provided this enables the farmer to get a reasonable idea of his SOC stocks and the method used proves to be accurate and scalable then it is useful. (GWTC)

NGO:

- This map would be useful for institutions such as EIT FOOD, perhaps less so for farmers who will need more detailed information on their fields. (EIT FOOD)

BUSINESS:

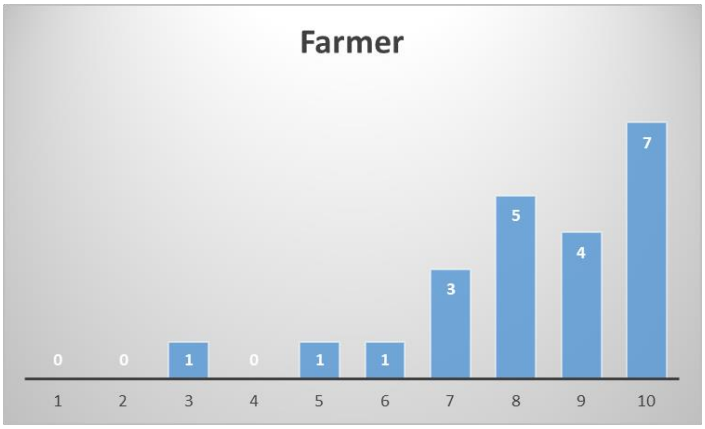
- It would be valuable to optimise the number of samples, but the assessment would have to include productivity and topography analysis.

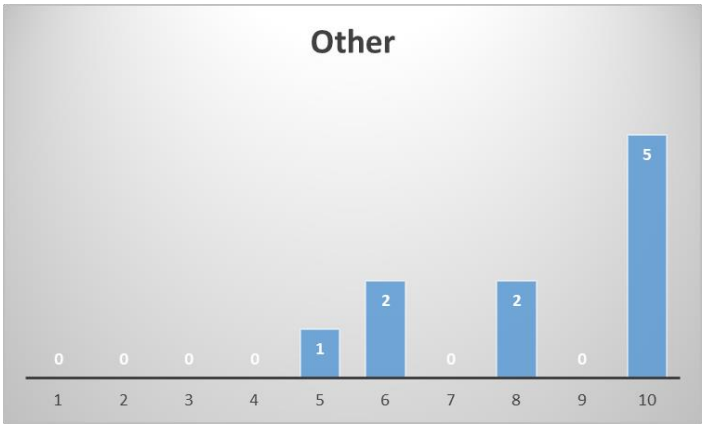
CERTIFICATION BODY:

- this service would potentially save on the cost of samples and provide a 'smart' samples solution

Question 12: Service will provide a highly accurate map of SOC stock in kg/ha over the agricultural field and the summary for the field.

How valuable would it be to you to? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 13: Do you need to be provided with any additional information related to the field level?

FARMER:

- Need to better understand the service.

- General soil health is always very useful to assess the amount of artificial fertiliser required for example, as if this can be reduced, it will reduce both greenhouse gas emissions and costs to the farmer.
- Any relationship with soil type and condition, including water-logging or compaction, would be helpful.
- I have precise data on the method of processing and applied quantities of artificial fertilizers and pesticides for several years
- Work primarily on the lands that are most problematic (SRB);
- Yes as this information will concern my farm (Greece)
- I don't know what exact information and in what form this will be on the map, but it is important to have information about my farm (Greece)
- I don't know what exact information and in what form this will be on the map, but it is important to have information about my farm (Greece)
- It would be useful if it reflected the reality of the field with all its complexity and if it is well calibrated, but we are unsure of how this would be done or if it would be truly representative and accurate. (Farmers association)

RESEARCH:

- To ensure that not just C but also other ecosystem services are rewarded (and delivered), it's important to have other indicators that can say something about these other ecosystem services. This is also because some practices (especially off-farm compost, biochar) may have impact on soil health if they bring in pollutants or otherwise negatively impact on soil health. (Ecologic Institute)
- Any relationship with soil type and condition, including water-logging or compaction, would be helpful. (GWTC)

NGO:

- Assuming that the assertion is true, yes it would be highly valuable. However SOC is just one of many parameters that should be taken into account if we want to understand soil health and biodversity. (EIT FOOD)

BUSINESS:

- Variability in time with volume of change.

PUBLIC AUTHORITY:

- More guidance in terms of the minimum size/shape of plots for applying different interventions (tree planting, application of BioChar/PAS100 comport etc) so that the impact of these on soil carbon can be accurately assessed. We are willing to design the different interventions around the sampling needs/requirements.

Question 14: The first SOC map for the field will be the baseline. When soil samples are taken next time (e.g. in a year, two years or five years) the service will generate new SOC map for the field and map of SOC change between the years in graphical and numerical way. Do you need any additional information related to SOC monitoring?

FARMER:

- Ensuring consistent soil moisture and sampling conditions.
- It would be necessary to know the evolution in a homogenous timescale eg. yearly? (Farmers association)

RESEARCH:

- Again, are there other indicators that can reflect improvements in soil biodiversity, soil ecosystem services? (Ecologic Institute)
- the proposed method is an excellent approach to overcome the quite time-consuming and costly traditional sampling approaches. (ELGO)
- The factors which contribute most to the increase or decline would be useful. (GWTC)

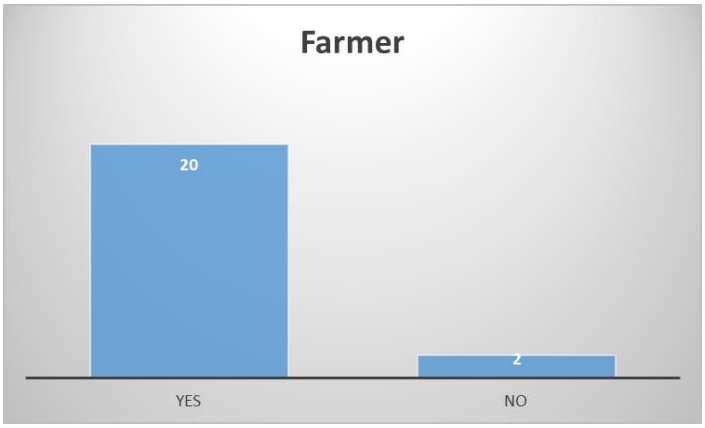
BUSINESS:

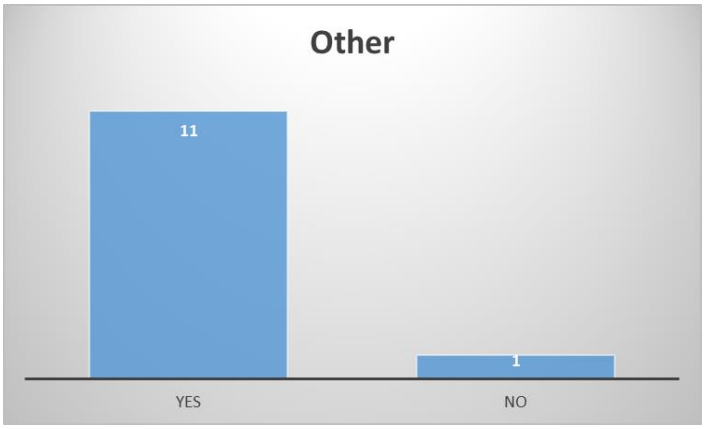
- We have measured SOC by soil sampling since 2016, controlling for samples GPS position. We are testing soil every 3 years.

PUBLIC AUTHORITY:

- We are likely to apply several different interventions within existing field boundaries. We will need to be able to clearly differentiate between the areas where the different interventions have been applied which may have a relation to the sample resolution (30m).

Question 14: Do you think this is a good way to monitor Carbon sequestration in soil and prove that Carbon credit is generated? Please describe your option.





FARMER:

- I don't think, credits related to soil management should be generated by carbon monitoring (maybe it could be a minor part of the evaluation). While it is easy to monitor soc stock in soil, it is not easy to increase it. And it is the risk of the farmer, if it does not happen. Still, the farmer implemented all the good methods and there are lots of benefits coming from the field now for e.g. adapting to

climate change, increased biodiversity, better water infiltration, reduced soil erosion, less pestizide use, compost application, ... As long, as we only look for one single soil function (carbon) to fight one single problem (climate change), we will not change to a systemic approach and we won't solve the complex problems, we are facing today on this planet.

- So long as it is a trusted validated methodology used, farmers and those buying carbon credits will all be confident in the system
- If it can be at a good value to farmer this would help.
- I think it's good to bind as much carbon as possible in as short a time as possible.
- Yes. Soil analysis would be a good way to check carbon sequestration (SRB)
- Yes, although as a topic it is difficult to understand for agronomists, let alone for farmers (SRB)
- I think so because every year the level of organic matter in the soil is lost or dropped by regular cultivation, and that should be prevented, considering that the process of creating humus is very slow. (SRB)
- I will see after the first results and repeated measurements (SRB)
- Yes, it is the best way. (SRB)
- I am not an expert on this subject, but i think that monitor Carbon sequestration it will be very important (Greece)
- As i can understand this is a good way to control carbon (Greece)
- Why i think they are related (Greece)
- I am not an expert on this subject, but my answer is surely yes (Greece)
- NO, we would need to understand more about how it will be measured and if it will be truly representative. (Farmers association)

RESEARCH:

- YES (ENMX)
- NO, The approach above is too generally described to be able to say whether it is sufficient or not. You would need to know what level of accuracy and what level of uncertainty you are getting with this method. (Ecologic Institute)

- Yes, but only when the technique is proven to be effective and accurate (GWTC)

NGO:

- I'm not sure - I need to understand the process more.
- YES if it is precise and accurate. (EIT FOOD)

BUSINESS:

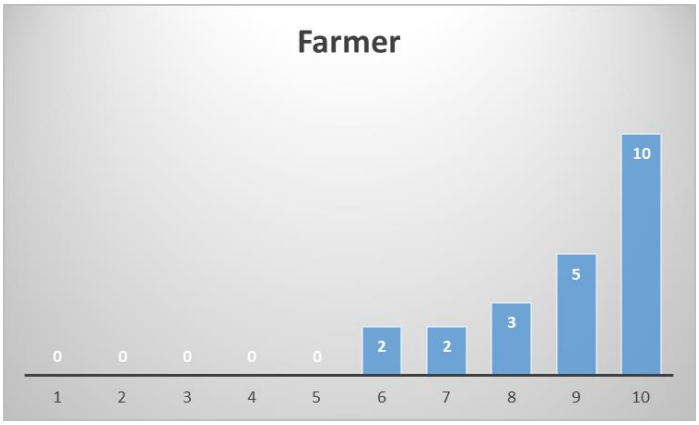
- Can be good tools to accreditation of carbon credits.

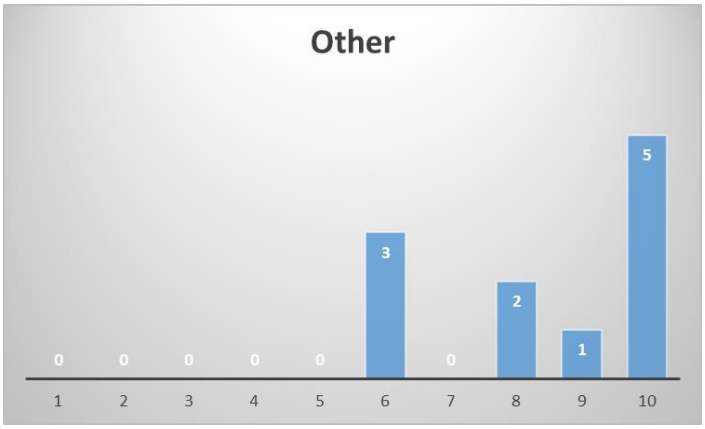
CERTIFICATION BODY:

- YES, this is in line with the methodology we are exploring

EXPLORE

Question 15: How valuable would be to you to receive the information on the estimated potential for SOC sequestration in a particular field if Reg Agri practice is applied? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 16: If you would use information, please describe how and why would you use it

FARMER:

- If reliable, this information would help me decide whether to implement a given practice, Most importantly in the issue of tillage;
- This would be of high interest, if you can guarantee the numbers from the models;
- Soil improvement and in support of ELMS;
- This will enable the farmer to assess what the potential is of their soil and then decide the value in trying to increase som. For example, a sand soil will not increase so much, but may be very good at growing high value crops with irrigation. Whereas a clay soil may have more potential to increase soc which can then be traded as well as increasing overall soil nutrition and workability of the soil;
- This would allow a cost benefit analysis for the potential of the field, the income that could be earned from sequestration and other environmental payments;
- In production planning and reducing production costs. -Environmental protection also plays an important role;
- I am planning to purchase machines for reduced tillage in the coming period (primarily I mean strip-till) and I am interested in the effects of reduced tillage primarily on the structure and quality of land, as well as the financial effects on production costs (SRB)

- Advice to farmers on the correct choice of production technology (SRB);
- Advisory work (SRB)
- I'm not very familiar with how to use data (SRB)
- To adapt agricultural techniques (SRB)
- To increase business efficiency. (SRB)

  Definitely the information is important, but I don't know how I could use them in practice because I have not been involved again with this (Greece)
- Based on this I will have information about which practices i could apply in my farm (Greece)
- For the time I don't know but definitely every information is important (Greece)
- This information is important, but I don't have in my mind how I could use them in practice (Greece)
- Given the practices that we as a regenerative agriculture association consider to be regenerative management practices, we feel that the list of practices provided in this survey leaves out too many key practices, such as correct animal grazing and others. (Farmers association)
- We could use the information to work out cost-effective Regen agriculture systems that include all the potential income streams (Retailer)

RESEARCH:

- The farmer can anticipate what payment they may receive. But farmers want to know also what those impacts are on productivity, water holding capacity, and that is not always clearly linked to SOC level alone, if I understand correctly. Farmers want to know what practice is going to deliver what over what period of time, not just in terms of SOC content. (Ecologic Institute)
- Valuable information for farmers to improve their yield as well as for local policymakers (ELGO)

NGO:

- One of several important parameters to consider. Can't say much without knowing more about the methodology. (EIT FOOD)

BUSINESS:

- Such information could prove right (or wrong) the approach to Reg Agri practices and estimated profits from carbon credits.

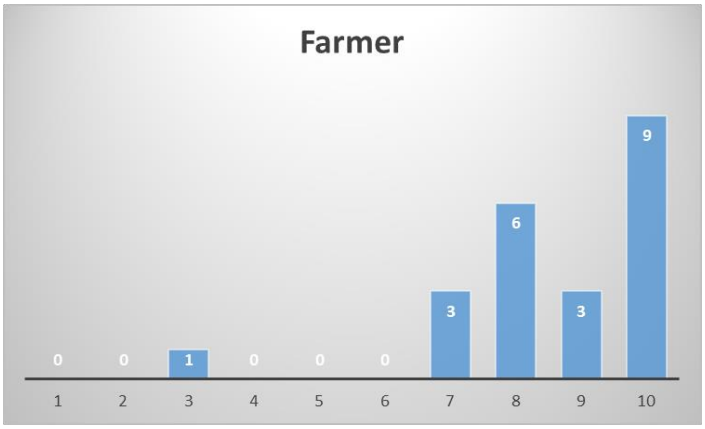
PUBLIC AUTHORITY:

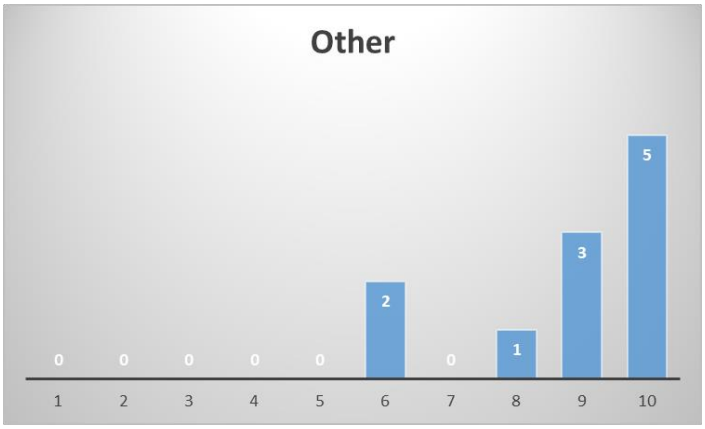
- It is likely that public authorities will look to manage land in their ownership in a way that will maximise the potential for Carbon sequestration (whilst satisfying any other obligations) to help them meet their commitment to Carbon neutrality.

