NBSOIL

Nature-Based Solutions for Soil Management

Roadmap for effective upskilling of soil health advisory services - identifying existing resources

Deliverable D3.2

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[1] **R**=Document, report; **DEM**=Demonstrator, pilot, prototype; **DEC**=website, patent fillings, videos, etc.; **OTHER**=other

[2] **PU**=Public, **CO**=Confidential, only for members of the consortium (including the Commission Services), **CI**=Classified

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D – Deliverable

EU – European Union

T – Task

WP – Work Package

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1 Executive Summary

This deliverable presents a Roadmap for effective upskilling of soil health advisory services - identifying existing resources. One of the main goals of NBSOIL WP3 ‘Prototyping the NBSOIL Academy’ is to develop a comprehensive training programme for next generation soil advisors and advisory services and this roadmap plays a significant role in this direction.

This roadmap is based on a review of available learning programs, notably from universities and technical schools for soil advisors, and the results of workshops and discussions with the educational communities related to Soil Health. A multi-actor approach was adopted to engage soil advisors, land managers and other stakeholders. Online workshops and live documents were also used to test and evaluate new forms of advice in order to make more effective use of digitisation and new models for advisor-farmer-data interactions.

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2 Expected impact.

This Deliverable D3.2 – Roadmap for effective upskilling of soil health advisory services - identifying existing resources was developed during the first 12 months of the NBSOIL project.

To complete this activity, in line with T3.3, Soil Association has conducted an extensive review of the existing resources concerning soil advisory services. A multi-actor approach has been used to engage relevant stakeholders such as soil advisors, land managers, universities, research institutions and independent soil advisory services; surveys, interviews and workshops have supported this process. The review process and stakeholder engagement have also considered the evaluation of new forms of advisory services that could make more effective use of digitisation and new models for advisor-farmer-data interactions.

Four themes have emerged through the process of this review that inform the roadmap pathway needed to upskill soil advisors: collaboration, targeted initiatives, networking and knowledge share and assessment.

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3 Background

There will be increased demand for soil advisors and knowledge from farmers due to the recognition of the importance of soil health in the production of crops, the role of soil in carbon sequestration and new laws and policies including the Soil Monitoring Law currently in consultation for the EU, and the public goods focused environmental schemes within the UK.

There is an increasing number of resources available for soil health advisors, however, this varies in delivery and course content. Training currently available is fragmented both within and across different countries with very little accreditation. This results in the learning material being well suited to farmers and growers wanting to expand their knowledge, but advisors require consistency in the delivery to ensure training given is well founded in science. Online courses offer widely accessible foundations in soil, however practical infield training should be included for both hands-on experience and peer knowledge exchange, which further develops understanding in the tactile nature and huge variation of soils. This level of in person learning and development of practical demonstrations can be time consuming, coupled with additional cost and resource requirements.

For a less fragmented approach accredited introductory, beginners and advanced level training could be introduced, to form part of a widely recognised continual professional development (CPD) plan spanning all sectors with specific learning opportunities that are more sector specific.

An increased focus on biological interactions within soils is required, utilising the different expertise across the spectrum of soils at different levels.

There is a significant lack of universal accredited training in good soil management and practice. Many of the courses reviewed are targeted at offering solutions for farmers and in turn the soil, without gaining a detailed understanding of the problems that are faced by land managers and the contributing factors affecting soil health. This is an area that requires more focus and understanding.

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4 Introduction

The overall objectives of the NBSOIL project are to collate and complement resources with the aim of designing a blended learning programme consisting of scientific based soil information, tools focusing on advice for advisors on the practicalities of seeking opportunities and developing business models that enable them to support land managers of all sectors and scales in implementing holistic soil management practices through Nature Based Solutions (NBS) to improve soil health.

This roadmap review is part of the outputs from NBSOIL work package three (WP3) 'Prototyping the NBSOIL Academy', focussing on developing a comprehensive training programme for next generation soil advisors and advisory services. NBSOIL project is engaging with advisory service providers, soil advisors and academic institutions and soil related regulatory bodies across the EU and associated countries, to strengthen the knowledge and skills base available, to provide impartial advice on soils and sustainable soil management.

Curriculum co-design will form the foundation of the training resources developed for the NBSOIL Academy, through collaboration and demonstration site testing, trials, and validation. NBSOIL is incorporating into this process, evidence, and insights from project work packages two and four respectively, that focus on Soil and Nature Based Solutions (NBS), including soil health indexes and NBS demonstration sites and soil sensing and mapping, that includes exploring the use of unmanned aerial vehicles (UAV) and geographic information system mapping (GIS) in the context of soil management and nature-based solutions.

The aim is to empower 300 participants to complete the training programme and create a network of next generation soil advisors.

Existing available learning programmes and resources for soil knowledge have been collated and reviewed for the purposes of this review, using multi-actor approaches such as surveys, interviews, online workshops and in-person workshops, to engage soil advisors, land managers, providers of soil courses and internal and external project stakeholders; namely those from universities, research institutions and independent soil advisory services. The knowledge gained from these activities has been collated using live documents/online products such as Mentimeter, Googledocs and Jamboard. The review process and stakeholder engagement has also considered the evaluation of new forms of advisory services that could make more effective use of digitisation and new models for advisor-farmer-data interactions. The primary focus of this review has been on agricultural land management and its related activities, as this sector dominates the soil advisory courses focus in general and represents the predominant land use in the majority of EU and associated countries included in this review, however other sectors are considered such as forestry, landscaping and land designated for development.

4.1 The growing demand for soil advisors

The growing demand for soil advisors is influenced by various factors related to broader agricultural and environmental trends. Over the past decade, there has been a growing global interest towards sustainable agriculture, with increased awareness of the pivotal role of soil health in environmental resilience and food securities. This emphasis has created a potential rise in the demand for soil advisors capable of guiding farmers and landowners in adopting sustainable soil management practices. Growing public awareness of environmental issues, including soil health, and increased funding initiatives for sustainable agriculture may

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have also led to a greater demand for advisors who can assist in implementing best practices for soil health and management.

The integration of precision agriculture technologies has become more widespread, and advisors proficient in utilising these technologies for optimised soil management and in conjunction with economic stability or recovery through reduced inputs, have experienced an increased demand for their services. Additionally, the introduction of new environmental regulations and policies, both at national and international levels such as the EU's Common Agricultural Policy (CAP) or the UK's Sustainable Farming Incentives (SFI), could contribute to an increased demand for soil advisors. Regulations addressing soil health, soil contamination, carbon sequestration, and sustainable land management may drive the need for further advisory services.

Advances in soil science research and the development of new technologies for soil analysis and monitoring, particularly in-situ monitoring and predictive analysis using satellite data and mapping (see AI4SoilHealth project) have heightened the demand for advisors with up-to-date technical knowledge and skills. It's important to note that the demand for soil advisors can vary regionally based on local agricultural practices, government initiatives, and environmental conditions and what is in demand in one region, may not be the same in another. It is this range of differing factors that contribute to the growing demand for soil advisors.

4.2 Why do we need to upskill the next generation of soil advisors?

Upskilled soil advisors can enhance agricultural productivity by implementing precision farming, customising soil management plans, and promoting sustainable practices. Their expertise can extend to optimising fertilisation strategies, managing diseases and pests, and integrating innovative technologies for real-time monitoring. Through continuous adaptation and comprehensive strategies, upskilled advisors can play a vital role in protecting and improving soil health, whilst ensuring resilient economics into agricultural systems. Importantly, upskilled soil advisors can integrate nature-based solutions into their professional practice, recognising the value of harnessing natural processes for soil health and overall ecosystem balance and demonstrating this in practice.

Upskilled advisors can play a pivotal role in implementing and promoting sustainable farming practices, crucial for ensuring long-term environmental health and resilience. These individuals can be equipped to adapt to changing conditions, addressing challenges such as climate changes and extreme weather patterns. They will be able to design and implement strategies to mitigate the impact on various aspects of management practices, including soil quality, crop yields, tree health, and overall water and air quality protections and improvements.