CERTIFICATION BODY:

- We would use this information to help with the certification and verification process of carbon credits

Question 17: How valuable would be to you to receive the information on the effect on farm economics from applying Reg Agri practice? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 18: If you would use information, please describe how and why would you use it

FARMER:

- It would help long term planning of potential changes to farming systems from a fixed cost machinery perspective, plus from overall environmental credentials that customers may require;
- Essential to know the economic model for regen agri practices. Especially around machinery ownership;
- From the beginning of dealing with agricultural production, I closely monitor the effects of each operation, on yield and financially, so in the same sense I would monitor the effects of regenerative agriculture (SRB)
- when planning procurement and input costs because there are no subsidies in this area (SRB)
- To improve the existing agricultural techniques (SRB)
- The information from the implementation of this practice is important and i would like to receive it because in this way i will know the effect on farm economy (Greece)
- To know how the implementation of practice in economics affects (Greece)
- To know how the implementation of practice in economics affects (Greece)
- It is very important information the relationship between regenerative agricultural practices with farm economy (Greece)

- Given the practices that we as a regenerative agriculture association consider to be regenerative management practices, we feel that the list of practices provided in this survey leaves out too many key practices, such as correct animal grazing and others. (Farmers association)

RESEARCH:

- For farmers it is very helpful to understand where the costs and benefits for them are, this can guide them in choosing the right kinds of practices for their field. But the information credibility for them is much higher when this comes also through demonstration and peer-to-peer learning, rather than just a software tool calculation. (Ecologic Institute)
- Valuable information for farmers to improve their yield as well as for local policy makers (ELGO)

NGO:

- Very valuable, but again there is more to farm economics than SOC (EIT FOOD)

BUSINESS:

- Such information can guide our decision about technology and operation activities.

PUBLIC AUTHORITY:

- This information would help Lancashire's public authorities assess the likely impact of reg agri on its rural economy (and biodiversity) and help plan for the provision of services and potential local interventions.

CERTIFICATION BODY:

- we can use this information to map agri practices (interventions) against carbon credits generated

Question 19: Which information related to the effects in farm economics would be of particular interest to you?

FARMER:

- The impact of tillage changes in light of changing water availability;
- Reducing fertiliser application and using sequestration to offset fertiliser input.
- Fuel, fertilizer and pesticide consumption, working hours, impact on revenues (SRB)
- Costs (SRB)
- Costs in the first place (SRB)
- All information (SRB)
- Product price and cost of the applications (Greece)
- The product price, cost of the practices (Greece)
- The product price (Greece)
- Product price and cost of the applications (Greece)
- Given the practices that we as a regenerative agriculture association consider to be regenerative management practices, we feel that the list of practices provided in this survey leaves out too many key practices, such as correct animal grazing and others, and so we would considerably amplify and diversify the evaluation of economic indicators. (Farmers association)

RESEARCH:

- How much will a particular practice cost in terms of labour, material costs. What is the short-term and medium-term cost of the practice, and what return can you expect in terms of benefits (cost-savings, soil workability, water holding capacity, labour savings). (Ecologic Institute)
- The specific correlation between the proposed applied Reg Agri practice on farm economics (ELGO)

NGO:

- For me the question is how will regenerative farming and grazing practices affect my business in terms of input costs, revenue from cash crops and revenue from ecosystem services provided. Important to consider time component. When will the farmer see the returns, not just economic but also environmental and social return. (EIT FOOD)

BUSINESS:

- Yield, quality, and production cost.

PUBLIC AUTHORITY:

- Not sure. But whatever is produced should be capable of further analysis using different geographies e.g., administrative boundaries or landscape or biodiversity designations etc.

CERTIFICATION BODY:

- the potential carbon sequestration per intervention would be of particular interest

SUPPORT SERVICE

Question 20: If you already use a crop monitoring of farm management application, please specify which one

FARMER:

- SatAgro, Metos, Software provided by Corn seed producers (Monsanto, Pioneer), RolnikON;
- Standard yield mapping on combine harvester to give broad overview;
- Gatekeeper, Soyl and Omnia.
- AgroSens (SRB)

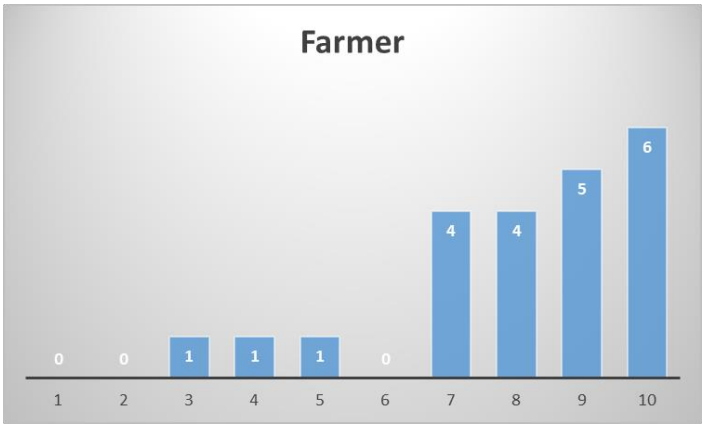
RESEARCH:

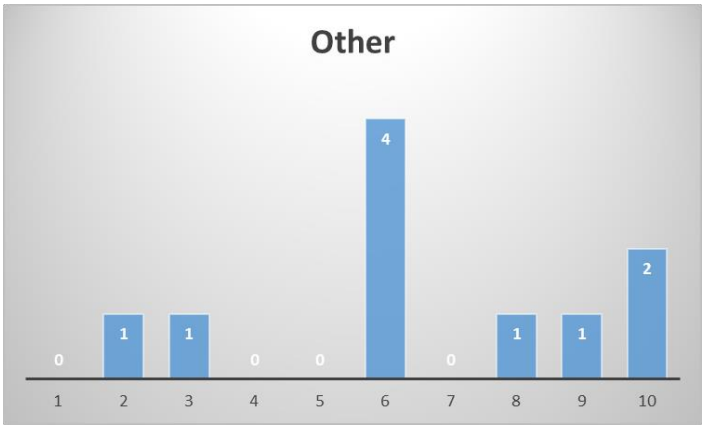
- Regenerative Agriculture practices such as no-tillage, proper pruning, proper weed management (weed mowing), and proper plant protection have been applied and recorded since 2017 in all the proposed parcels. (ELGO)

BUSINESS:

- Free images from Sentinel 2 and Landsat 8, and QGis to process them. GateKeeper. SatAgro (re-starting to use; now as part of AgricaptureCO2)

Question 21: How valuable would be Integration of data from soil moisture sensors to you? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 22: If you would use Integration of data from soil moisture sensors, please describe how and why would you use it

FARMER:

- Decisions related to sowing dates;

- Only interesting, where irrigation is available and when monitoring in different spots and depths;
- Much of our land is quite wet and often being able to carry out field tasks is influenced more by wetness rather than being too dry;
- It would be useful to have, but in our system probably not necessary at the moment. Our soils tend to hold moisture well and the climate is temperate;
- This would allow timely sowing dates based on this information, when was the optimum time to travel on soils, apply plant protection products.
- Selecting the optimal moment of sowing and irrigating the soil (SRB)
- tillage time, sowing time, assembly, nutrient application (SRB)
- To monitoring certain data (SRB)
- I do not use but i consider it is important data for the definition of time and irrigation dose (Greece)
- I do not use soil moisture sensors but i believe that help determination of time and irrigation dose (Greece)
- I do not use soil moisture sensors but i believe that help determination of time and irrigation dose (Greece)
- I do not use but, nevertheless my farms is rainfed, i consider it is important data for the definition of time and irrigation dose (Greece)
- Where and how would these be located, how would they be paid for and maintained? (Farmers association)
- I would need to know a lot more about the metrics before answering this question (Retailer)

RESEARCH:

- to optimize the irrigation schedule/water efficiency (ELGO)
- Of limited value to Policy Makers but of more use to farmers (GWTC)

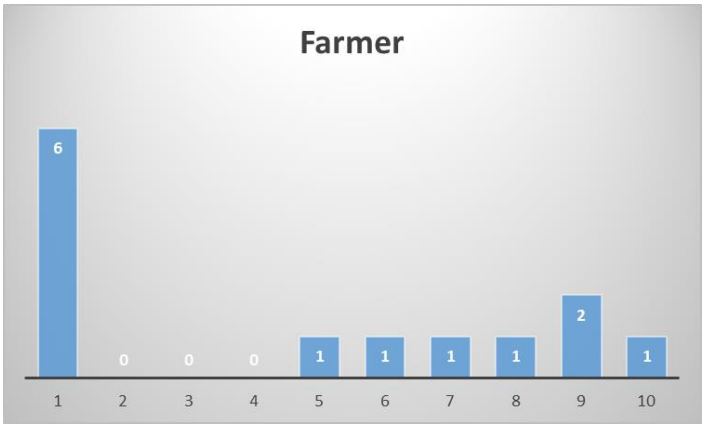
BUSINESS:

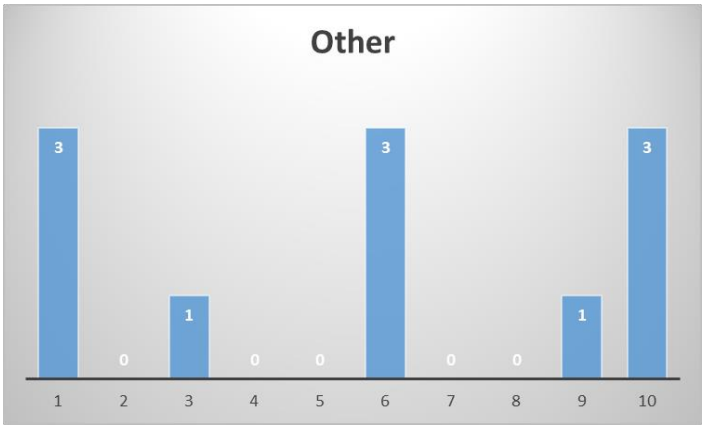
- Information from soil moisture sensors could be useful to calculate water needs in irrigation potatoes.

CERTIFICATION BODY:

- unsure until further research carried out on soil sequestration methodologies

Question 23: How valuable would be Precision agriculture for resource efficiency in olive production to you? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 24: If you would use Precision agriculture for resource efficiency in olive production, please describe how and why would you use it

FARMER:

- I do not apply, but I consider it is important since it is a specialized and targeted precision agriculture technique that responds to the farm needs (Greece)
- I do not apply, but I think that precision agriculture is a very important tool for improving the efficiency of my farm. (Greece)

- I do not apply, but surely is a very important task for water saving (Greece)
- Our members use all sorts of cover crops and crops, especially in combination with regenerative grazing of farm animals. (Farmers association)

RESEARCH:

- Precision agriculture could be a useful tool for farmers in order to improve their yield and overcome difficulties such as low water availability, low-quality irrigation water (saltwater). Agriculture in Greece is characterized by small or average-sized holdings (small farms), which in some cases negatively affect the agricultural productivity as the economies of scale offered by modern farming practices have limited the applicability on small parcels, typically occurring in Greece. The application of precision agriculture in olive production at a farm-scale could be a solution to the above issues. (ELGO)
- N/A (GWTC)

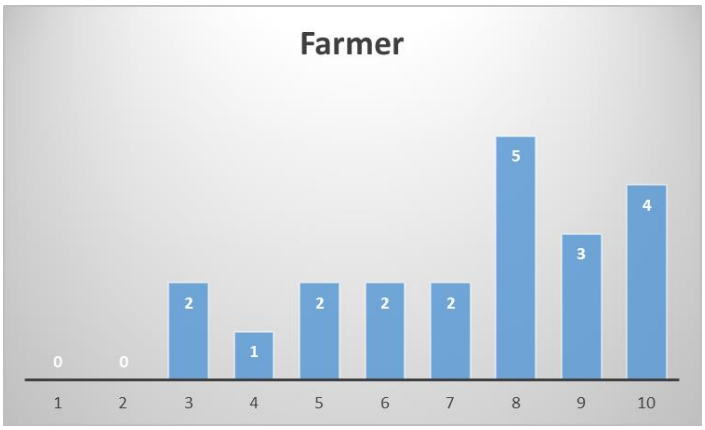
NGO:

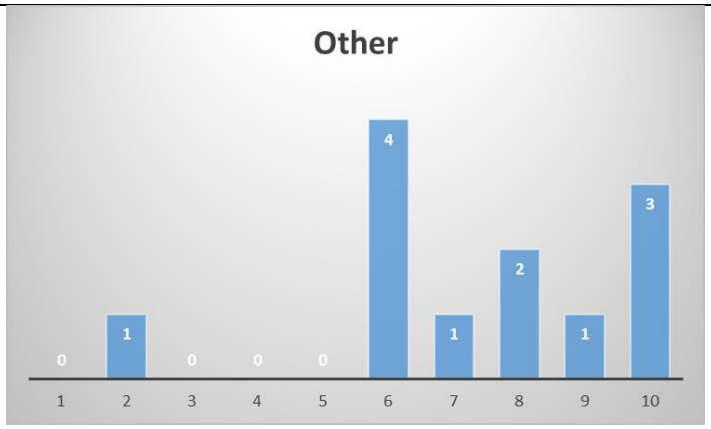
- If I were an olive grower it would be very valuable (EIT FOOD)

CERTIFICATION BODY:

- unsure until further research carried out with olive farmers

Question 25: How valuable would Soil management module be to you? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 26: If you would use Soil management module, please describe how and why would you use it

FARMER:

- Archive of soil information - should include extant herbicide fungicide information following spraying (some compounds are harmful to other crops even 2 years after use);
- To improve soil condition and organic matter;
- I would have to understand a bit more about it before I could comment or score properly.
- An important recommendation for me is the required amount of fertilizer, but at the moment I do not have a spreader for variable fertilization, so I would rather use the data for the whole plot or parts of plots (SRB)
- Optimization of fertilization costs depending on the targeted and achievable yield (SRB)
- application of fertilizers and sowing (SRB)
- To monitoring certain data (SRB)
- Regarding soil, i apply only fertilizers,
- while for weeds only weed mowing (Greece)
- This information could be used for proper fertilization / fertigation (Greece)
- I make weed mowing and apply fertilizers when is needed (Greece)
- It is very important to have information about proper fertilization (Greece)

- In our view of regenerative management, one of the bases is avoiding the use of any chemical fertilizers in favour of maximizing life in the soil and ecosystem function to increase and care for fertility. (Farmers association)

RESEARCH:

- The soil management module could be a crucial tool for farmers ensuring water saving at the farm scale.

  This includes increasing soil organic matter which in turn can improve the soil water storage/holding capacity, especially at drought-prone areas in the summer period such as our case study. In addition, a proper soil management module will give the write directions concerning the reduction of soil tillage, especially in sloppy areas (ELGO)

- This could be useful in optimizing inputs and reducing the carbon footprint and nutrient losses. (GWTC)

NGO:

- We advise farmers, so it would be very useful (EIT FOOD)

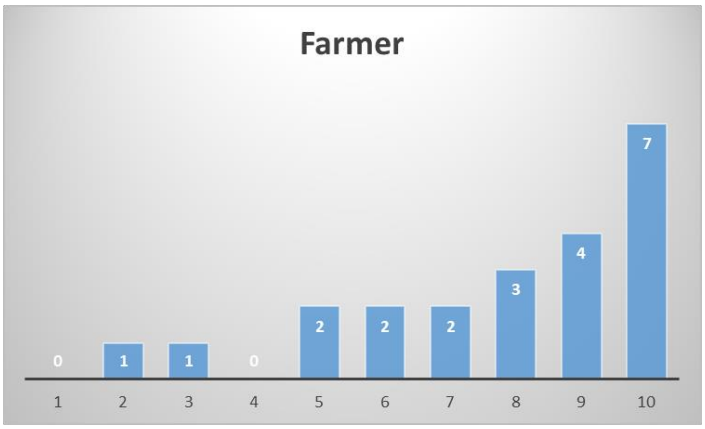
BUSINESS:

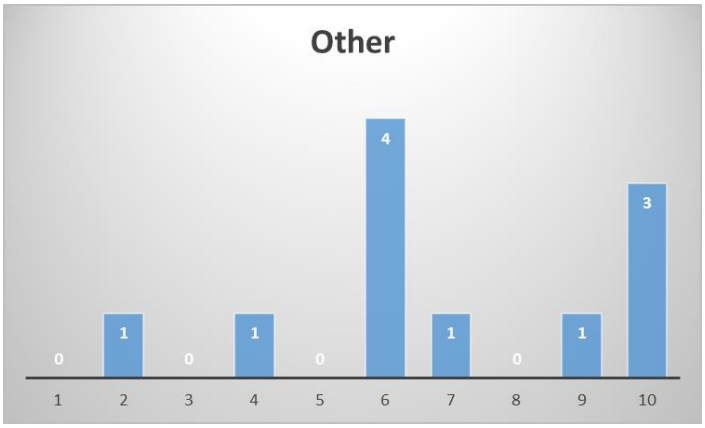
- It is a very broad term. Support in managing spatial differences in soil fecundity would be very useful.

CERTIFICATION BODY:

- Unsure of what soil management module would entail

Question 27: How valuable would Nature strips on low profitability field zones be to you? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 28: If you would use Nature strips on low profitability field zones, please describe how and why would you use it

FARMER:

- 1200 ha is a lot of land to manage, a tool would make it easier to designate such areas;
- Identification of low productivity zones does need only two or three years of farming experience;
- Some heavily sievy (rush) fields in ned of improvement.
- Poor yielding areas are often near areas where biodiversity and habitat is already present and can have a big impact and farmers can claim agri-environment payments.
- I don't think that's the case on the plots I cultivate, but I'm interested in the opinion. If the income from C loans were at least close to the realized income from farming, it would be ready to allocate land (SRB)
- Elimination of unprofitable areas in arable farming(SRB)

- Planting energy plantations, woody (SRB)
- To make a better situation (SRB)
- I know that they are important for carbon sequestration and for maintenance of biodiversity in the field (Greece)
- I know that they are important for carbon sequestration and for maintenance of biodiversity (Greece)
- I know that they are important for carbon sequestration and for maintenance of biodiversity in the field (Greece)
- I do not apply, i know that they are important for carbon sequestration and for maintenance of biodiversity in the field (Greece)
- We promote the use of correctly managed cattle in such areas, in combination with trees, shrubs and other vegetation and forage. (Farmers association)
- We could use Countryside Stewardship to monetise these areas effectively (Retailer)

RESEARCH:

- I am not sure about the applicability of this practice, as in an Eastern Crete the water availability is a crucial issue, while in some cases the grazing occurs (un case of uncontrol farms) a fact that could minimize the success of natural strips. (ELGO)
- This could be very useful. (GWTC)

NGO:

- This is something that most farmers can determine from empirical observation. But good to have a second opinion. (EIT FOOD)

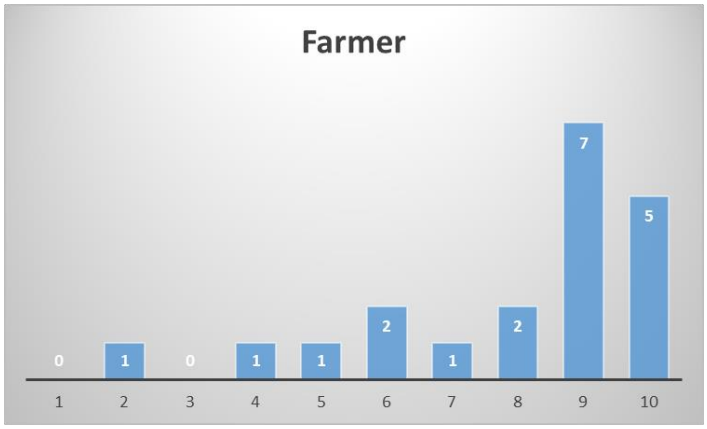
BUSINESS:

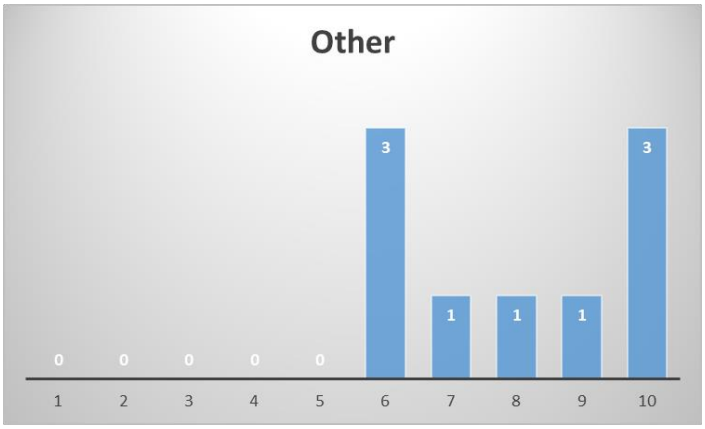
- We use nature strips into a limited extent, e.g. wildflower meadows. To have them permanently, there can be problem with keeping them safe from pesticide spray.

PUBLIC AUTHORITY:

- Would help us plan and address our biodiversity objectives and work with farmers on their delivery using the new UK agri-environment schemes which will be more focussed on public and environmental benefits.

Question 29: How valuable would Alerts for local pathogen risks be to you? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 30: If you would use Alerts for local pathogen risks, please describe how and why would you use it

FARMER:

- currently use METOS pathogen alerts to implement fungicide and pesticide use;
- Not sure until better understanding of the service;
- We currently use this provided by agronomist against certain pests, but it could be used on more species if available;

- Could inform plant protection product policy and build up disease spread picture across region;
- I regularly follow the recommendations and warnings of PSS, so I am also interested in your insight into the risks of pathogens (SRB)
- Advisory work (SRB)
- Variable and integrated application of fungicides, conservation of beneficial insects (SRB)
- To try to doing in an adequate way (SRB)
- They are important contributing to the local treatment of the risks that appear and the avoidance of unnecessary effects. (Greece)
- I don't know the possibilities but i would like to use these to organize possible applications (Greece)
- I would take advantage of them in order to apply focused treatment avoiding unnecessary surgeries (Greece)
- I do not apply (Greece)
- We aim to increase the system's biodiversity and trophobiosis as a way to increase resilience and deal with pathogens. (Farmers association)

RESEARCH:

- A tool for proper alert regarding the olive pathogens risks. Based on the real-time knowledge of meteorological parameters the scientific team could suggest proper actions to mitigate the risk from pathogens. (ELGO)
- Not really useful to Policymakers. (GWTC)

BUSINESS:

- It would be useful for planning activity on the fields and choosing plant protection methods, incl. relatively inaggressive for nature.

PUBLIC AUTHORITY:

- Depends on the type of pathogens. Agricultural may be less relevant to us than wider environmental pathogens such as *Hymenoscyphus fraxineus*.

Question 31: Please describe some specifications of each of the listed services/information that you would use (for example: I would like to see graphic of time series of soil moisture data measured by the sensor installed in the field)

FARMER:

- Charts of weather data and maps to intuitively access the information;
- I would like to know the decision-making matrix behind all of the models;
- Moisture data could be useful;
- Should feed into an easily understood desktop or interface which has an easily accessible summary page. Live page and summary page. Guidance advice on moisture and disease, inform farmer when to take action or observe more regularly;
- Soil moisture data and presentation of unprofitable areas, and most of all data on chemical characteristics of soil (SRB)
- I would like to see the offered charts on my parcels (SRB)
- I would like to see a graph of time series of soil moisture data of measured sensors installed in the field and to follow all measurements (SRB)
- I would like to see a graph of time data series for content N in plant.
- I don't know the possibilities but i would be interested in data data, diseases from pathogens, rain. (Greece)
  soil moisture data, applications regarding the fertigations as well as warnings about pathogens (Greece)
- I don't know the possibilities but i would be interested in data data, diseases from pathogenes, rain (Greece)
- Warnings about local risk, proper pruning as well as proper fertilization (Greece)

RESEARCH:

- I would like to see a graphic representation of all the real data monitoring in the fields/farms (for instance soil moisture and soil EC) as well as the creative maps concerning the SOC and so on (ELGO)
- SOC fluctuations in response to cropping and soil type. (GWTC)

BUSINESS:

- Interesting will be graphics showing soil moisture, biomass, and temperature of the soil.

PUBLIC AUTHORITY:

- Nature strips should be classified in a way which identified their potential for uplift.

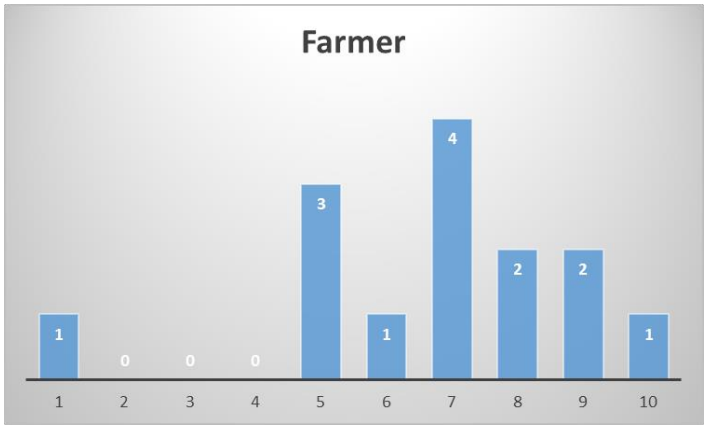
CERTIFICATION BODY:

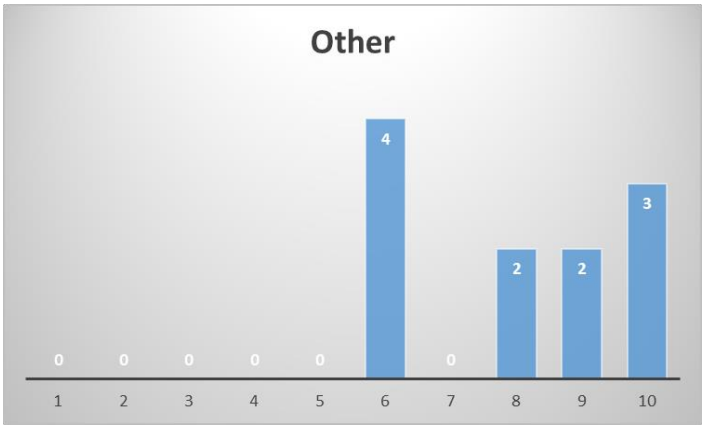
- I would like to use earth observation to predict where soil samples should be taken on an annual basis.

- I would like to have access to monitoring equipment for soil sequestration linked to real time feedback on farms. It would it be really interesting to understand the technical capabilities and specifications of earth observation when supporting Soil Sequestration methodologies.

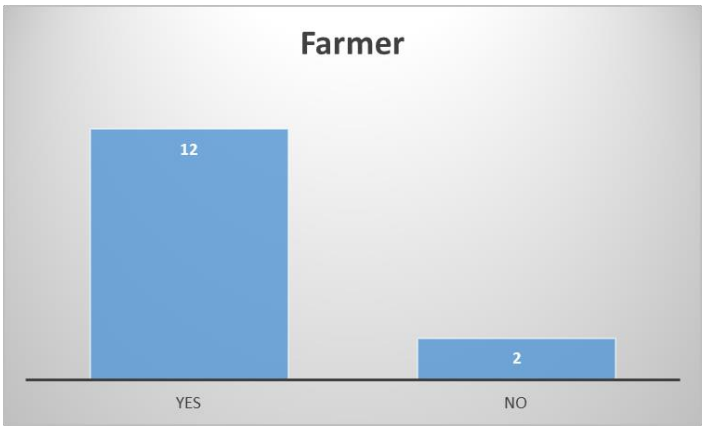
VERIFY

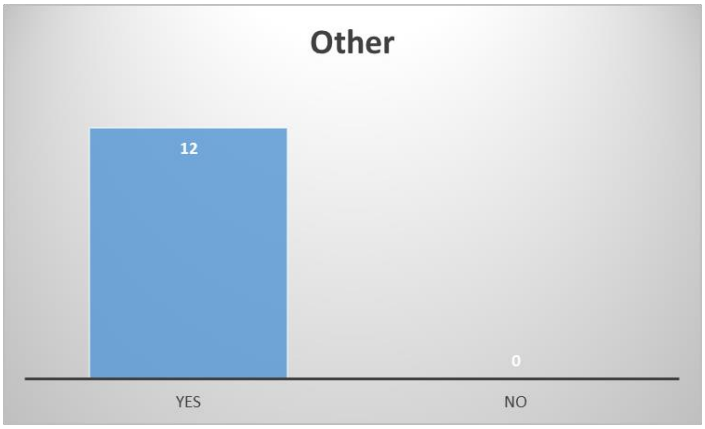
Question 32: How valuable is the information on whether a Reg Agri practice was applied in a field or not? Scale 1-10 (1 not valuable, 10 highly valuable)





Question 33: Would you use this type of information?





Question 34: For what purpose?

FARMER:

- Better information will inform decisions about farm activities;
- We record all field information already, so wouldn't need this information from elsewhere as we already have it;
- For provenance, food branding and assurance schemes;
- Yes, it is a kind of information (Greece).
- for maintaining databases (Greece)
- In order to have more information (Greece)
- Yes (Greece)
- Maintaining histological databases (Greece)

RESEARCH:

- for comparison reasons among the farms (ELGO)
- To help to understand SOC fluxes (GWTC)

NGO:

- Remotes auditing process.
- Important to first come up with a consensual definition of regenerative agriculture in Europe and who will certify and for what purposes (EIT FOOD)

BUSINESS:

- To prove which practice was done as part of reg agri

PUBLIC AUTHORITY:

- Potentially useful for monitoring the delivery of Biodiversity Net Gain when it comes into effect in the UK development planning system eg https://cieem.net/i-am/current-projects/biodiversity-net-gain/.
  It would also be useful to those responsible for monitoring UK agri-environment schemes (Defra)

CERTIFICATION BODY:

- Yes, this may enable remote verification of interventions carried out

Question 35: Would you like to have verification of another Regenerative or Conservation agricultural practice(s) not listed above? Which one(s)?

FARMER:

- tillage depth (plowing), numbers of passes over a field, pestizide application;
- I consider that all these are important (Greece).
- Nevertheless, I am not expert, I CONSIDER THAT ALL THESE ARE IMPORTANT (Greece).
- I consider that all these are important (Greece)
- Yes (Greece)
- I not expert but i consider that all these are important (Greece)Ć
- For us, Regenerative Agriculture includes a whole series or practices that go well beyond the list that is cited here (such as use of cattle and its appropriate management on the land, Keyline design, biofertilizers, microbiota and fungi management, etc). (Farmers association)

RESEARCH:

- Probably information about the chemical fertilization as input at the farm level. (ELGO)
- Addition of other sources of OM e.g Farmyard manure (GWTC)

NGO:

- There are so many practices, within soil, livestock and crop health. How have you chosen the ones above and why?