Efficient resource management is a hallmark of skilled advisors who optimise resource use, minimising waste and reducing environmental impact. Improved soil management practices contribute to economic stability by enhancing crop yields, reducing input costs, and promoting overall agricultural sustainability.

In the context of meeting global food demand, upskilled soil advisors become instrumental. They can play a vital role in ensuring food security by maximising the productivity of existing agricultural land, addressing the challenges posed by a growing global population.

Furthermore, these advisors will actively contribute to agricultural innovation and research, fostering a culture of continuous improvement within the industry. Upskilling initiatives facilitate the smooth transfer of knowledge

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from experienced advisors to the next generation, supporting effective succession planning in the agricultural sector and related industries.

Environmental stewardship will be a key focus for upskilled advisors, as they are more likely to adopt and promote practices that protect natural resources, biodiversity, and overall ecosystem health. In summary, upskilled soil advisors contribute comprehensively to sustainable agriculture, economic stability, and environmental well-being through their strategic, innovative, and environmentally conscious practices.

By investing in the upskilling of the next generation of soil advisors, we address current agricultural challenges and prepare for the future, where sustainable and efficient soil management will be increasingly critical to food production, water, and air quality, and increasing environmental and human resilience to climate change.

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5 Review of available learning programmes

In the review available learning programmes have been split into five different categories:

- Universities
- Professionally Accredited, Independently Monitored Courses
- International Internally Accredited Courses
- Technical Schools for Soil Advisors and Land Managers
- Online Interest Courses.

5.1 Universities

Universities across the European Union (EU) and United Kingdom (UK) already offer academic courses which specialise in soil, starting from short-term classes that can be found across several undergraduate courses and continuing into higher learning postgraduate levels where soil is the focus of study, including Masters of Science (MSc), Master of Research (MRes) and Doctor of Philosophy (PhD).

On the undergraduate level, multiple courses across different careers (Geography and Agronomy for example) offer soil related modules as part of the curriculum. However, these tend to be smaller introductory options that do not integrate into a clear "soil focused" study pathway; for students interested in pursuing a soil-focused career the next stage can be either going to learn on the field –a learning-by-doing approach- or focusing on deepening their knowledge by choosing a soil-focused postgraduate option.

Higher learning postgraduate levels are predominantly delivered in person at an academic or specialist institute; the focus tends to be heavily academic. While in some cases funding support will be available – through public or private grants, some of them funded by a specific sector of industry interested in soil research - if funding is not available students will need to take on the extra costs this requires; this is a limiting factor to consider. As mentioned, these courses have a predominantly science-based curriculum and are mostly undertaken by early career scientists rather than future practitioners (such as future advisors, for example); that is why they are often delivered at a high technical level by academic experts in the field of soil health, but are often perceived to lack a marked practical aspect, which can deter practitioners looking for higher learning opportunities. Table 1 highlights some of the courses available and a more comprehensive list can be found in Appendix 1.

Table 1: Examples of academic institutions that provide courses specific to soil science and management.

Country	Institution	Course Title
UK	Bangor University	Soil and Environmental Science
UK	Edinburgh University	Soils and Sustainability
Sweden	Swedish University of Agricultural sciences	Soil, Water and Environment
Austria	BOKU	International Masters in Soil and Global Change

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Switzerland	ZHAW	Environment and Natural Sciences/Regen Farming
Spain	Upna	Masters in Soil and Water Management
The Netherlands	Wageningen University and Research	BSc Soil, Water, Atmosphere

Some examples of these courses and the topics they focus on can be found below:

- Swedish University of Agricultural Sciences: Masters in ***Soil and Water Management*** includes modules in hydrological processes in soil-plant ecosystems, environmental Geochemistry; soil biology and biogeochemical cycles and environmental monitoring and assessment.

- The UPNA University in Spain: Masters in ***Soil and Water Management*** offered at, combines specialists from four universities and teaches geology, chemistry, biology, and soil science. This makes the course content applicable to agronomy, forestry, and hydrological engineering.

- The Soil and Environmental Science course at Bangor University in Wales, UK, offers a PHD or MPhil so a more self-guided postgraduate research route. There is also in development within the UK there is First higher-level work-based apprenticeship course. This is a MSc level qualification which is achieved whilst in the workplace. This course therefore has a wide scope for different industries.

  The award is a soil scientist level 7 qualification. It is broader than other postgraduate courses available as it is designed for different industries where a knowledge of soil science is required. Fourteen duties are required to be undertaken as part of the students employed work and passed to gain the qualification.

  Examples of these duties include:
  - **Duty 1** Establish the context of the problems faced by the client taking account of the soil policy context and any regulations, authoritative legislation, guidance, and procedures that may apply.
  - **Duty 2** Conduct a desk-based assessment to collect and critically assess available soil data, to inform proposed approach.
  - **Duty 3** Design appropriate soil survey and analysis methodologies.
  - **Duty 4** Conduct field-based surveys to collect soil data.
  - **Duty 5** Commission soil surveys, testing and analysis.
  - **Duty 6** Interpret and critically evaluate information and data relating to the chemistry, biology and physics of soil and synthesise the data to consider soil functions and changes over time.
  - **Duty 7** Critically evaluate secondary data and information including soil maps and Geographic Information System Mapping (GIS).
  - **Duty 8** Review data and statistics and design statistically valid comparisons using appropriate data analysis and data science techniques.

    (Source: Soil scientist / Institute for Apprenticeships and Technical Education)

- ***BSc Soil, Water, Atmosphere*** offered by Wageningen is a true cross disciplinary course that covers the physical, chemical and ecological processes that is integral to the learning of sustainable land management. There is an emphasis on laboratory, field and modelling practical exercises that prepare

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students to embark in further learning in meteorology, soil science, marine ecology and engineering. Many of the students will move on to take a Masters once completing BSc to enable them to specialise further in their chose field such as Master in Earth and Environment, Climate Studies, Geographical Information Science and Development and Rural Innovation.

- Edinburgh University offer ***Soils and Sustainability*** MSc to enable them to undertake careers in land-based management and environmental protection across all sectors. Throughout the programme students explore soil formation, function and the role they play in mitigating climate change. Soil health and degradation alongside the management required to conserve and improve soil health. Practical skills in analysis and surveying will also be covered to validate the processes and practices students are taught.

- MSc ***Soil, Water and Environment*** equips students with the broad knowledge in soils and water management and the effect these management practices have on human induced effects on the environment. Many graduates progress to fulfil careers in private consultancy, government bodies and go on to further PhD studies.

- ***MSc International Masters in Soils and Global Change*** from BOKU specialises in soil biochemistry and the effect of global change. Throughout the course expertise from Ghent University (Belgium), University of Natural Resources and Life Sciences (Austria), University of Gottingen (Germany) and Aarhus University (Denmark) are bought together in this joint masters course.

5.2 Professionally Accredited, Independently Monitored Courses

The review has shown that there is a multifaceted landscape of technical educational institutions, each assuming distinctive roles, notably characterised by professional accreditation, independent monitoring, and industry recognition, thereby garnering a respected position in the (soils) educational sector. Such establishments traditionally cater to a wide range of professionals and include those within the agricultural and affiliated sectors, representing a longstanding tradition of educational excellence.

A notable example is the SIKB in the Netherlands—a collaborative network where governmental bodies and industry stakeholders converge to formulate practice-oriented quality guidelines spanning soil, water, archaeology, soil protection, and data standards. The overarching goal is to instil rigorous standards of quality assurance and enhancement across diverse market entities and governmental bodies.