BUSINESS:

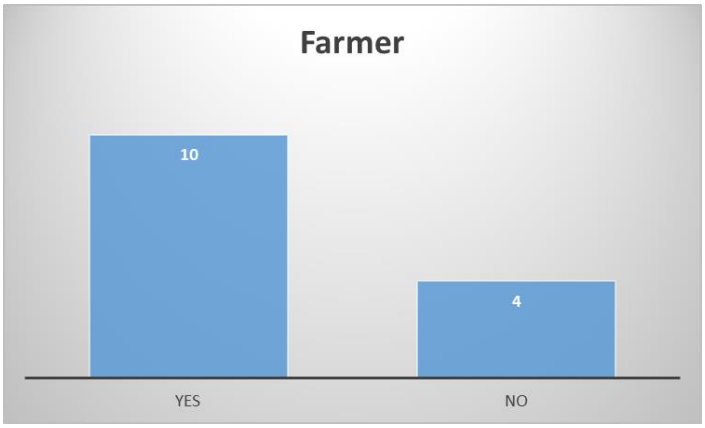
- Variable Rate Application

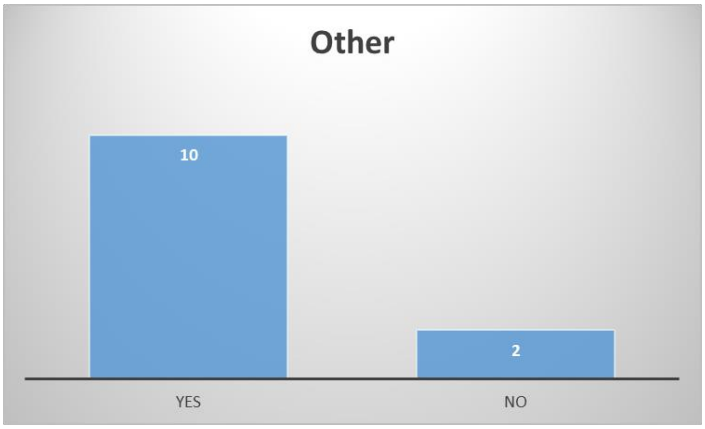
PUBLIC AUTHORITY:

- To identify if fertiliser is likely to have been applied to grassland.

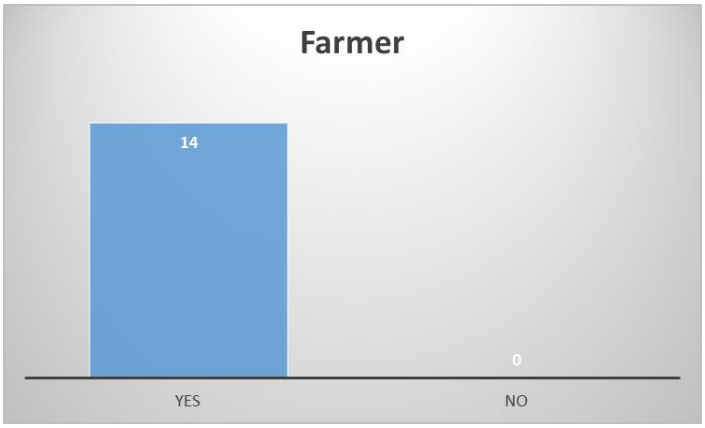
CERTIFICATION BODY:

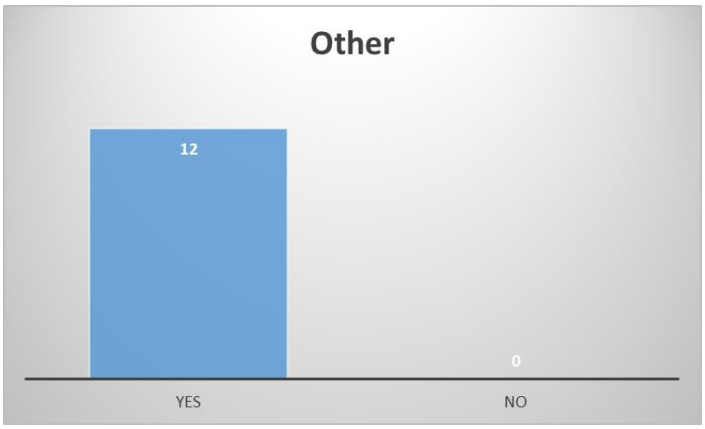
- YES, we would like to work with farmers and LEAF/consortium to identify any further practices to write into methodology. This will enable more carbon credits to be generated.





Question 36: Are you interested in being able to see a time series of satellite images and vegetation indices (e.g. NDVI) and data analytics (e.g. graph of changes of NDVI during time) in order to see the vegetation dynamics in a field?





Question 37: Why? How would you like the images and data to be presented and what analytics would be useful?

FARMER:

- We have such information provided by the hail insurance company in Austria, I did not find it very usefull, therefore I would like to see, what you are providing;
- To inform decisions about farm improvements.
- NDVI related back to yield and a series of time dated maps;
- I don't know what possibilities are there, but i would like the application to be friendly to user (Greece)
- I don't know exactly which could be the possible applications of these. (Greece)
- We would be interested in this information once it has been interpreted and made relevant to the activity being developed and the health of crops (eg. hydric stress, health situation, lack of minerals...). (Farmers association)

RESEARCH:

- It will be very interesting for comparison reasons (for instance to check applied pruning or estimate the yield). In addition, we can compare the NDVI index from satellite images with in-site measurements (using Leaf Spectrometer) to define appropriate correlations (between satellite images and measurements in fields) regarding the water stress of trees. (ELGO)
- Useful to see how crop canopy density varies with SOC. (GWTC)

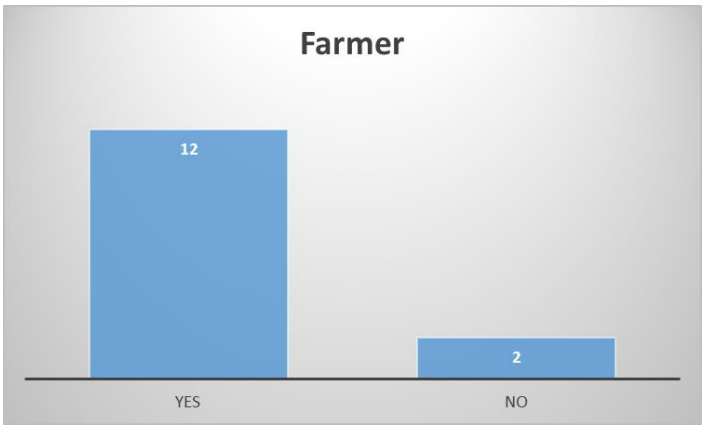
BUSINESS:

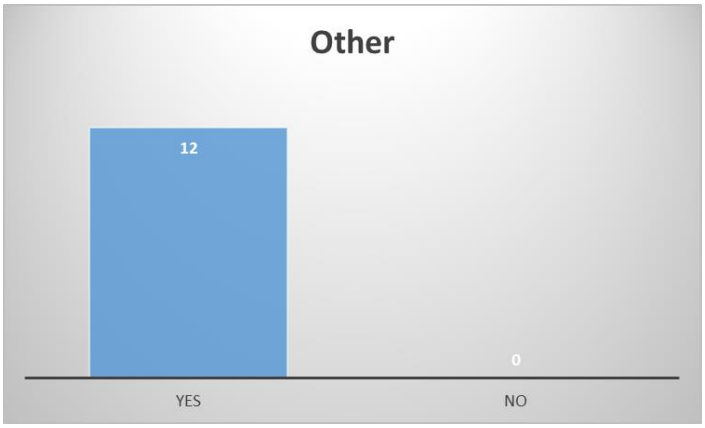
- To confirm activities for e.g. growing cover crop, Dynamics increasing biomass in line graphs. Images of biomass on surface.

CERTIFICATION BODY:

- YES, this will help with further research into methodologies and reporting

Question 38: Is the above presented concept of information appropriate for you (e.g. In Field X, during 2020, application of cover crop is verified/not verified/uncertain)?





Question 39: If NO, please describe what information would be more appropriate for you related to monitoring of application of Reg Agri practices

FARMER:

- as a farmer these services do not concern me;
- We feel it is insufficient and inaccurate, not representative of the practices carried out being truly regenerative as we understand them. (Farmers association)

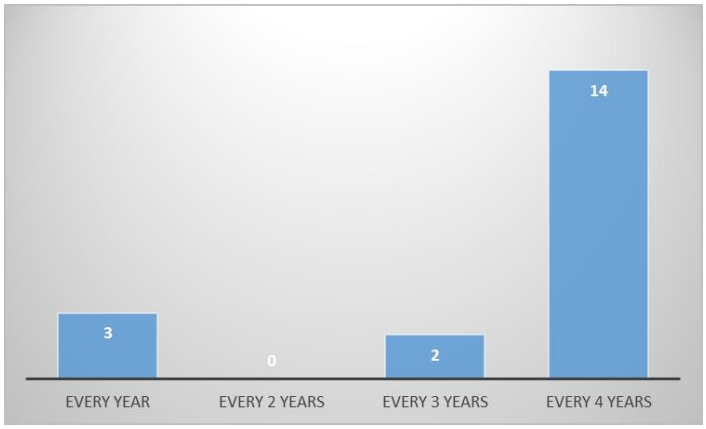
3.2 Support service related survey

In this survey, 20 farmers from three AgriCapture use cases (Farrington Oils – UK, ELGO – Greece, UPOR – Serbia and SatAgro - Poland) provided their feedback. For each question, graphs represent the number of farmers agreeing with the offered option. Furthermore, for each textual answer or comment (if provided), the use case origin is presented.

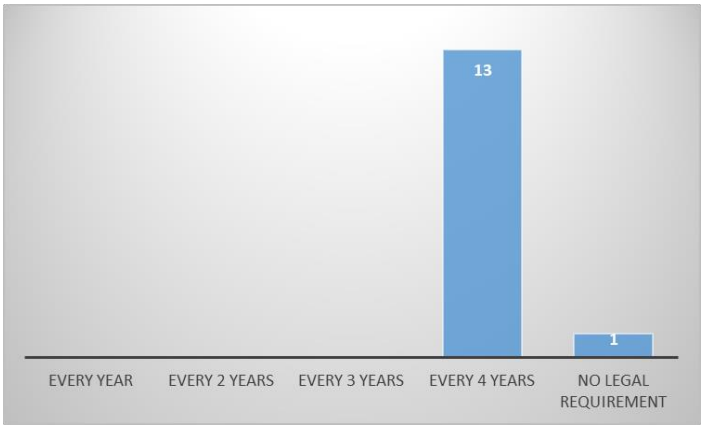
Soil management module - Supporting Variable Rate Application of fertilizers based on satellite and in situ data (when in situ related to agri chemistry is available). This service would enable farmers to track changes in their crop field's soil chemistry between different parts of the field and over time, both standard micro and macro elements and soil carbon, and enable them to create VRAs based on the data.

How often do you perform soil chemistry tests on your farm?

UK Farrington Oils: Magnessium, occasionally do full Albrecht soil analysis



What is the legal requirement in terms of testing frequency?

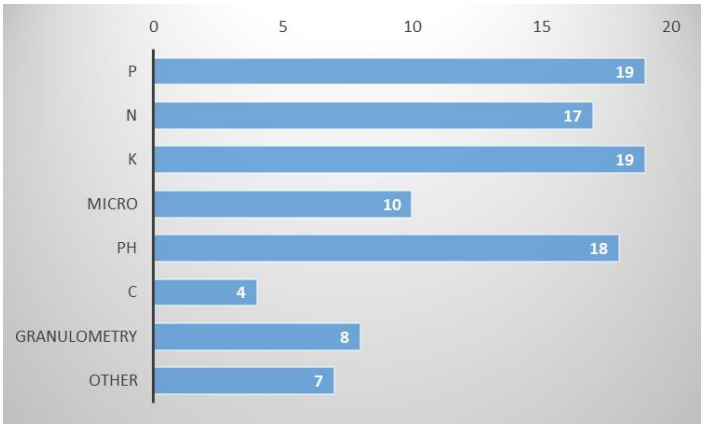


What are the soil properties that you test for?

ELGO: Organic matter

UPOR: Humus and calcium carbonate content

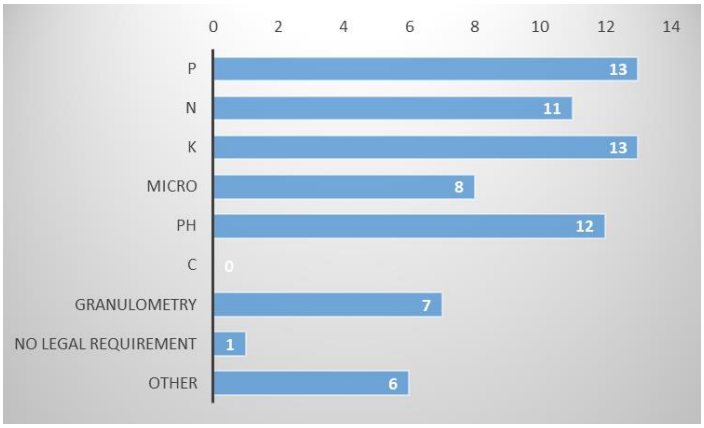
SatAgro: Calcium, Sulphur



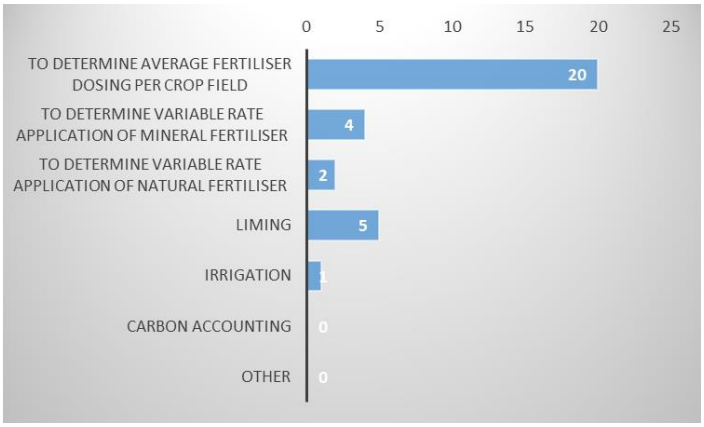
What is the legal requirement in terms of testing scope (soil parameters)?

ELGO**:** Organic matter

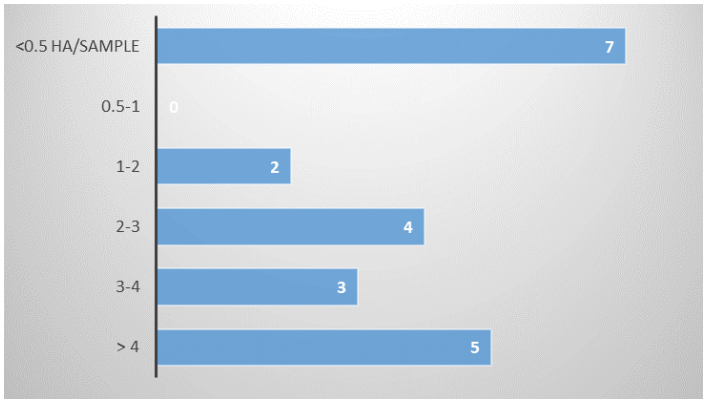
UPOR**:** Humus and calcium carbonate content



How do you utilise soil data in your operations?

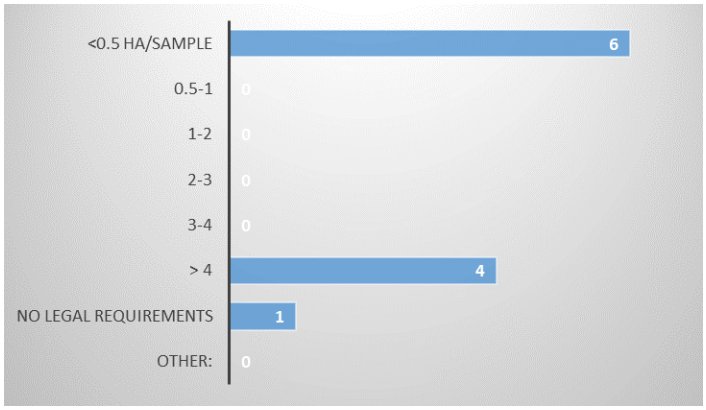


What is the sampling density at your farm?



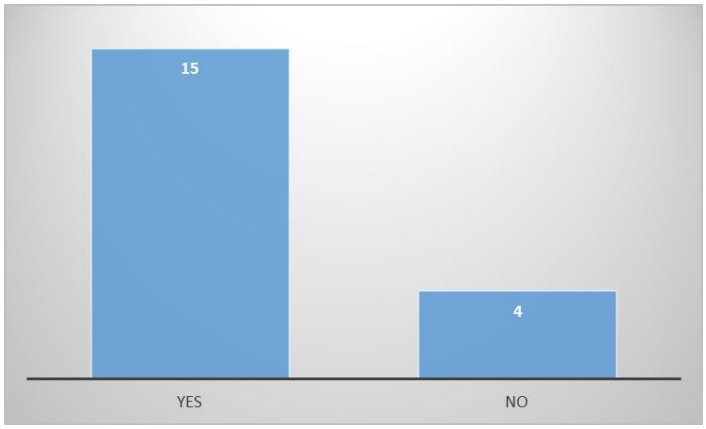
What is the legal requirement for sampling density?

- No legal requirement, for lime it is several samples per field. For general tests it is one or two per field

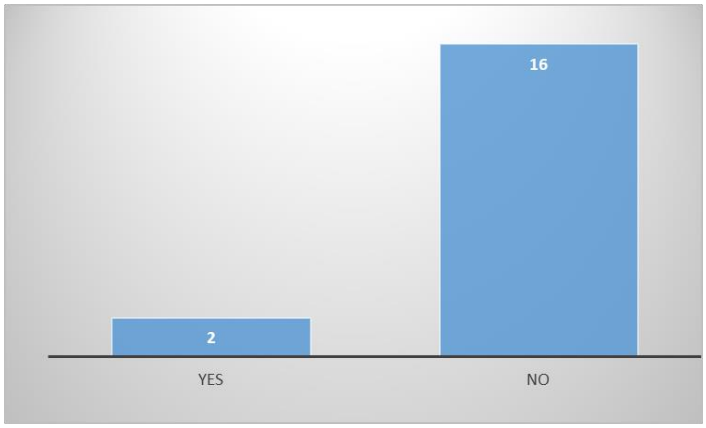


Are your sampling zones regular? If not, please write down how are they determined?

UK Farrington Oils**:** Walk W pattern across field to get a good average. If different soils types in same field will look at each area



When sampling your soil in subsequent years, do you use the same sampling locations?



How do you currently store information about your soil chemistry? E.g. pdf reports, software (please name) etc.

UK Farrington Oils**:** hard copy and spreadsheet

ELGO:

- I store them in written forms or in excel files

- I store them in written forms
- Written forms
- I store them in written forms or in excel files
- I use written forms
- In written forms

UPOR**:**

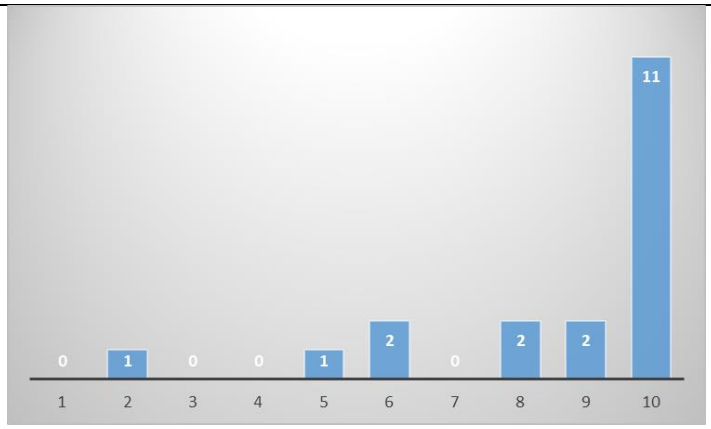
- I do not keep
- Analog format – paper
- PDF format
- I have data for analyzes done in 2012, so from 2014-2021
- PDF
- .doc file
- Reports
- Print reports
- PDF, print reports

SatAgro:

- PDF, excel, shapefile
- pdf reports, Excel reports, Shapefile created in QGIS

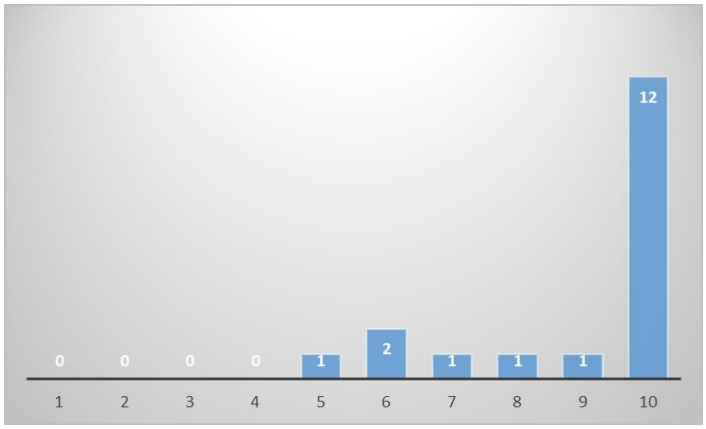
How valuable would information on changes to your soil chemistry in an interactive dashboard be to you? Scale 1-10 (1 - not valuable, 10 - highly valuable)

UK Farrington Oils: interesting, but would need to invest in precision farming for it to become useful



How valuable would seeing a dynamic comparison of soil chemistry over time be to you? Scale 1-10 (1 - not valuable, 10 - highly valuable)

UK Farrington Oils: This is more useful as it would show trend of how farming practices affect the soil over time



Are there any tools / functions which you would like to use, but for whatever reason not able to at the moment?

UK Farrington Oils: Probably lots such as soil biology, nitrogen content, leaf tissue analysis. We need to understand benefits of each tool commercially before investing in it.

ELGO:

- I do not know any tools or functions but I am interested to know about them

UPOR:

- Maybe
- Soil sampling machine, variable sowing and fertilization.
- Hydraulically driven sampler
- Basically, I save and process all the data in Excel spreadsheets, so I have no idea at the moment which tool I would currently be missing.
- Hydraulically driven sampler
- contactless land scanner, determination of EC zones on the parcels

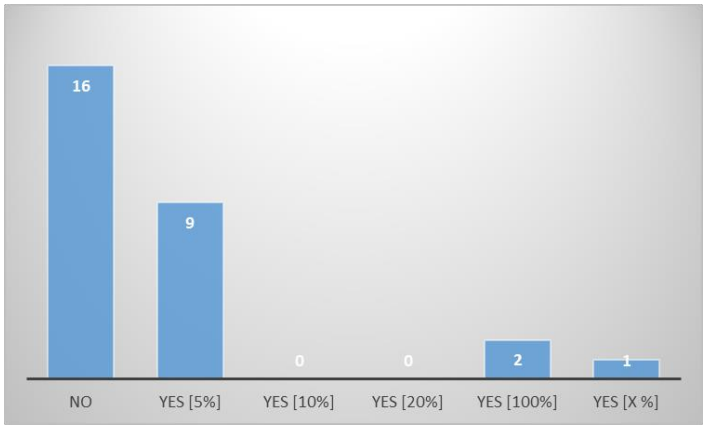
SatAgro:

- If budget were no issue, I would like to do more precise lab tests (in Polish they are called vegetable tests). Due to budget constraints I do not do them too often, other than for sugar beets.
- Creating and viewing soil chemistry maps and interactive dashboard on the phone in the field – geolocation

Nature strips on low profitability field zones - Identification of field zones where crop cultivation is unprofitable to be converted in Carbon sequestration plant communities (trees and shrubs).This service would enable farmers to delineate areas of their crop fields where crop profitability is lower and carbon capturing plant communities ("nature strips") could be considered. This tool would be integrated with the services described in the Exploration package and present users with an estimation of the impact of these interventions and potential savings/profits from carbon credits.

Have you taken parts of your land out of cultivation within the last 5 years? If yes, please estimate the percentage.

UK Farrington Oils: 3%



If you have taken any land out of cultivation, or just considered to do so, which is / would be the resulting land type?

UK Farrington Oils: Arable combinable crops land

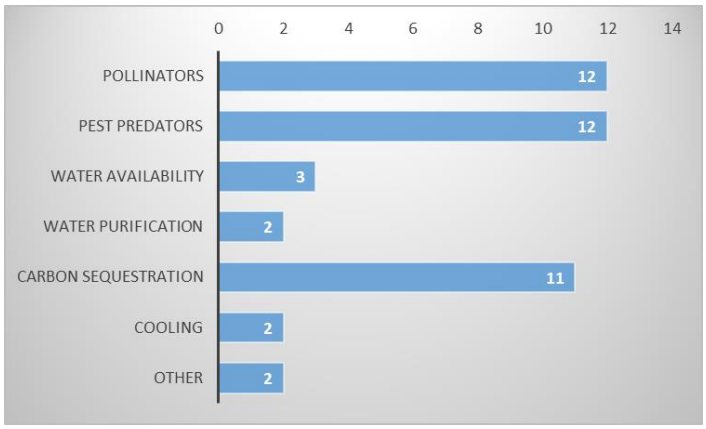
UPOR: Fruit trees

SatAgro: forestry or long-term legumes

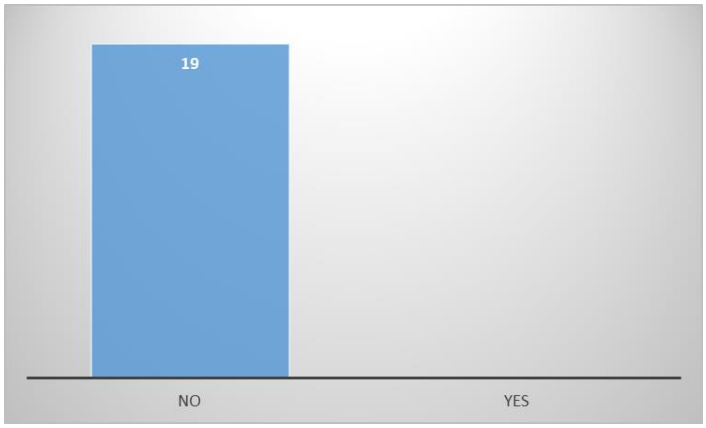
In your opinion, which ecological services are supported when land is taken out of cultivation?

UK Farrington Oils: Farm woodland and hedgerows add to landscape enhancement, timber production as well as above

UPOR: the problem of breeding wild boars and their damage to crops



Have you ever used software to map land quality and profitability when making the decision to transfer? If YES, please write the name of the software and any comments its advantages and disadvantages.



In your opinion, which factors should be considered before deciding which parts of land should be taken out of cultivation?

UK Farrington Oils: Field shape, shaded areas adjacent to woodland, poor soils, areas attacked by pests such as rabbits, poorly drained areas, steep slopes, adjacent to watercourses

ELGO: unprofitable parts of land, peripheral parts of the field so as not to create a problem

UPOR:

- Financially
- There is strong opposition among farmers, they want to cultivate all land
- Chemical analysis and individual physical characteristics
- Mechanical composition of land, a type based on parcel
- Negative profit on that part of the land

SatAgro:

- primarily profitability, also water resources

Please determine the amount of annual compensation per hectare which would make you decide to keep land out of cultivation. Also please specify the type of cultivation this case applies to.

UK Farrington Oils: Value to be at least comparable to income off average wheat crop output plus any amount for additional management required

UPOR:

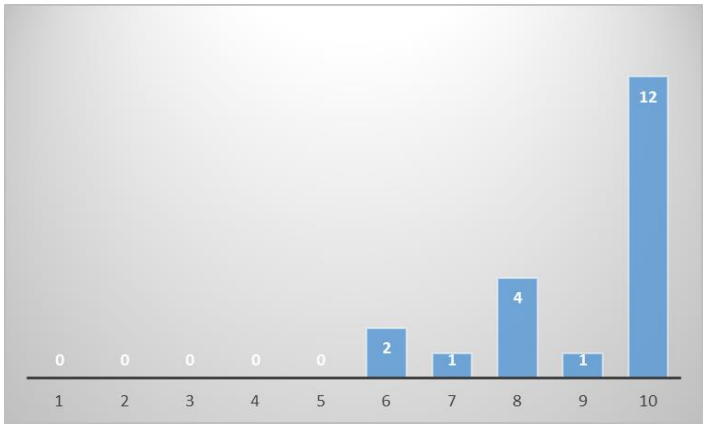
- € 500/ha, which is the minimum amount I earn from wheat crops
- Does not exist in Serbia but at least 250 EUR / ha with an increase with the increase of different plant species
- 700 eur/ha

SatAgro:

- more than the profits available through normal cultivation
- 500 eur/ha

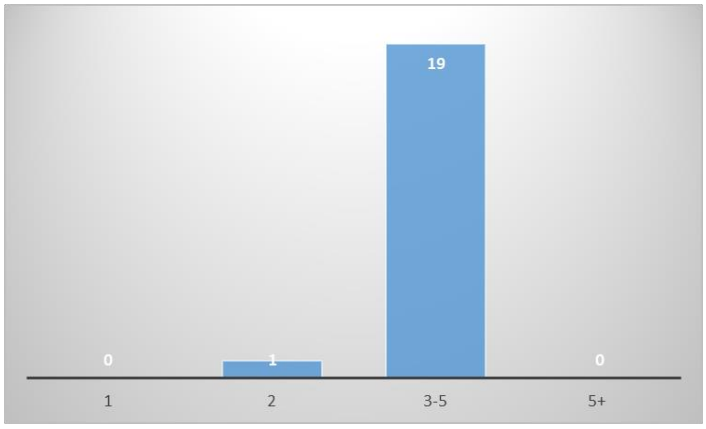
How valuable would information on spatial variability of land quality and profitability in your crop fields be to you? Scale 1-10 (1 - not valuable, 10 - highly valuable)

UK Farrington Oils: 7, but we can get an idea of this from combining yield mapping data



How many growing seasons of profitability data should be included in the analysis for you to have confidence in the results (a map of areas designated as unprofitable) of such a tool?

UK Farrington Oils: 3-5 farmers will know which parts of fields to use, but this data will help advisers who do not know the land



How big does an area of low profitability land have to be for you to consider subdividing it out of your field? Input number in hectares.

UK Farrington Oils:

Depends, if it is an awkward corner or strip next to water course it can be very small (0.1ha) as it will make rest of field operations more efficient. If it is area within field it will need to be big enough or of the right shape to fit with machinery. Width and shape is more crucial than area e.g. 4-6m to fit cultivator, 24m to fit sprayer

UPOR:

- 10
- 0.5 ha
- 10
- depends on the analysis
- 2ha

SatAgro:

- min 1ha

Are you aware of payment schemes other than carbon-related that you think could help reward farmers for designating nature strips?

UK Farrington Oils: Yes, currently in Countryside Stewardship scheme, this will move to Environmental Land Management scheme in future

ELGO:

- I don't know
- No I do not
- No I do not
- I do not know
- No I do not

UPOR:

- No
- No
- No
- No
- Some old examples in Germany

SatAgro:

- There are EU-CAP and national programs that incentivise agroforestry and leaving land fallow for a couple seasons

Have you converted any natural land into arable land in the last 5 years? If yes, could you share your motivation, and if your expectations have been met?