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The SIKB course in the Netherlands is called the Foundation for Infrastructure Quality Assurance Soil Management and an example of some of the guidelines and protocol for soil are:

Guidelines and protocols for soil	
AP04	Accreditation programme for the inspection of batches of soil, building materials and granular waste
BRL SIKB 1000	Sampling for batch inspections (certification)
AS SIKB 1000	Sampling for batch inspections (accreditation)
BRL SIKB 2000	Fieldwork environmental soil and sediment research (certification)
AS SIKB 2000	Fieldwork environmental soil and sediment research (accreditation)
BRL SIKB 2100	Mechanical drilling
Directive 2200	Construction and installation of fire pits

(Source: Guidelines and protocols - SIKB

Within the Netherlands there is also Bureau Erkenningen which provides training and accreditation for all practitioners who are selling, handling or using plant protection and vermin control products. Within this organisation there is little learning resources and licensing that focuses on the holistic and integrated approach to crop management and more specifically soils. In the United Kingdom (UK), agricultural-focused soil advisors, including farmers and agronomists, can undergo comprehensive training through BASIS-accredited programs. Courses such as Sustainable Land Management, Soil and Water Management (with a pronounced agricultural focus), and Quality of Soils (adaptable for a more amenity-focused approach) are integral to their professional development. BASIS, as the accrediting body, delineates the syllabus, and training providers meticulously craft course materials to ensure comprehensive coverage.

The content of the BASIS Soil and Water Management Course offered in the UK, includes:

- Soil protection and soil health
- Prevention of water and wind erosion.
- Mechanics, economics, and environmental aspects of cultivation.
- Soil physical properties – texture and structure.

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- Soil organic matter.
- Soil water properties.
- Drainage and irrigation.
- Plant macro/micronutrients and fertiliser planning.
  Manures and soil organic inputs to enhance crop growth and their effects on diffuse pollution.

The external examination and moderation process imposed by BASIS mandates that training providers adhere to the entirety of the syllabus, eliminating biases in content delivery.

Conversely, industry-recognised schemes are potentially absent in Poland, Austria, Italy, and Spain and this requires further investigation. In Switzerland, the Bodenpraktiker holds wide recognition within the agricultural sector, although its verification and certification status are not necessarily recognised outside of Switzerland and is a potential example of fragmentation across borders that could be refined in future and as part of an upskilling approach within the EU and associated countries such as Switzerland and the UK.

Delving into the specifics of the BASIS Soil and Water Management Course in the UK reveals a robust curriculum encompassing vital topics such as soil protection, soil health, erosion prevention, cultivation mechanics, economic and environmental considerations. The syllabus explores the intricacies of soil physical properties, encompassing texture and structure, soil organic matter, soil water properties, drainage, irrigation, and the nuances of plant macro/micronutrients. The course culminates in a comprehensive exploration of manures, soil organic inputs, and their nuanced impact on crop growth, with an emphasis on their role in mitigating diffuse pollution. The content of the BASIS Soil and Water Management Course offered in the UK, includes:

- Soil protection and soil health
- Prevention of water and wind erosion.
- Mechanics, economics, and environmental aspects of cultivation.
- Soil physical properties – texture and structure.
- Soil organic matter.
- Soil water properties.
- Drainage and irrigation.
- Plant macro/micronutrients and fertiliser planning.
- Manures and soil organic inputs to enhance crop growth and their effects on diffuse pollution.

5.3 International Internally Accredited Courses

Dedicated individuals have identified an opportunity within the domain of soil advisory services for accessible courses underpinned by a holistic and ecologically oriented framework, targeted to those entering the horticultural and agricultural sector from unconventional routes and those seeking a baseline in soil knowledge and practical application of it. Notably, there has been a recent influx of these courses targeted at aspiring individuals wishing to specialise as soil experts and provide soil advisory services. Table 2 below highlights a few of these courses with a more comprehensive found in Appendix 1.

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Table 2 - Examples of International Internally Accredited Courses

Soil Food Web	Soil Food Web
Integrity Soils	Create Coaching
BCA Biological Crop Advisors	Biome Makers

These courses typically bear trademarks and internal accreditations, offering participants the option to enrol in an online registry designed to enable those seeking advisors who have completed these specialised programs to find and hire the soil expertise they need.

The financial commitment associated with these courses is sometimes substantial, and admission is variable and not necessarily contingent on prior industry experience, and this means that these courses are not yet recognised within a wider industry context, particularly outside of small-scale horticulture and land management e.g., large scale agriculture, construction, and planning.

This emergent course trend reflects a growing interest in soil health dynamics and its pivotal role amidst the contemporary climate change crisis, thereby fostering a paradigm shift towards agroecological systems in food production. Of significance is the observation that participants typically on these types of courses often deviate from conventional agricultural backgrounds or trajectories, contributing to a diversified demographic engaged in these educational endeavours.

5.4 Technical Schools for Soil Advisors and Land Managers

The sector experiencing the most pronounced growth in educational initiatives for soil advisors is that of technical schools, which are often not for profit, independent and teaching and research focused organisations focusing on providing training and support in holistic land management and agroecological practices. The increase in their popularity is further fuelled by a heightened emphasis on soil health, propelled by an enhanced understanding of its pivotal role in increasing resilience from climate changes and extreme weather events, the constraining impact of soil conditions on agricultural yields and nutrition, and the intricate interplay between soil health and broader biodiversity concerns.

There is a range of delivery techniques used by these technical schools including in person, online, learning resources and hybrid working. However, many have recognised the value of the importance of practical in field experience.

Within agriculture sectors, encompassing farmers, horticultural growers, and agricultural advisors, there is a discernible increase in the availability of in-field, soil-specific short courses. These courses, ranging in duration from a single day to several months, cater to diverse sectors, including specialised areas such as sustainable/organic/regenerative agriculture, horticulture, and urban farming. Notably, these courses are characterised by practical in-field delivery methods, enabling participants to engage in hands-on learning experiences.

A distinctive advantage intrinsic to these practical infield courses (Table 3 - a more comprehensive list can be found in Appendix 1) lies in the dual facilitation of knowledge and skill transfer. Beyond the unidirectional transfer from trainers to participants, a noteworthy dimension is the facilitation of peer-to-peer knowledge

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exchange among participants. This collaborative learning dynamic contributes significantly to the overall efficacy of these educational endeavours.

Table 3: Examples of in-field technical soil courses

UK	Farm ed	Soil Health and Agricultural Regen Practices for farmers
UK	Farm ed	Improving soil health in arable systems
Ireland	National Organic Training Skill Set	Growing healthy vegetables in healthy soil.
Belgium	Living Soil Academy	Living Soil
Belgium	House of Agroecology	Farmer of the future
France	Earth Worm Production	Agroecology living of soils
Germany	Bioland	The Soil Practitioner
Switzerland	FIBL	Soil Practitioner

The types of course syllabus covered are outlined below:

Living Soil Academy, Living Soil – Belgium

The course is delivered throughout a year over 10 days and covers the following subject areas:

- Agroecology,
- Crop rotation
- Weed management
- Diseases and pests
- Soil fertility
- Crop genetics
- Livestock Genetics
- Climate Change
- Processing and Marketing products
- Economy

Included in the course is practical visits to demonstrate truly integrated systems. There are ten free spaces available each year for farmers who meet the below criteria:

- Arable, livestock or mixed farm
- Farm business is 20Ha or larger
- Candidate is recognised as a principal farmer or as a secondary occupation
- Demonstrates been motivated to move towards agroecological farming practices
- Candidates must be open to sharing experiences with others.

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Earth Worm Production, Agroecology of living soils – France

This is a platform that provides training courses that covers a wide range of topics about the agroecology of soils. Training is offered in groups, one to one and bespoke courses dependent on requirement. They cover all the agricultural sectors including viticulture, gardening, field crops and livestock and arboriculture.

Earthworms, indicators of soils

From 08/01/24 to 18/01/24

Saint Malo (35)

4:30 p.m.

Agronomic Fundamentals of Living Soils

On request

Mixed Digital

11:30 p.m.

(Source: Earthworm Production | Training | Living Soil Agronomy (verdeterreprod.fr)

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Bioland, The Soil Practitioner – Germany

This training programme is targeted at farmers to enhance their understanding of improving soil health and fertility. It encompasses topics such as:

- Soil structure and formation
- Soil chemistry and the effect that has on crop nutrition.