UK Farrington Oils: No

ELGO:

- No
- No
- No
- No
- No
- No

UPOR:

- No
- No
- No

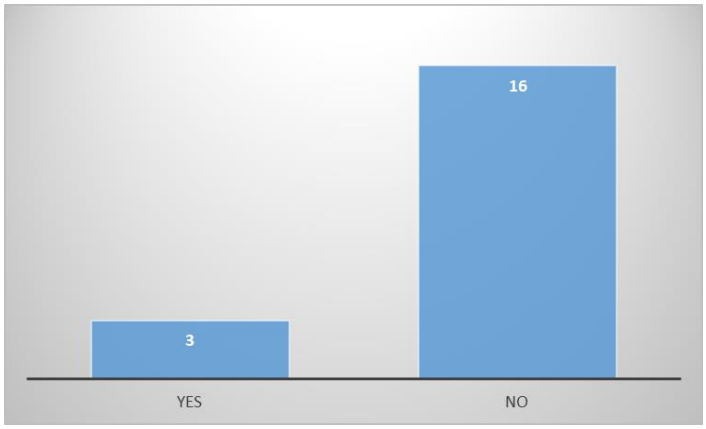
SatAgro:

- No, because turning land from permanent grasslands into cropland is connected to limited EU CAP payments

Integration of data from soil moisture sensors - Connecting farmer-owned soil moisture sensors to farm management application, displaying sensor time series data on a map and on a graph, along precipitation and temperature data. Also, farmers are able to filter measurements by sensor ID, date and time.

Do you use soil moisture sensors?

UPOR: I use data from the AgroSens application and data from fieldclimate.com where PSS loads data from their sensors located near my parcels



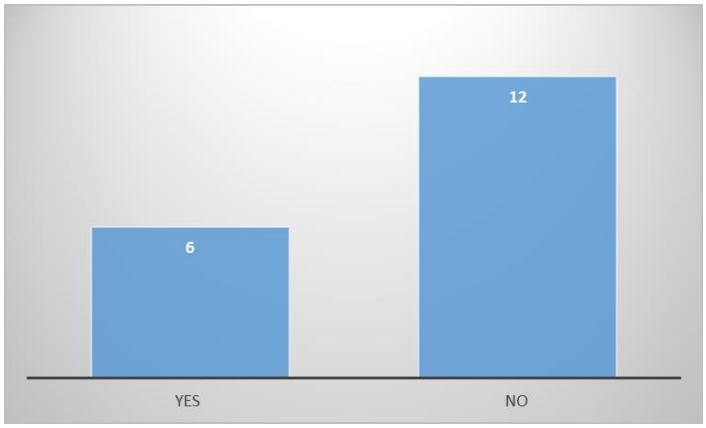
Do you use any other sensors?

UPOR:

- Penetrometer for measure soil compaction
- N Tester and NDVI for nitrogen application on crops
- NDVI GreenSeeker

SatAgro:

- weather station, supplementary air/soil temperature sensors at height/depth 5 cm, 0 cm -5 cm
- Relative humidity, air temperature, wind speed, precipitation, insolation, dew point, vapor press deficit, daily ETo



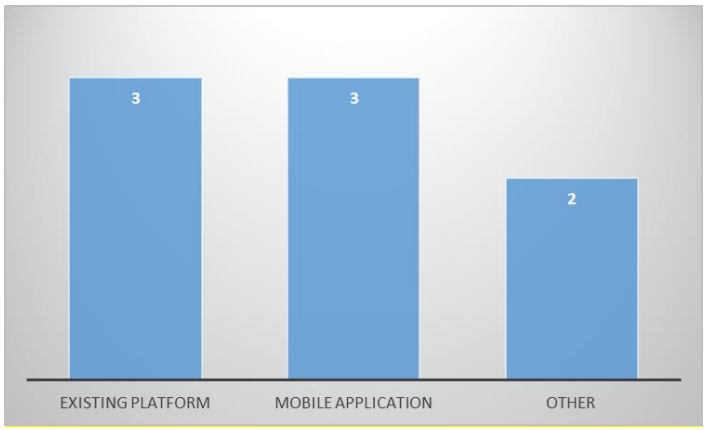
How do you manage sensor data?

UPOR:

- Mark with a marker on the parcel
- Simple table because mobile app doesn't work anymore

SatAgro:

- fieldclimate metos, SatAgro



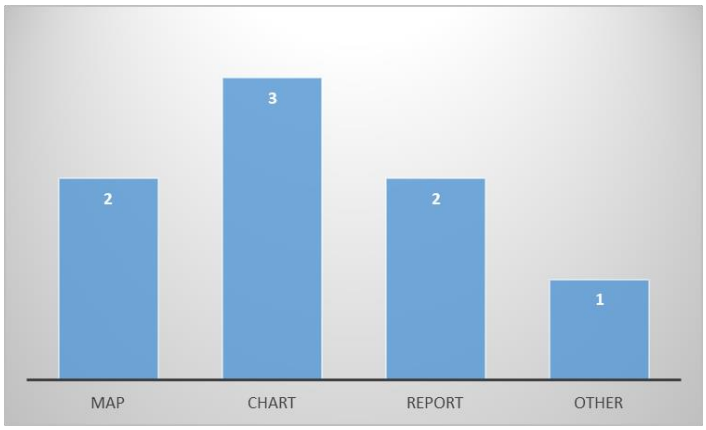
How do you visualize data from sensors?

UPOR:

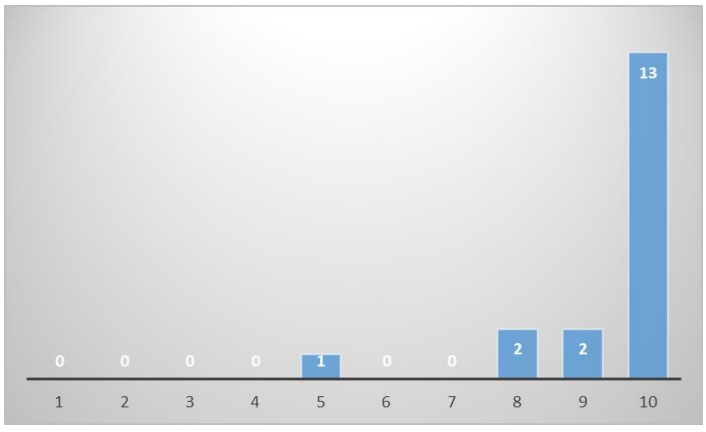
- mostly on my parcels I know which part is which

SatAgro:

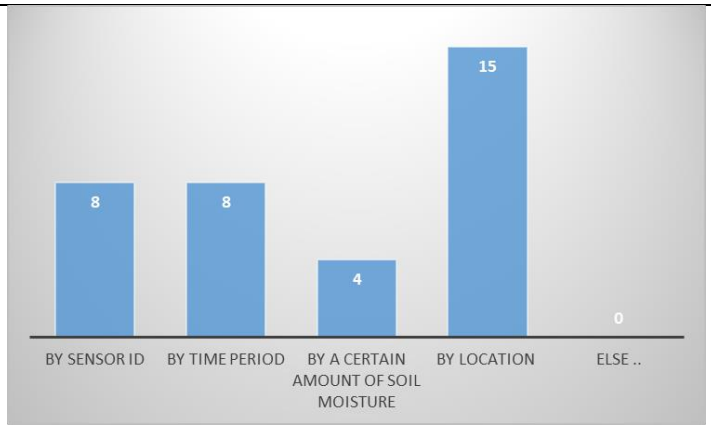
- Export excela



Would you like to be able to see the real time and historical measurements from your sensors in web/mobile application along the data on temperature and precipitation and weather forecast? Scale 1-10 (1 - not valuable, 10 - highly valuable)

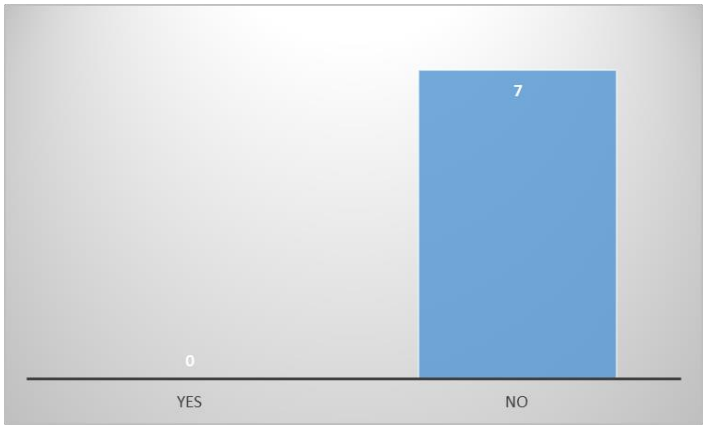


If you would like to find a certain data from your sensors, what the filtering criteria would be:

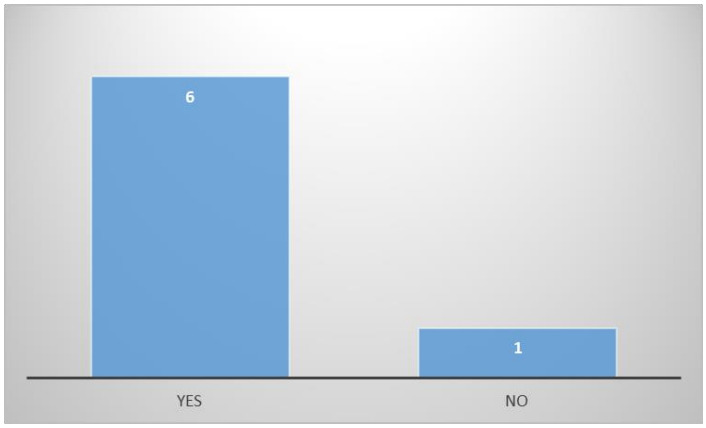


Precision agriculture for resource efficiency in olive production - The service will provide: (i) when is optimal time for irrigation and quantity of water needed, (ii) when is optimal time to prune, (iii) when to mow cover crops. The purpose is to minimize water use. This service would enable farmers useful information for water conservation. Soil moisture will be measured by soil sensors. Meteo forecast data will be used to calculate when irrigation is needed, and in what quantities (i.e. water use rate – expected precipitation), and when pruning/cover crop mowing should take place to minimise plant transpiration in the farming system.

Have you ever used software to map and accurately monitor olive crops in terms of the optimal time for irrigation, pruning, and harvesting? If YES, please write the name of the software and any comments its advantages and disadvantages.

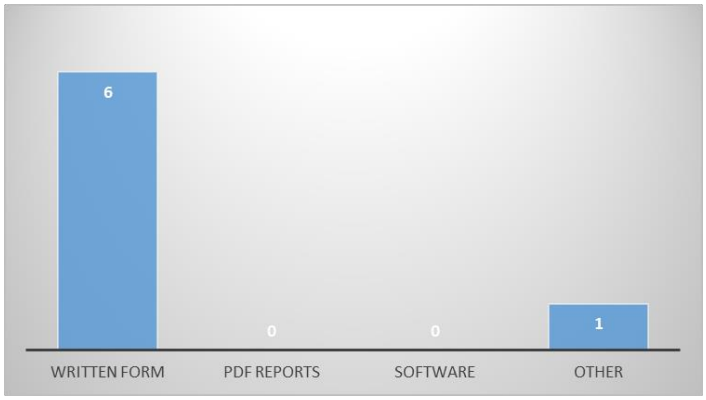


Do you want to be able to record and store the data on the time and amount of irrigation, pruning and mowing through this service?



How do you store data on irrigation, pruning, and mowing dates?

ELGO: In excel files



How do you determine the optimal time for irrigation? What parameters affect it?

ELGO:

- I take the advice of Agronomist consultant and meteorological data
- I take the advice of Agronomist consultant and meteorological data
- No irrigated fields during last years due to water shortage
- I take the advice of Agronomist consultant and meteorological data

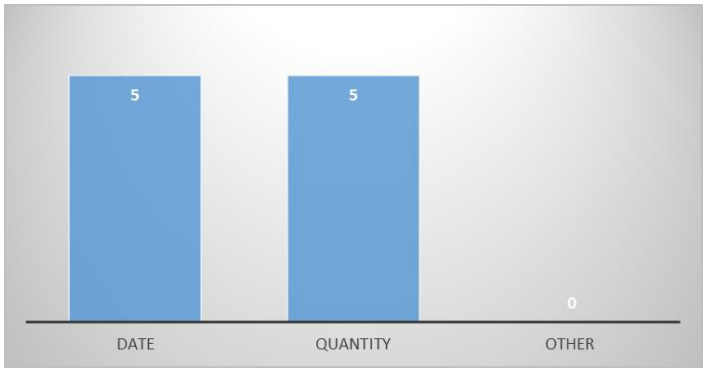
- I am taking the advice of Agronomist consultant and meteorological data
- N/A because of no irrigated fields

How do you determine how much water is needed? What parameters/information do you use for this?

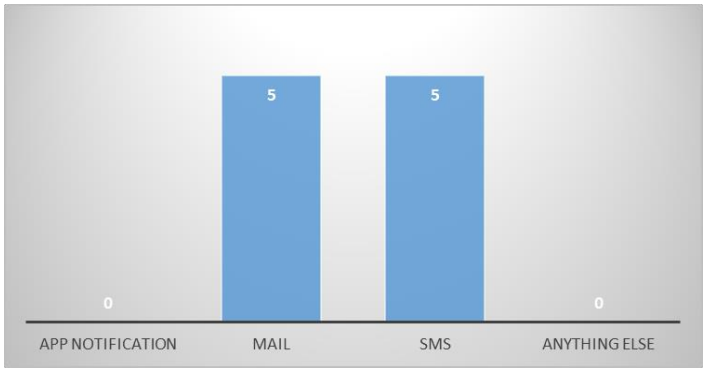
ELGO:

- I am not sure how much water is needed
- Agronomist consultant, meteorological data

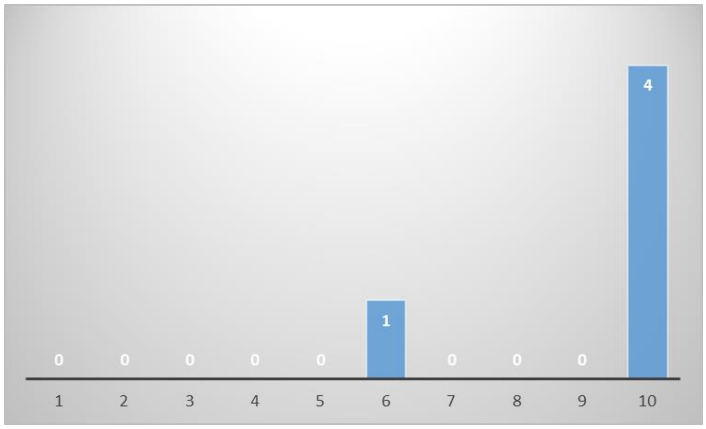
What kind of irrigation data do you want to get?



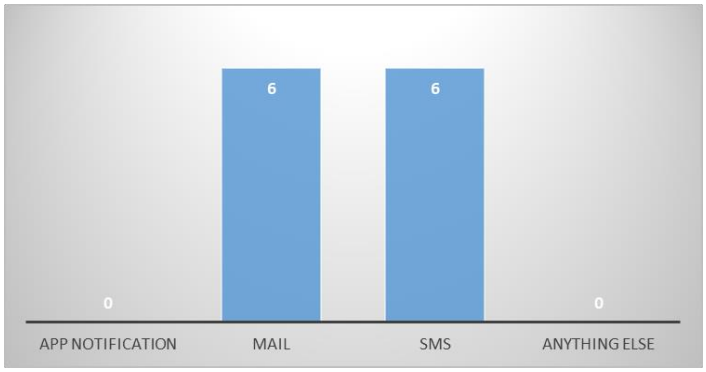
How would you like to get the information on the optimal time for irrigation?



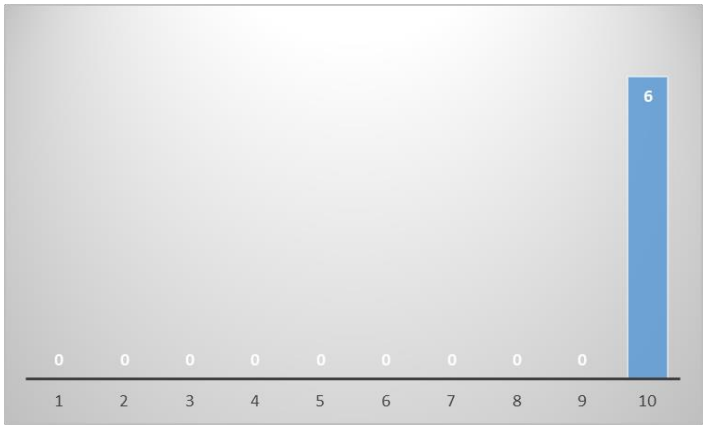
How valuable information on the optimal time for irrigation? Scale 1-10 (1 - not valuable, 10 - highly valuable)



How would you like to get the information on the optimal pruning time?



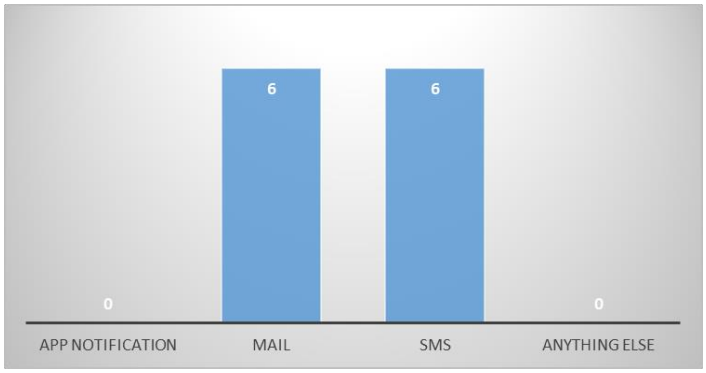
How valuable is the optimal pruning time information? Scale 1-10 (1 - not valuable, 10 - highly valuable)



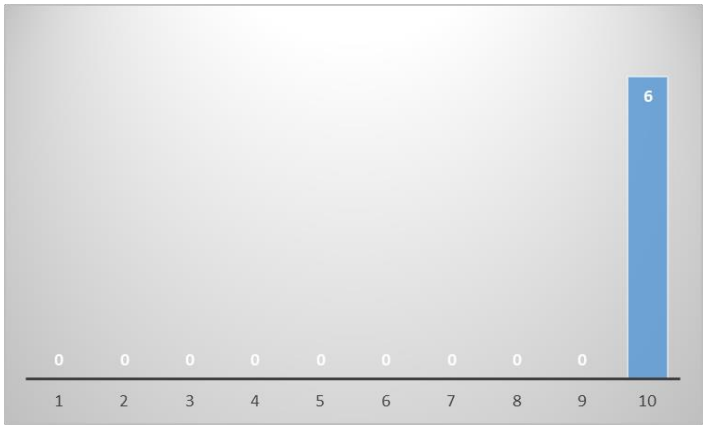
How do you determine the optimal mowing cover crops time? What parameters affect it?

N/A

How would you like to get the information on when is the time for mowing cover crops?

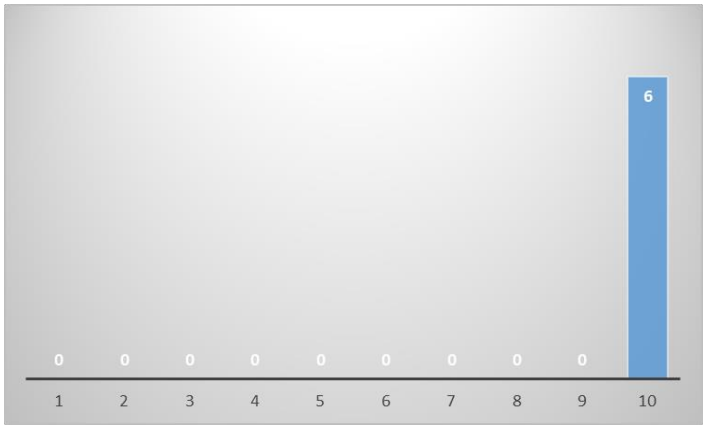


How valuable is the information on when is the optimal mowing time for cover crops? Scale 1-10 (1 - not valuable, 10 - highly valuable)



How valuable would it be to you to be able to see dynamic comparison irrigation, pruning, and mowing over time? Scale 1-10 (1 - not valuable, 10 - highly valuable) Which parameters would you compare?

ELGO: Costs and Energy consumption



Are there any tools / functions which you would like to use, but for whatever reason not able to at the moment?

N/A

Alerts for pathogen risks – Service will provide real time information related to risks for specific areas. This service would provide farmers with warnings information relating to each use case in terms of temperature, air moisture, seasonal meteo trends, time in the season, and etc. in real-time. The alerts rely on time series, meteo data, soil sensors, NDVI index.

Which pathogens (diseases, pests…) are common in your fields?

UK Farrington Oils:

Pests: Cabbage stem flea beetle, aphids, slugs, orange blossom midge, pea and bean weevil, pigeons

Disease: Septoria, rust, mildew, sclerotinia, chocolate spot

ELGO: Bactrocera (Dacus) oleae and Prays oleae

UPOR:

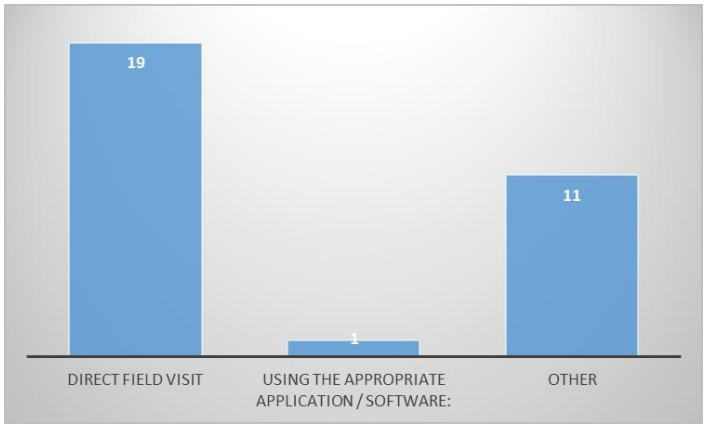
- Wild boars, mice, badgers
- Diseases of wheat and bean leaves: powdery mildew, powdery mildew, rust, fusarium, Lema insects, lice, etc.
- Apple scabs (*Venturia inaequalis*), codling moth (*Cydia pomonella*)
- Wheat diseases, corn pests
- Click beetle (*Elateridae spp.*), fusarium head blight (*Fusarium spp.*), leaf rust (*Puccinia triticina*)

How do you track the potential problems in the fields?

ELGO: I am taking the option of Agronomist consultants

UPOR:

- PSS SMS messages with information and warnings
- In some cases, setting traps
- Checking for the presence of pathogens in the laboratory and monitoring traps
- A warning issued by the PISG (Plant Protection Forecasting Service) for my region



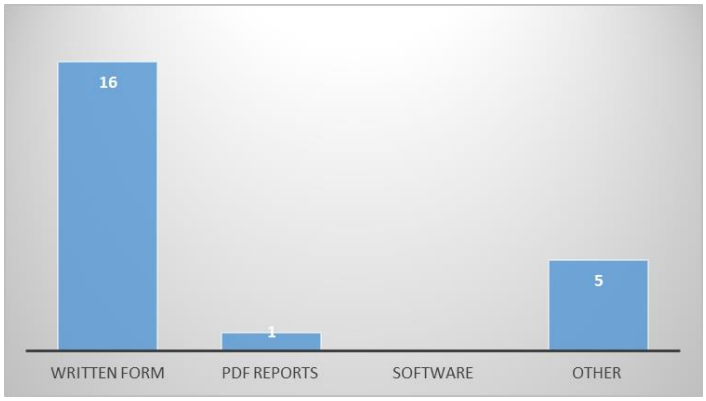
How do you store the data on previous risks in the field?

UK Farrington Oils: Advice from agronomist who will also use local data

ELGO: Excel files

UPOR:

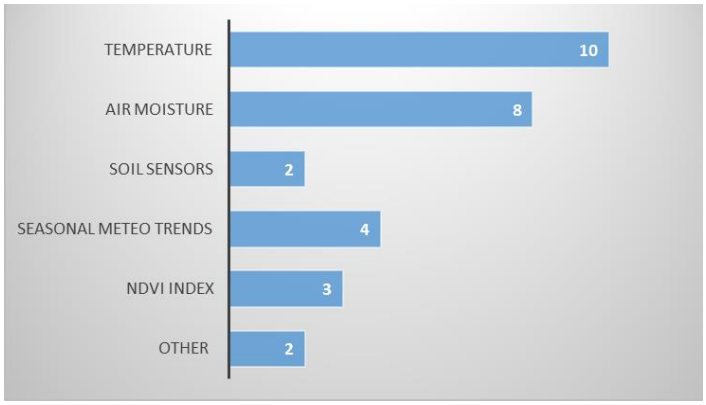
- Excel tables
- I do not store it



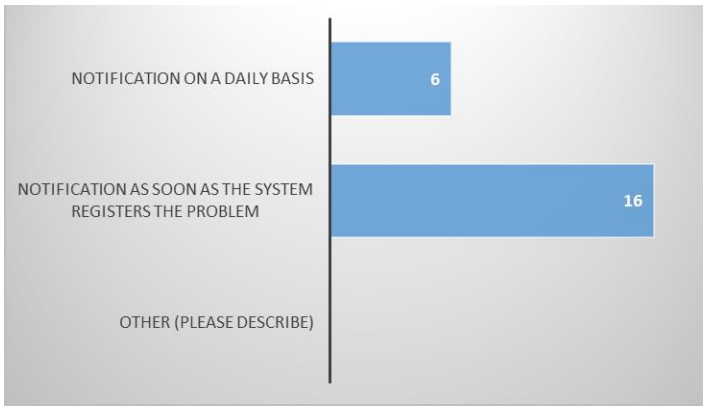
Which parameters in the field are monitored to identify the risk of pathogen occurrence?

UK Farrington Oils: Advice from agronomist who will be using data to monitor parameters

UPOR: Changes in plants



How would you like to receive information on potential pathogen occurrence?



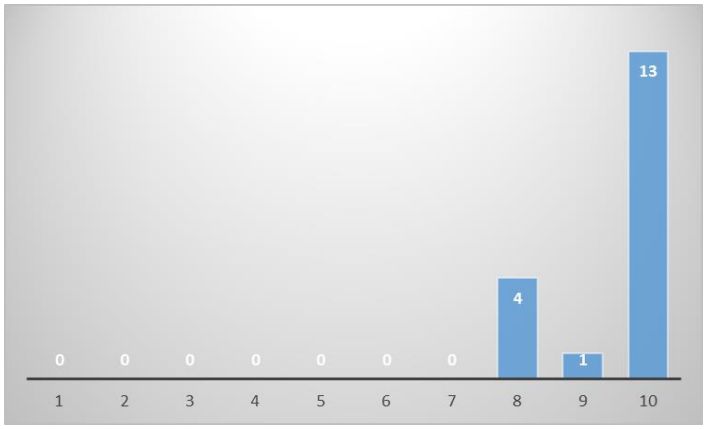
When should you get the information at the latest?

ELGO: the sooner as possible

UPOR:

- One day earlier
- 24h
- Report at least twice a week
- If I get it on a daily basis, it is also expected to get a forecast for the next period of occurrence
- immediately before treatment, at least 2-3 days earlier as an expected problem
- While it is possible to react in a timely manner

How useful would it be for you to be notified that there is a potential problem in the field? Scale 1-10 (1 - not valuable, 10 - highly valuable)



4 AgriCapture End-Users

Based on an initial analysis of the tools and the results of the survey, we have compiled a list of end-users and how they would make use of the variety of AgriCapture services.

	Usability of AgriCapture services
Farmer	**Quantify**: Farmer checks on pan-European SOC stock map the current status of his fields and optimal locations for soil sampling in order to get the most accurate SOC estimation **Explore**: Farmer wants to know how much carbon credits from SOC sequestration will be able to generate if he adopts practice(s) of Regenerative Agriculture. He will be informed on how much he can potentially earn by selling carbon credits but also how much he can save on reducing fuel consumption and application of fertilizers and chemicals. **Support**: Farmer will use the functionalities of crop monitoring and farm management web/mobile application to optimize the crop production. In addition to the standard crop monitoring tools, the farmers will be able to: 1) connect their soil moisture sensors with the application and monitor the values in real time thus optimizing the water consumption while irrigating, 2) receive soil management maps needed for precision agriculture, 3) find out which areas of the farm will be more profitable if turned into natural areas, 4) receive up-to-date information on the potential disease and pest risk.
Project developer	**Quantify**: Project developer uses the data provided by the service for project planning and designing a Project Design Document (PDD).

	Project developer monitors project according to the monitoring plan and uses the data from the service to prepare reports for verification. **Explore**: Project developer uses the data provided by the service for project planning and designing a Project Design Document (PDD). **Verify**: Project developer uses the data provided by the service for project planning and designing a Project Design Document (PDD). Project developer monitors project according to the monitoring plan and uses the data from the service to prepare reports for verification.
Auditor (Validation and Verification Body-VVB)	**Quantify**: VVB uses the data provided by the service for assessment of the PDD (validation that the project is in line with the standard requirements). VVB uses the data provided by the service to assesses GHG emission reductions or removals in accordance with Carbon offset standard rules and provides verification report. **Verify**: VVB uses the data provided by the service for assessment of the PDD (validation that the project is in line with the standard requirements). VVB uses the data provided by the service to assesses GHG emission reductions or removals in accordance with Carbon offset standard rules and provides verification report.
NGOs and researchers	**Quantify**: Environmental and Climate Change NGOs and researchers will use the services to explore the high resolution SOC stock data across Europe for their projects. **Explore**: Environmental and Climate Change NGOs will use the predictions of the potential for SOC sequestration as well as the effects on farm economy from the service to

	promote transfer from conventional land management and industrial agriculture to Regenerative Agriculture. **Verify**: Environmental and Climate Change NGOs and researchers will use the service for their projects (e.g. Reg Agri, agroecology, …) and to monitor/verify the implementation and results.
Public authorities	**Quantify**: Public authorities (government bodies) at various levels will use the services to explore the high resolution SOC stock data for their projects and reporting. **Explore**: Public authorities (government bodies) at various levels will use the services to explore the high resolution SOC stock data for their projects (e.g. promoting agroecology). **Verify**: Public authorities (government bodies) at various levels will use the service for their projects (e.g. Reg Agri, agroecology, …) and to monitor/verify the results.

5 User requirements

Based on the results of the survey presented in chapter 3, we have compiled, sorted and analysed data to identify user requirements for the different AgriCapture services.