External soil experts and practitioners and soil scientists are the predominant speakers on the 9 day course that is carried out over a year and candidates that complete the course receive a Soil Practitioner Certificate.

(Source: BiolandStiftung-Boden_Bildungs-Flyer_100x297_09-2021_Ost_WEB.pdf)

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5.5 Online Interest Courses

There has been significant growth in the number of both freely available and paid courses which are delivered online only. These are delivered by universities, subject specific societies, and general online providers in many sectors including education and business (Table 4). A full comprehensive list can be found in Appendix 1.

These types of courses are typically not accredited, however a good introduction to soil related subjects, often with free access to experts in the field, peers, and peer to peer learning, as well as industry specific courses that focus on specialist subjects.

Table 4: Examples of online interest courses

International	Cornell University	Soil Science
UK	Open University	Sorting out soils
International	FAO	Climate Smart Soil and Land Management
International	Alison	Soil Science
UK	Lancaster University	Soils: The World Beneath our Feet
UK	ARTIS	Soil and Water
Sweden	Sweden Carbon Institution	Regenerative Agriculture
Germany	German Soil Science Society	Various Soil Courses
France	Ludi Soil Association	The Living Soils workshop
Belgium	KULeuvenX	An introduction to soils, ecosystems, and livelihoods in the Tropics
Ireland	National Organic Training Skill Set	Growing healthy vegetables in healthy soil.

Cornell University Course:

The Cornell University course constitutes a higher education academic curriculum, disseminated without charge through the YouTube platform. This instructional program addresses soil science within the framework of diverse relevant industries.

Comprising thirty-nine lectures, each session extends from forty-five minutes to an hour. The thematic scope of the lectures encompasses crucial topics including nutrient cycling, soil ecology, soil erosion, soil quality, and the management of soil organic matter.

Recorded a decade ago, these lectures have garnered viewership ranging from two thousand to thirty-six thousand individuals per video, demonstrating the increased demand and popularity of online learning courses about soil.

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Food and Agriculture Organisation (FAO) course:

The international course presented by the Food and Agriculture Organisation (FAO) is two hours long and includes:

- Key concepts, including soil, land, soil degradation, ecosystem services, the effects of climate change on soil and land, and the benefits of sustainable management.
- Important Sustainable Soil and Land Management (SSLM) practices, including prevention and mitigation of degradation, control of soil erosion, management of soil organic matter and improvement of water use.
- Information sources, assessment practices and techniques for scaling up.
- Voluntary guidelines for sustainable soil management and how they contribute to the creation of an enabling environment for SSLM.

Online training platforms e.g., Alison

Alison is an online training platform which delivers free online certificates and diplomas. There are ten courses which are soil science specific and the two most popular are Introduction to Soil Science and Technology and the Advanced Diploma in Soil Science and Technology'.

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6 Stakeholder groups

This section of the review synthesises external stakeholders' feedback received by the NBSOIL WP3 team on upskilling soil health advisory services across Europe; what existing resources are available to support the process, what is missing and what should be considered to improve upskilling opportunities.

This feedback was collected throughout two online workshops held during May 2023. During these events the NBSOIL WP3 team had the chance to engage with participants from multiple educational institutions, organisations, and businesses across Europe, including academics and practitioners that teach or specialise in soil health and nature-based solutions. The workshops presented NBSOIL and the goals of the project and included a collaborative mapping exercise, identifying existing study opportunities related to soil health within university programs, informal courses, online modules, and workshops. The workshop exercises enabled the NBSOIL team and external stakeholders to present and explore together existing soil related challenges, nature-based solutions, and available educational courses about soil health and management, to better understand the needs of soil advisors across the EU. It was also a great space to share knowledge and practices and explore available knowledge share opportunities and gaps across the EU Member States aiming to support upskilling soil health advisors, from very structured options available to wider less formal educational opportunities, where those interested can widen their soil health knowledge with low barriers to entry/costs associated.

Participants engaged in a lively discussion around the opportunities, challenges, and barriers to learning and upskilling actors on soil science and regenerating soils across the EU. Some of the main conclusions were:

- Recognition of soil diversity needs:
  Diversity needs should be acknowledged in this area of work: there is no one practice/methodology that provides all answers for soil health; this very complex issue requires a wide array of knowledge and management options suited for specific conditions and geographical areas. Acknowledging and embracing this need for diversity should lead to more diverse curriculums and participant representation across upskilling spaces.
- The Necessity of Applying Theoretical Knowledge in Practical Settings:
  Translating knowledge into practical steps for learning and implementation will be essential for practical upskilling: while there is a growing corpus of research -already scientifically proven and published, the challenges are "translating" it, making it easily available to practitioners and turning it into actionable practice in-situ / in-field e.g., soil microbiology remains high.
- Significance of First-Hand Experiences:
  First-hand experiences/examples of what has been tried, what has worked and what has not worked is critical for practice change on the ground and effective upskilling of advisors. However, it is currently difficult to find examples of what works and what fails in the current available programs.
- Incorporation of Soft Skills:
  Importance of teaching soft skills as well as practical knowledge: beyond the practical science, another relevant conclusion of the workshop was the importance of listening to farmers and creating trust between advisor or researchers and farmers when upskilling farmers in soil health. Following from this, the suggestion is that in addition to formal and practical knowledge, soft skills should also be considered when upskilling soil advisors.

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- Optimal Learning Environment:
  Finding the right local space to learn together: While in recent years there has been new types of more accessible training online and on-campus, the relevance of being outside and having the physical experience of soil is an important part of the learning process. An advantage of in-field event is the opportunity for participants to “feel” the topic, feeling, smelling, and touching the soil; and engaging with others thus practicing soft skills in ways that are not as implementable for courses delivered online. The biggest challenge identified around the option is finding accessible demonstration sites for learning to put into practice any techniques learnt online, given that soil advisors/farmers are spread out geographically.

The culmination of this feedback is integral to Informing the development of the Advanced Modules within the future NBSOIL Academy. In response to this feedback, consideration will be given to hybrid delivery models that facilitate collaborative online learning on overarching topics, while also affording participants the opportunity to engage in practical exercises addressing subtopics relevant to their specific contexts.

Despite the absence of legislation within the EU and associated countries for specific soil protections like those of water and air quality, the European Commission’s current proposal for a Directive on Soil Monitoring and Resilience – the Soil Monitoring Law (SML) currently under consultation (at time of writing, October 2023) is anticipated to augment a policy focus on soil health monitoring and management. Additionally, initiatives such as the EU’s Common Agricultural Policy (CAP) or the UK’s Sustainable Farming Incentives (SFI) have started to support, promote, and financially reward soil management practices that support soil health and biodiversity. This represents a growing recognition of soil health is pivotal role in food security, biodiversity, and climate management and accentuates the potential and growing urgency of training initiatives supporting soil health education and advisory services, particularly those that utilise innovative advisory models and digital platforms for enhanced advisor-farmer-data interactions in soil health management and peer to peer learning and knowledge exchange.

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7 Interviews

As part of WP3.1, interviews are being conducted with soil scientists and academics across the UK, Austria, France, Italy, Netherlands, Poland, Spain, and Switzerland who are delivering soil-based courses to advisors.

In analysis and synthesis of interview findings so far, many students are first exposed to soil health concepts early in their studies. Universities and professional institutes offer some opportunities for early career scientists to get entry level knowledge through courses such as Geography, Environmental Management and Agriculture for example: often early training and experience came from the initial teaching these organisations provided. An important caveat across European Union Member States (EU MS)is that access to these initial higher education courses vary between countries: for example in Austria courses are funded, whereas other countries a substantial financial investment by students is required to access such spaces.

From that point onwards, however, often follow on experience allowing for further upskilling is acquired through everyday work rather than formal training.