5.1 Explore

#	Requirement	Usability
E-1	The user wants to receive information on how much SOC can be sequestered per ha per year on a particular agricultural field dependent on the agriculture practice(s) applied	High
E-2	The user wants to receive information on how much carbon credits can be generated on a particular agricultural field dependent on the agriculture practice(s) applied	High
E-3	The user wants to receive information on how much cost savings can be achieved annually on reduction in fuel consumption and fertilizers application dependent on the agriculture practice(s) applied	High

5.2 Support service

#	Requirement	Usability
Integration of data from soil moisture sensors		
S-1	The user wants to connect his soil moisture sensors installed with web/mobile application	High
S-2	The user wants to visualise and inspect the real time and historical data from sensors	High

	through the web/mobile application graphically (i.e. using maps, charts, reports)	
S-3	The user wants to filter the data from the sensors by multiple criteria (i.e. by sensor ID, by time period, by a certain amount of soil moisture, by geographical location)	High
Precision agriculture for resource efficiency in olive production		
S-4	The user wants to record and store the data on the time and amount of irrigation, pruning and mowing through this service	High in the Mediterranean Otherwise, Low
S-5	The user wants to get the information on the optimal irrigation date and quantity, when to prune, when to mow cover crops for the olive fields	High in the Mediterranean Otherwise, Low
Alerts for pathogen risks		
S-6	The user wants to get alerts (notifications) for local pathogen risks on fields as soon as the system registers the problem.	Moderate
Soil management module		
S-7	The user wants to see the number, acreage and course of the boundaries of the soil sampling (management / productivity) zones within his fields.	Moderate-High
S-8	The user wants to export the zones in a GSP compatible format to be used for soil sampling	Moderate-High
Nature strips on low profitability field zones		
S-9	The user wants to get multiannual (several growth seasons) information on spatial variability of land quality and profitability in a chosen field (parcel)	Moderate-High

S-10	The user wants to get information on a map for a chosen field (parcel) which area of the field should be kept out of cultivation	Moderate-High

5.3 Quantification and Verify

User requirements related to Quantify and Verify arise from the Carbon Credits generation methodologies approved by Verra, Gold Standard and PlanVivo. When AgriCapture methodology is defined, the requirements will be appropriately supplemented to reflect the needs of the methodology.

The current methodologies applicable for agriculture:

- VCS (Verra) methodologies: VM0042, VM0021
- Gold Standard methodologies: GS SOC Framework Methodology, GS SOC Improved tillage
- PlanVivo methodology: PV SHAMBA

#	Requirement	Usability
Applicability conditions – VERIFY		
QV-1	Determination of the project unit (field) historical status (cropland/grassland)	**VM0042:** Project activities must be implemented on land that is either cropland or grassland at the project start date and remains cropland or grassland throughout the project crediting period (i.e., land use change is not eligible, including conversion from cropland to grassland and grassland to cropland) **VM0021:** As of the project start date all of the project area consists of grasslands or croplands. **GS SOC Framework Methodology**: Managed cropping systems (e.g. single crop or crop rotation) must have been in

		place for at least 5 years prior to project implementation **GS SOC Improved tillage:** Managed cropping systems (e.g. single crop or crop rotation) must have been in place for at least 5 years prior to project implementation
QV-2	Determination of the native ecosystems historical status (mapping of native ecosystems changes) Forest status	**VM0042:** The project area must not have been cleared of native ecosystems within the 10-year period prior to the project start date **GS SOC Framework Methodology**: Project area (s) shall not be on forest according to the LUF Activity Requirements: No Deforestation: The eligible area shall not meet the definition of forest 10 years before project start date and at project start date. Annex C of the LUF Activity Requirements document provides guidelines to conduct spatial forest/non forest assessment with remote sensing.
QV-3	Determination of wetlands	**VM0042:** The project activity cannot occur on a wetland. Note that this condition does not exclude crops subject to artificial flooding where it can be demonstrated that crop cultivation does not impact the hydrology of any nearby wetlands. **GS SOC Framework Methodology**: Project area(s) shall not be on wetlands.
QV-4	Identification of biomass burning	**GS SOC Framework Methodology**: No biomass burning for site preparation is allowed in the project scenario.

QV-5	Detection of surface and shallow water	**GS SOC Framework Methodology**: Project activities shall not include changes in surface and shallow (<1m) soil water regimes through flood irrigation, drainage or other significant anthropogenic changes in the ground water table. **PV SHAMBA:** Soils in the project area are not waterlogged or flooded regularly.
QV-6	Conservation tillage detection Identification of reduced tillage, crop residue and mulch	**GS SOC Improved tillage:** Under this Activity Module, conservation tillage methods are applied, meaning forms of minimum or reduced tillage, where residue, mulch, or sod is left on the soil surface to protect soil and conserve moisture. After planting, at least 30 percent of the soil surface remains covered by residue to reduce soil erosion by water.
BASELINE AND PROJECT SCENARIO AND ADDITIONALITY – VERIFY		
QV-7	Crop Type(s) identification	**VM0042:** For each sample unit (field), a schedule of activities in the baseline scenario will be determined by assessment of practices implemented during the period prior to the project start date. The interval over which practices are assessed, x years, must be a minimum of 3 years and include at least one complete crop rotation, where applicable. Where a crop rotation is not implemented in the baseline, x = 3 years. For each year, t = -1 to t = -x, information on agricultural management practices must be determined.
QV-8	Approximate date(s) planted determination	
QV-9	Approximate date(s) harvested / terminated determination	
QV-10	Tillage identification: (Y/N)	
QV-11	Depth of tillage (if applicable) determination	
QV-12	Frequency of tillage (if applicable) determination	
QV-13	Percent of soil area disturbed (if applicable) determination	

QV-14	Crop residue removal determination	Agricultural management practices: • Crop planting and harvesting • Nitrogen fertilizer application • Tillage and/or residue management • Water management/irrigation • Grazing practices Additionality is demonstrated by the adoption, at the project start date, of one or more changes in pre-existing agricultural management practices. A practice change constitutes adoption of a new practice (e.g., adoption of one or more of the practices covered in the categories included in the applicability conditions as well as the illustrative improved agricultural land management practices listed in Appendix 1), cessation of a pre-existing practice (e.g., stop tillage or irrigation), adjustment to a pre-existing practice, or some combination. Any quantitative adjustment (e.g., decrease in fertilizer application rate) must exceed 5% of the pre-existing value to demonstrate additionality. **PV SHAMBA:** Section 4.2 Agricultural activities - Information that must be provided for baseline and project scenarios where crops are planted. **GS SOC Framework Methodology**: The relevant baseline scenario is the
QV-15	Percent of crop residue removed (if applicable) determination	
QV-16	Irrigation identification (Y/N)	
QV-17	Irrigation rate (if applicable) determination	
QV-18	Flooding identification (Y/N)	
QV-19	Grazing identification (Y/N)	

		continuation of the historical land management practices that are being followed in the last 5 years before the project start date (business as usual (BAU).
		
		For both baseline and project scenario, the land shall be stratified into modelling units (MU) according to*:
		• Soil type
		• Climate zone
		• Land management / cropping system
		• Input levels (e.g. fertilization)
		• As applicable (to be defined in SOC Activity Modules):
		  • Tillage practices
		  • Soil properties (e.g. nutrient status or soil health)
		  • Hydrology
		  • Risk of carbon loss (e.g. fire risk)
		* some of the listed criteria data layers for stratification will be produced by AgriCapture

QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS - QUANTIFY		
QV-20	Determination of SOC stock and bulk density at field level	**VM0042:** Soil organic carbon stock and bulk density (initial), determined ex ante for baseline scenario and at project start (re-measured every 5 years or less) for the monitoring.

		Acknowledging the wide range of valid monitoring approaches, and that relative efficiency and robustness are circumstances specific, sampling, measurement and estimation procedures for measuring are not specified in the methodology and may be selected by project proponents based on capacity and appropriateness. Stratification may be employed to improve precision but is not required. For baseline scenario: Directly measured at t=0 or (back-) modeled to t =0 from measurements collected within +/-5 years of t =0, or determined for t=0 via emerging technologies (e.g., remote sensing) with known uncertainty. For project scenario: Directly measured or estimated via emerging technologies (e.g., remote sensing) with known uncertainty, every 5 years or less.
QV-21	Determination of SOC sampling points geographic locations Measured soil organic carbon must be determined from samples collected from sample plots located within each sample unit. All organic material (e.g., living plants, crop residue) must be cleared from	**VM0042:** Data / Parameter: SOCwp,i,t - Areal-average soil organic carbon stocks in the project scenario for sample unit i in year t (t CO2e/unit area) Measured in the project area. **GS SOC Framework Methodology**: Follow VCS's sampling protocol- VMD0021 Estimation of Stock in the Soil Carbon Pool

	the soil surface prior to soil sampling. Soil must be sampled to a minimum depth of 30 cm. Soil organic carbon stocks must be estimated from measurements of both soil organic carbon content and bulk density taken at the same time, at the project start and re-measured every 5 years or less. Geographic locations of intended sampling points must be established prior to sampling. The location of both the intended sampling point and the actual sampling point must be recorded.	
QV-22	Quality of SOC estimates Estimates generated must be demonstrated to be unbiased and derived from representative sampling	**VM0042:** Data / Parameter: SOCwp,i,t - Areal-average soil organic carbon stocks in the project scenario for sample unit i in year t (t CO2e/unit area) Measured in the project area.
QV-23	Accuracy of measurements and procedures is ensured through employment of quality assurance/quality control (QA/QC) procedures (to be determined by the project proponent and outlined in the monitoring plan). Standard QA/QC procedures for soil inventory including field data collection and data	**VM0042:** Data / Parameter: SOCwp,i,t - Areal-average soil organic carbon stocks in the project scenario for sample unit i in year t (t CO2e/unit area) Measured in the project area.

	management must be applied. Use or adaptation of QA/QCs available from published hand-books, such as those published by FAO and available on the FAO Soils Portal or from the IPCC GPG LULUCF 2003 is recommended	
QV-24	Estimates of soil properties other than bulk density and soil organic carbon from direct measurements must satisfy the following: Derived from representative (unbiased) sampling Accuracy of measurements is ensured through adherence to best practices.	**VM0042:** Soil properties (other than bulk density and soil organic carbon), continuously monitored ex ante as model inputs for the baseline scenario, and continuously monitored ex post as model inputs for the project scenario.
QV-25	Project area stratification for soil carbon	**VM0021:** Task 2.1, Task 3.1 and Task 4.1- To divide the project area into one or more strata within which the existing soil carbon pools and soil carbon dynamics are relatively uniform. Use module VMD0018 Methods to Determine Stratification, with soil carbon as the relevant variable X. **GS SOC Framework Methodology**: the land shall be stratified into modelling units (MU) according to: • Soil type • Climate zone

		• Land management / cropping system • Input levels (e.g. fertilization) • As applicable (to be defined in SOC Activity Modules): o Tillage practices o Soil properties (e.g. nutrient status or soil health) o Hydrology o Risk of carbon loss (e.g. fire risk)
QV-26	Estimation of the current carbon content of the soil carbon pool (SOC stock) for a stratum in tC Calculated from soil samples	**VM0021:** Task 2.2 and Task 4.2-To sample the organic and inorganic soil carbon content in each stratum with a sampling intensity sufficient to estimate, at the required levels of statistical precision and accuracy, the amount of soil carbon per unit area. Use module VMD0021 Estimation of Stocks in the Soil Carbon Pool. GS SOC Framework Methodology: Equation 3 and Equation 5
QV-27	Daily prediction of meteorological variables (temperature and precipitation)	**VM0042:** Climate variables (e.g., precipitation, temperature), continuously monitored ex ante as model inputs for the baseline scenario, and continuously monitored ex post as model inputs for the project scenario. Measured for each model-specific meteorological input variable at its required temporal frequency (e.g., daily) model prediction interval. Measurements are taken at the closest continuously-

		monitored weather station, not exceeding 50 km of the sample field, or from a synthetic weather station
QV-28	For all direct-sampled parameters, the project monitoring plan will clearly delineate spatially the sample population and specify sampling intensities, selection of sample units and sampling stages (where applicable).	**VM0042:** Application of this methodology may employ a range of potential sample designs including simple random samples, stratified samples, variable probability samples, multi-stage samples, etc. The sample design will be specified in the monitoring plan, and unbiased estimators of population parameters identified that will be applied in calculations.

The user requirements related to Reg Agri certification are based on LEAF methodology for Sustainable Farming certification and verification of Reg Agri practices application:

#	Requirement	Usability
Soil Management and Fertility		
RA-1	Estimation of percent of residue cover	**Standard 2.2**: Measures are taken to conserve and build up soil organic matter. Soil Management Plan (see 2.1) states measures to conserve and build up soil organic matter. Measures include incorporation of crop residues and efficient use of other organic materials where available and appropriate
RA-2	Measuring Soil Organic Matter User requirements QV-20-22	**Standard 2.2**: Measures are taken to conserve and build up soil organic matter. If soil organic matter is being measured, LEAF Sustainable Farming Review Question

		Soil Organic Matter % (SM.SD.01) has been completed with appropriate figures.
RA-3	Defining optimal locations for soil sampling (for Soil Health measurement) User requirement QV-21	**Standard 2.14**: Soil health is measured. Business identifies and implements an appropriate sampling strategy
RA-4	Crop Type(s) identification User requirement QV-7	**Standard 2.8**: All cultivations and field operations are recorded. Field operation records by crop type or by field Checking field records can be very onerous on large farms with small fields so grouping may occur and is acceptable
RA-5	Approximate date(s) planted determination User requirement QV-8	
RA-6	Approximate date(s) harvested / terminated determination User requirement QV-9	
RA-7	Tillage identification: (Y/N) and approximate date User requirement QV-10	
Landscape and Nature Conservation		
RA-8	Land cover annual map	**Standard 8.1**: There is a documented Landscape and Nature Conservation Audit (including map). Landscape and Nature Conservation Audit includes map(s) with reference to the following key environmental features:

		o areas and sites on farm with any statutory landscape designation o lakes, ponds and watercourses o semi-natural habitats (e.g. moorland, wetlands, lowland heath, species-rich grassland, carbon sinks etc.) o linear features (e.g. hedges, fence lines, verges, field margins, walls, ditches) o public rights of way o archaeological or historical sites o land on which other important species are found o areas that are grazed o lists of any important species recorded in the area o traditional buildings o fire breaks that help protect crops and habitats **Standard 8.7:** There is an implemented Landscape and Nature Conservation and Enhancement Plan. o The implementation of the Plan is reviewed at least annually, recording achievements and progress towards all targets, and used to inform updates to the Plan Standard 8.7 (*see below*)

		Standard 8.11: In-field trees and trees in boundaries and hedgerows are retained. Hedgerows and trees are present as recorded in the Landscape and Nature Conservation Audit (see 8.1)
RA-9	Time series of RGB satellite imagery	**Standard 8.7**: Traditional field boundaries, environmental/landscape features and other natural habitats are retained. Field boundaries, environmental/landscape features and other natural habitats have not been removed and maps and plans show no intention to remove them. Standard 8.1 (*see above*) Standard 8.11 (*see above*)
RA-10	Annual verification if a Reg Agri practice is applied on a field Reg Agri practices: - Cover crops - Crop rotation - No tillage/ low tillage - Leaving crop residues - Intercropping - Perennial crops - Agroforestry - etc.	N/A

6 Conclusion

The document provides an analysis of the ecosystem in which the AgriCapture technology will operate. It is shaped by the domain of Carbon markets and Regenerative Agriculture and the stakeholders that will be affected. We have recognised farmers as the main actors and the driving force within the ecosystem. They are adopting regenerative practices which eventually lead to carbon sequestration, improvement of soil quality and positive effect on biodiversity and the environment.

The analysis is based on desk research of reports, scientific papers, methodologies and experts' opinions, but also on the results of the surveys designed to collect feedback from the identified stakeholders directly. The outcome of the process was the identification of the AgriCapture end-users and defining their requirements which will be further used to shape AgriCapture products and services.

The requirements related to certification of carbon credits and regenerative practice are based on the current methodologies approved by VCS, Gold Standard, Plan Vivo. Since one of the goals of the project is to define a new AgriCapture methodology, the user requirements will be expanded to reflect new developments later on.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 101004282.