As mentioned in the previous chapter, some academic institutions, large companies, or independent consultants will run bespoke soil-based training to a targeted audience who are previously not accredited on the topic. For example, in the UK agricultural focused soil advisors -such as farmers and agronomists- are predominately trained through BASIS accredited training rather than University or Institute courses; BASIS offers courses such as Soil and Water Management or Quality of Soils (see Professionally Accredited, Independently Monitored Courses Section).

There are similar providers and training courses across EU MS: SIKB in the Netherlands is a network organisation where government and industry come together to create practice-oriented guidelines for soil, water, archaeology, soil protection and data standards. The aim is quality assurance and improvement among market parties and governments.

So far, no industry recognised schemes in France, Poland, Austria, Italy, or Spain were identified through these interviews, but some organisations are stepping in. For example, in Switzerland Bodenpraktiker is widely recognised within the agricultural industry as a key place to go for knowledge, but it is not verified or certified; or in France Aurea Agrosciences offers training to professionals and farmers on agronomy, fertiliser, environmental legislation, and soil improvers.

- While there is some positive feedback from interviewees regarding specific courses–- an interviewee from the Netherlands for example, stated that the courses offer in the Netherlands had "*good quality content, with lot of courses on offer",* there are widespread concerns and challenges coming from these interviews which we should take into consideration. The lack of regulation around who can give advice "*is a concern"* shared across MS interviewees. As one interviewee indicated, there are "*too many advisors from private companies that give incomplete and uncoordinated advice";* amongst them, advice is often linked to sales of products. This concern was complemented the apprehension expressed by an interviewee in Austria around the fact that *"there is not really a body of professional soil advisors, expertise on nutrients and soil health are to be distinguished".*
- Interviewees also expressed that an additional focus on soil health is needed. This need for more soil-specific advice is shared across the different countries where interviews were conducted. An interviewee from Spain expressed that, in their opinion, *there are general agricultural advisors or forestry advisors"* but not soil specific ones and added "*that use of formal advice on soil is occasional for most farmers".* Another interviewee in Italy commented that "*advisors or consultants are generalists*

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with basic notions of soil conservation" and respondents agree that there is no soil-specific, broadly accessible offer of training for soil advice.

- Recognising the complexity of the topic and developing courses that reflect it was relevant for interviewees. One candidate interviewed in the UK raised concerns that current soils courses do not go in depth enough to account for the complexity of soil science.
- Practical know-how skills were repeatedly highlighted by interviewees. While academic research is highly valued, is not enough for those looking for suitable soil health advice. They agree that qualification and scientific foundations are needed for people advising, but a common theme with interviewees was their assertion that "*having practical in person training is very important to experience the tactile properties of soil and see it in different geographical locations and climatic conditions".* A Spanish interviewee highlighted the disconnect between courses target for people with a research/science background and more practical courses. Time, expense, and availability of people to prepare soil pits and do in person training can be a blocker to undertaking practical hands-on training, especially as training and other land-based education outside of academic institutions are not founded as heavily as some academic approaches.
- The point above also applies to individual farmers and growers upskilling: as an interviewee in Austria highlighted –and which reflected is a common experience in individual countries- "*a lot of online available material is rather ""scientific dissemination"" and not really training.* Signposting and interpretation of this material is a potential barrier. A common theme is a lack of awareness about existing training courses for these audiences.
- Local-specific information is a relevant aspect they highlight as well. As regenerative agricultural –and therefore soil, a protagonist around which many regenerative practices are organised- is being more widely discussed and represented in mainstream press and agricultural events -such as Groundswell in the UK, and across the EU-, online learning and information have enabled advisors and farmers to learn from experiences globally. However, as one interviewee stated, *"we need to be aware of what may be applicable in each country".*
- User-focused approaches where farmers become relevant stakeholders to consider were also important for interviewees: one interviewee in Switzerland stated "*One challenge is to develop site specific expertise and integrate farmer" knowledge. There is a lack of awareness on the importance of soil in some programs".* An interviewee in Italy commented "*another issue is to make sure people who attend such courses are the ones working with farmers. Not just very niche specialists from specific fields or interest persons".*
- Farmers also need direct training in soil management techniques that improve soil quality, understand the impact of poor soil management and how to assess soils. Peer to peer learning and on farm events are a useful resource, but scientific understanding needs to be brought into these events as well.
- Course offers are mainly supply driven, but the supply of courses is not coordinated, and quality assurance of the courses is not monitored. Generally, there are good quality courses available that not everyone is aware of. Therefore, before developing new resources, these should be built on.

This feedback will be extremely useful when developing further work in NBSOIL, and especially when modelling new advisor models for advisor-farmer-data interactions across the project, and in our Soil Academy in particular.

We can address some of the concerns around finding the right balance between science and practice. This will be a guiding practice throughout our Academy modules, reflecting the specific needs identified not only across interviewees, but also during our workshops. We can also ensure that diversity is acknowledged and,

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through specific strategies, ensuring that location-specific characteristics and challenges are highlighted and explored through our modules.

We can also strive to engage with a variety of stakeholders across our modules, allowing them to inform us with different perspectives, from end-users to advisors and academics, all working together in a space where their specific capacities are welcomed as key parts of the "course puzzle"; this would allow participants not only to learn about soil health across different EU MS but, within a specific area, to understand what challenges and capacities can be leveraged across actors to ensure they can jointly improve and take care of their soils together.

There are further lines of work that go beyond NBSOIL project scope, but which could be taken on board by the organisations working within the project and their stakeholders, for example:

- Work package five (WP5) with their focus on business models and policy frameworks, could take on board some of the biggest regulation-related challenges and make sure these are highlighted with relevant stakeholders.
- EU countries have an important number of knowledgeable societies for soil science, which could be engaged in the creation, design and/or management of customised soil education schemes; for example, the Fachstelle Boden in Switzerland or the British Society of Soil Science in the UK. Engaging with and exploring what role these types of organisations could play within the NBSOIL Academy other projects within the EU Mission – a soil deal for Europe, would be recommended as part of the roadmap initiatives for upskilling soil advisors.

There is a requirement for Continuous Professional Development to be acquired.

To keep up to date with recent scientific and technological advances and a code of ethics to commit to, such as in other professions. In the UK continuous professional development (CPD) is a required for both BASIS qualified agronomists for advice on crop protection and nutrient management. In the Netherlands similar CPD and accreditation can be found through Bureau Erkenningen and the licencing they do for professionals using, handling and storing chemical plant protection and pest control products. But there are no similar requirements in the UK or EU for soil health.

As soil health becomes more prevalent in agricultural advisory services, agronomists are receiving more in-house training to address the increasing request for answers around soil related questions. While soil seems like a natural space for agronomists, as the relevance of soil health spreads across industries agronomists with this skill set face an opportunity which is also a challenge: without regulation, there is potential for these advisors to spread their operations into other industries outside their areas of expertise and without sufficient knowledge they could provide inaccurate or conflicting advice on management practices.

Globally, for example in United States of America (USA) and Australia, there are certified professional soil scientist accreditation schemes. For example, in the USA, the Soil Science Society of America provides certification for the USA and states it brings "credibility, opportunity, motivation, ability, and validation".

The requirements to be certified are:

- Minimum of bachelor's degree in Soils or related field

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- 5 years of experience post bachelor's or 3 years of experience post master's or PhD (or working towards post degree experience)
- Credential forms approved by board.
- Passing of Fundamentals exam

In Australia the requirements are:

- Documentation of at least five years' relevant experience
- Evidence of four tertiary soil science units OR a pass in the Soil Fundamentals Exam OR a willingness to sit an Australian exam
- Contact details of two professional referees
- Evidence of English language competency

The Certified Professional Soil Scientist accreditation recognises high-level professional competence in soil science and management, derived from a broad soil science knowledge base. This foundation in soil science, accompanied by demonstrated years of professional practice provide soil advisors and those using their services, a level of trust and accreditation in analysis and advice given.

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8 Effective use of digitisation and new models for farmer data interactions

Throughout this review we have highlighted many challenges and opportunities associated to the upskilling of stakeholders on soil health across the EU MS. Many of them are associated to the new opportunities opened by digital services, both around effective use of digitisation and new models for farmer data interactions.

'Farmer data interactions' refers to the various ways in which farmers and landowners can engage with and utilise data in the context of agricultural and land management practices. It involves the collection, analysis, and application of data to make informed decisions on the farm, estate, or land in question, including the management systems adopted both historically and/or in the future. This interaction with data can take several forms:

- Data collection:
  Farmers gather data from various sources, including in-situ sensors, machinery, weather stations, and historical records. This data may include information on soil health, weather conditions, crop growth, and even emissions.
- Data analysis:
  Farmers analyse the collected data to derive insights into the performance of their crops, the condition of the soil, and the overall efficiency of their farming practices. This analysis often involves the use of technology and data analytics tools.
- Decision-making:
  Based on the insights gained from data analysis, farmers make decisions to optimise their farming operations. This could include adjusting irrigation schedules, choosing specific crops or crop rotations, implementing precision agriculture techniques, or addressing pest and disease management and even where to apply nature-based solutions.
- Precision farming:
  Farmer data interactions play a crucial role in precision farming, where technology is used to tailor farming practices to specific conditions within a field. This can lead to more efficient resource use, improved yields, and reduced environmental impacts.
- Monitoring and adaptation:
  Farmers continuously monitor their operations through ongoing data interactions. If unexpected challenges arise, for example, extreme weather events such as flooding or drought, they can adapt their strategies in real-time to mitigate risks and optimise outcomes.
- Technology integration:
  The use of technology, such as farm management software, mobile and/or in-situ monitoring devices, and satellite and mapping imagery, can facilitate farmer data interactions. These tools provide valuable information to farmers for better decision-making.

It is becoming increasingly important for soil advisors to have the skills and knowledge to support farmers and landowners in the collection, analysis, and interpretation of their data for management practice adjustments and future system designs and planning. In the context of new models for advisor-farmer-data interactions for soil health, innovative approaches and systems that can enhance the exchange of data between advisors (such as soil health experts) and farmers are becoming more essential to soil advisory services and therefore a key requirement of the upskill needs. This could involve the use of technology platforms, data-sharing

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protocols, and collaborative initiatives to improve soil health management based on accurate and timely data and there are emerging technology products that support this such as the UK Soil Association Exchange (Appendix 1).

Online learning

As the interest in soil health gains momentum, there is growing access to online resources and training courses focusing on soil health. Some of their advantages are allowing people in different locations to come together in a digital space and share their experiences despite geographical limitations; online also allows people in different time zones and / or with different time availability to take advantage of the asynchronous nature of these courses. These advantages are especially relevant for those living in remote areas (rural areas in particular), and/or for those whose schedules require some flexibility for them to access such information.

Undoubtedly these digital courses open opportunities across time and space that were unimaginable decades ago, but they do present some challenges that require addressing:

- Internet speed could still be a barrier in some geographic regions particularly in rural locations.
- The skills required to access and utilise both online platforms and relevant apps are not necessarily within all stakeholders skillsets or physical capabilities.
- Soil is a very tactile subject and therefore some level of practical in-person learning is essential when understanding soil structure and it's place in the environment. Online learning can play it's part in scene setting for much of this work but should not be seen as wholly replacing practical in field experiences.
- As highlighted by some of the stakeholders interviewed, the fragmentation of these resources makes it hard to access them sometimes. Sourcing the correct course across multiple providers can be very difficult.
- There is a challenge not only around creating expertise and learning hubs for soil health, but around successfully connecting relevant advisors, academics and farmers to any resources developed.

Digital Enhanced Learning Techniques

There are many examples available of digital tools available that further enhance the learning of candidates and students undertaking many of these courses such as soil health monitoring applications and in field sensors. They are additional tools to aid the scene setting and developing further understanding of soil health and management. They are not aimed at replacing in person practical experience but should be seen as additional tools that can help target field based learning to extract maximum benefit for participants.

Two examples of these tools are listed below and they both support farmers and land managers in advising how and what to look for when inspecting their soils. They also then provide a portal for recording data to track progress and reporting.

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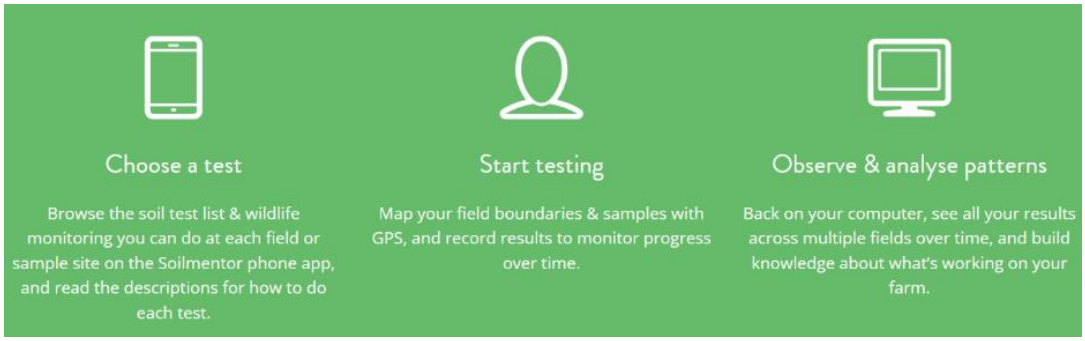
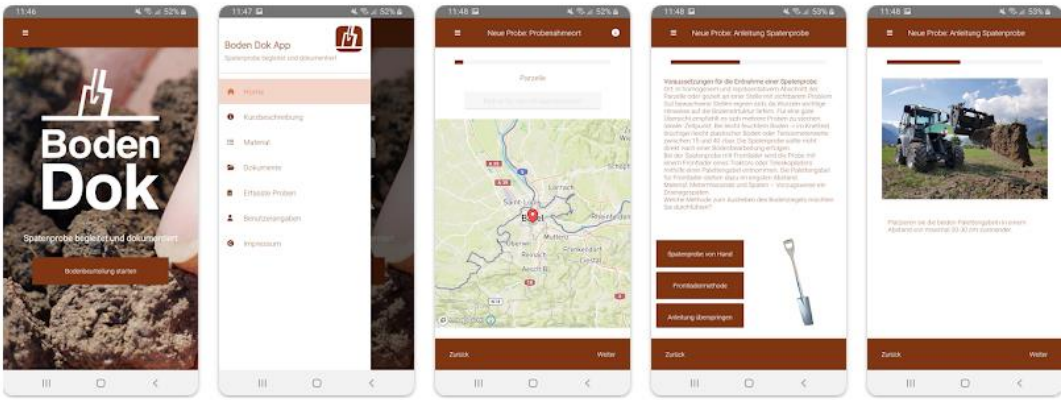
Soil Mentor App by Vidacycle



(Source: Soilmentor – The app for regenerative farmers (vidacycle.com)

Boden Dok App by Fibl



(Source: SoilDoc – Apps on Google Play)

These tools replace some of the written instructions previously required when taking samples and inspecting soils. Encouraging participants to assess and monitor their soils outside of the courses they are undertaking enables them to gain more practical experience in their own farms and environments which can lead to be more targeted questions when on the course. It may also enable some of the course facilitated field work to be tailored to the participants and therefore have more relevance.

There are some disadvantages to these app's and they are outlined as follows:

- Some resources, such as soil mapping websites have only been developed at a local/ country scale which can lead to frustration for some actors located in areas where specific resources have not been created; although this is also an opportunity to be addressed by up-and-coming tools.

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In situ field sensors

These in field sensors are another additional digital resource which can support farmers, land managers, soil practitioners and scientists in making decisions and contribute to validating their learning experiences in the courses they undertake. A plethora of digital tools are being developed to better understand soils in specific farms. However, knowing which one to choose can also be a challenge as there are no clear "winners" that have been widely adopted so far (see below for some of the tools currently being developed); and as these technologies are still in development, the usability of information and training for users' needs further investigation. Examples of these sensors is listed below:

- Yardstick – Soil carbon and bulk density measurement
- Digit Soil – SEAR: Soil Enzyme Activity Reader
- Microbiometer – Microbial biomass and Fungi to bacteria ratios
- IRGA (Infrared gas analyser)–- Soil CO2 Efflux, Net canopy CO2 Flux
- FTIR Portable gas analysers (Gasmet) – up to 50 x GHCs including methane
- General in-situ sensors for pH, soil moisture, weather etc
- In-situ crop nutrient density sensors.

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9 Main Barriers

Throughout this review, several critical barriers to the upskilling of advisors have been identified, such as:

Availability of Qualified Trainers:

Currently, there is a shortage of properly qualified trainers capable of delivering courses that effectively bridge scientific knowledge with practical infield applications. Regulatory specifications around who qualifies as a soil advisor are not explicitly clear across all member states and associated countries, allowing almost anyone to provide advice regardless of experience and qualifications. Even if soil advisors would like to gain qualifications or accreditation there is often a lack of a common framework of accreditation in their region.

Identifying existing soil health experts across the EU and associated countries that can be part of the upskilling roadmap activities and training the trainers, is recommended and could be a primary step for NBSOIL Academy co-creation.

Lack of Clear Pathway to Become Soil Advisors:

The absence of a shared pathway to become a soil advisor across EU MS and associated countries contributes to the upskilling challenge ahead. While some areas offer potential models, such as incorporating soil training into roles related to crop protection and nutrient management, there is a lack of standardised training for soil health advice. Crop protection advice and nutrient management advice training in several of the MS involves accredited training and CPD regulations, due to the sales of plant protection products and fertiliser. A similar model could be implemented for soil health advice and education.

With access to soil health information and courses growing, alongside growing interest and awareness of its key importance, there is an opportunity to consolidate information and educational resources and address fragmentation, creating a clear pathway from early career stages throughout a soil advisor's professional life, as new knowledge becomes available. The EU Soil Monitoring Law represents a potential opportunity for MS to explore possibilities at a local scale through their CAP planning, policy direction and at frameworks level, for a unified approach to soil education and soil advisory services.

Need for Hybrid Training Models:

This review has emphasised the necessity of developing models that combine online and classroom training with infield experiences. Soil health understanding often requires sensory tests that cannot be learned in an online or classroom environment. Blended learning approaches, addressing different learning styles, can contribute to better-quality advisors. Recognising diverse learning preferences, a blended approach can facilitate mutual learning among future or current advisors.

Throughout this review, we have identified the lack of "hands-on" learning as a key barrier that is particularly relevant when upskilling soil advisors, as better understanding soils and their health often requires sensory tests: touch and smell the soil, standing in a soil pit to see the profile in person, observe the biology, and understand different cultivations and field drainage designs. These skills are not achievable/ learnable in an online environment, or even a classroom. This does not mean leaving soil research aside: these courses should reflect the growing science around soil health and provide the tools to implement it in a practice-oriented way.

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Additionally, it is important to understand that different people learn differently, and an appropriate blend of learning strategies can also secure better-quality advisors. Following the Honey and Mumford (1992) model, for example, we can better understand different styles and imagine blended courses that address these: some learn best by doing, others by understanding the theory behind actions, others by seeing how they can apply their learning to the real world and others through observation and reflecting on results. A blended approach can help address this variety of styles and help future or current soil advisors to learn from each other.

Fragmentation of Training Offers:

The increasing availability of soil health courses, both in-person and online, poses a challenge as well as an opportunity, due to the lack of qualifications/accreditation frameworks and the diverse conditions impacting soil health. Addressing this fragmentation and aligning courses with appropriate qualifications and accreditation, could enhance the number of qualified soil advisors, trust in services and an increased capacity.

Additional barriers and considerations for effective upskilling of soil advisors include:

- Language variations, funding, and technology access:
  Challenges include variations in the languages that some specific courses are delivered in, where courses are physically available, accessible funding mechanisms for training, and the accessibility of suitable technology. These factors further contribute to the complexity of upskilling initiatives and require careful consideration in planning and implementing effective training programs.
- Limited number of qualified trainers:
  The shortage of qualified trainers for soil advisors, contributes to the limited access to tailored training programs. Identifying existing soil health experts across the EU and associated countries, is crucial for knowledge transfer and a commitment to continuous training the trainers is recommended.
- Financial constraints:
  The lack of a clear pathway and regulatory specifications for becoming a soil advisor, coupled with financial constraints, hinders advisors from participating in training programs. Aligning upskilling efforts with broader agricultural policies and initiatives and funding opportunities for professional development, could begin to address these challenges.
- Technological infrastructure:
  Inadequate access to modern technologies and a lack of infrastructure, can hinder the adoption of advanced soil management tools. Initiatives promoting specialised training programs and technology training, could mitigate this barrier.
- Resistance to change:
  Overcoming resistance to change, especially among experienced advisors, is crucial and an important aspect of maintaining relevance and keeping up to date with technological advances in a rapidly changing sector. A blended learning approach, incorporating online, classroom, and infield training, caters to diverse learning styles, fostering openness to innovation and new practices and could work towards mitigation of this barrier.
- Time constraints:
  Acknowledging the time constraints faced by soil advisors, particularly those learning on the job or outside of specific academic learning routes and accommodating in continuous professional

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development (CPD) programs, can provide a framework for ongoing learning, allowing advisors to balance work commitments with educational pursuits.

- Limited collaboration and networking:

  The need for establishing platforms for knowledge sharing, directly addresses the challenge of limited collaboration and networking. Networking events, conferences, and webinars create forums for advisors to exchange experiences and best practices.
- Policy and regulatory challenges:

  The lack of supportive policies or regulatory frameworks is an overarching challenge. Collaboration with government agencies and policymakers is essential for aligning upskilling efforts with regulatory framework and funding opportunities.
- Inadequate recognition of the profession:

  Recognising the profession of soil advisory services, is crucial for incentivising advisors to invest in continuous upskilling. Collaboration with agricultural organisations and educational institutions and applying a regulatory framework, can contribute to fostering recognition.
- Language, Legal and Cultural Barriers:

  Addressing the diversity in languages and cultural contexts across Europe requires consolidating information and creating a clear pathway to it. This would contribute to overcoming language and cultural barriers and promoting standardised training programs. Different countries and regions within the same countries have various laws focusing on soil health and management. These are to be understood in a local context to ensure the context that is taught is appropriate.
- Limited Research Integration:

  Integrating the latest research findings into practical training programs is essential. Collaborative research projects and initiatives can bridge the gap between academic knowledge and infield practice.

In conclusion, a collaborative cross-disciplinary effort involving policymakers, educational institutions, agricultural organisations, and advisors is necessary to create an environment conducive to continuous upskilling in soil advisory services, addressing the multifaceted barriers identified.

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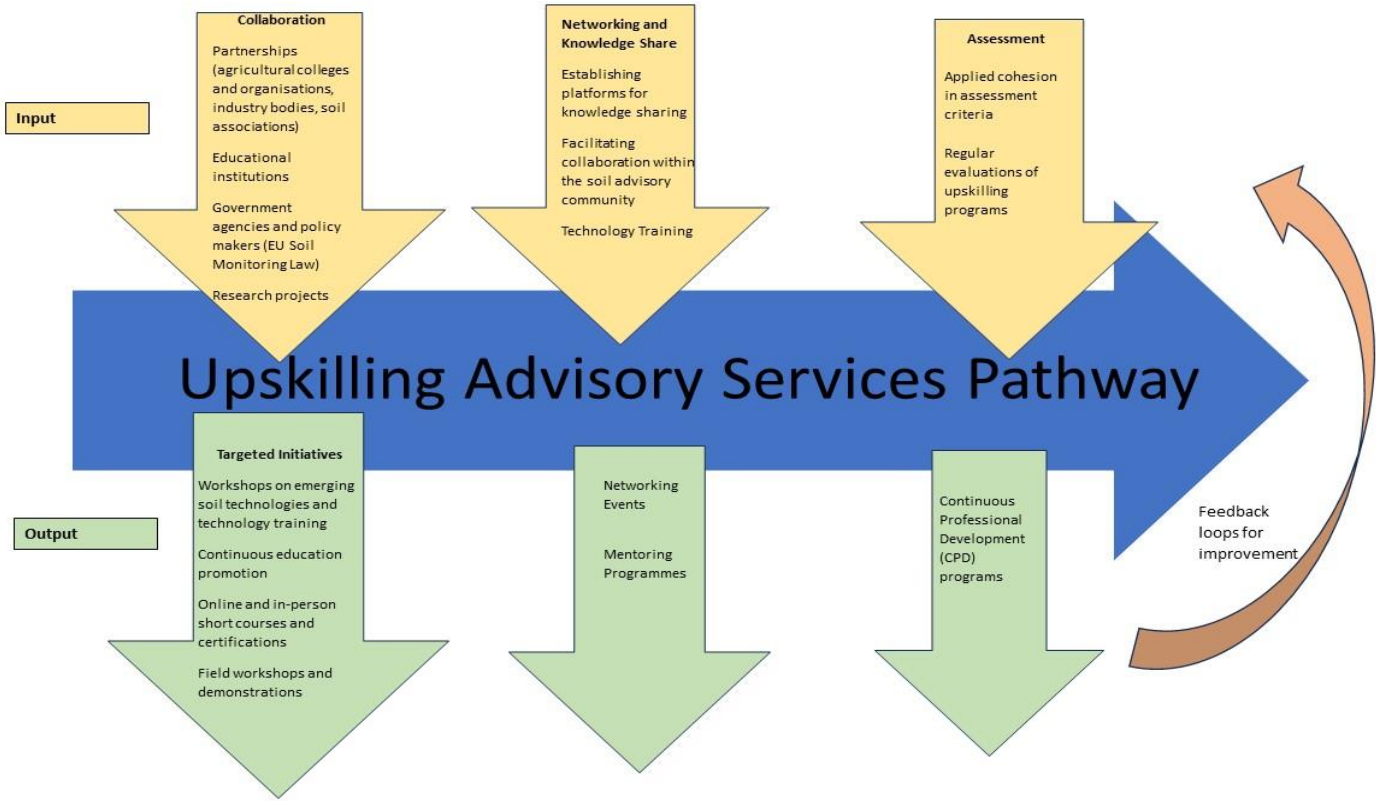
10 Soil Health – Upskilling Advisory Services Pathway Overview

Upskilling soil advisors in Europe and associated countries will involve collaboration between agricultural and land management organisations, educational institutions, government agencies and policy makers. This cross organisational collaboration is vital to reduce fragmentation and ensure a cohesive learning pathway for soil advisors. It will also entail cross disciplinary collaboration between different facets of soil science expertise and application, and other related disciplines such as the social sciences, to ensure effective soil advisory education for the future.

A comprehensive approach is needed to ensure a holistic and ongoing strategy for upskilling soil advisors, covering collaboration, targeted initiatives, community building, and continuous improvement through assessment and feedback.

Initiatives will include specialised training programs, workshops on emerging technologies in soil management, and promoting continuous education for soil advisors to stay updated on the latest research, technologies, and practices. Additionally, fostering networking opportunities and knowledge-sharing platforms could enhance collaboration within the soil advisory community. Regular assessments and feedback loops will ensure the effectiveness of upskilling efforts.

Four themes have emerged through the process of this review that inform the roadmap pathway needed to upskill soil advisors demonstrated in the infographic below.



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Collaboration

- Partnerships:
  Agricultural colleges, courses and organisations partnering with industry bodies, cooperatives, and relevant local, national, or international soil associations to pool resources and expertise. Identifying shared direction/initiatives and creating specialist working groups for specific soil related themes/challenges.

- Educational institutions:
  Collaborating with universities and research institutions to design and deliver relevant soil advisory programs with strong scientific foundations covering all aspects of soil science and emerging technologies.

- Government agencies and policy makers:
  Working with governmental bodies to align upskilling efforts with broader agricultural policies and initiatives, and creating collaborative approaches for soil advisors to feed into policy recommendations for future resilience and management practices that support nature-based solutions.
  EU Soil Monitoring Law provides a potential opportunity for member states to reduce fragmentation in soil courses, agree levels of accreditation across member states that can dovetail with other international frameworks, and provide cohesive country specific learning pathways.

- Collaborative research projects:
  Facilitate partnerships between soil advisors and universities or research institutions, especially those that can facilitate cross disciplinary research, encouraging engagement in joint research initiatives to contribute to the latest findings in soil science and nature-based solutions.

Targeted initiatives

- Workshops on emerging soil technologies:
  Conducting hands-on and online workshops to introduce advisors to the latest tools, sensors, and technologies in soil analysis and management, creating opportunities for knowledge share and blended learning approaches.

- Continuous education promotion:
  Encouraging soil advisors to pursue ongoing education and continuing professional development (CPD) through webinars, online and in-person specialist courses, and attendance at conferences, to stay updated on evolving practices.

- Online and in-person short courses and certifications:
  Develop specialised online and in-person courses covering specific specialised topics such as soil health, nutrient management, nature-based solutions for soil management and agroecological practices. Include themes emerging in the scientific or technical fields of soil advisory services, such as microbiology, fungi, bacteria, and macrofauna, soil restoration and soil amendments, soil protection and conservation practices, and nature friendly precision agriculture techniques. Additionally, how to interpret soil health analysis and wider ecological knowledge, into practical in field advice.

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Provide certifications upon course completion to validate acquired skills at specific points in time.

- Field workshops and demonstrations:
  Create opportunities for applied learning, by conducting hands-on workshops in the field to showcase the implementation of modern soil testing techniques, precision agriculture tools, and specific conservation practices that maintain and improve soil health.

- Technology training:
  Research and address the potential emerging digital skills divide through further discussion on potential internet connectivity issues creating barriers to access online training and networks, especially in rural areas. Research and address any skills gaps for technology; what they are and where they are found. Organise training sessions on the use of advanced technologies like soil sensors, GIS mapping, and data analytics for improved soil management decisions.

Networking and knowledge share

- Establishing platforms for knowledge sharing:
  Creating forums, online communities, or conferences where soil advisors can exchange experiences, best practices, and the latest research findings in multiple local languages.

- Facilitating collaboration within the soil advisory community:
  Encouraging partnerships and joint projects among advisors, to foster a collaborative and supportive professional environment.

- Networking events:
  Arrange conferences, seminars, or webinars that bring together soil advisors, researchers, and industry experts to share knowledge, experiences, and insights.

- Mentorship programs:
  Create mentorship opportunities where experienced soil advisors guide and share their expertise with newer professionals, fostering networking and community building within the field.

Assessment

- Applied cohesion in assessment criteria:
  Explore application of similarly relevant frameworks e.g., crop protection, nutrient management to soil advisory education programmes. Opportunity to apply common levels of education to soil advisory education and services i.e., introduction, intermediate & advanced levels, or similar chartered status such as those seen in other sectors e.g., engineering, ecology.

- Regular evaluations of upskilling programs:
  Implementing periodic assessments to measure the effectiveness of training initiatives and identify areas for improvement and areas that require updating due to emerging technologies and practices.

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- Feedback loops for improvement:
  Gathering feedback from soil advisors on the relevance and impact of upskilling efforts and using this input to refine and enhance future programs.

- Continuous professional development (CPD) programs:
  Implement assessment mechanisms within the framework for ongoing learning to measure the effectiveness of the programs and identify areas for improvement. Establish a framework for ongoing learning, encouraging soil advisors to attend relevant conferences, read scientific literature, and participate in webinars to stay abreast of industry developments.

This four-step thematic approach aims to ensure a holistic and ongoing strategy for upskilling soil advisors in Europe, covering collaboration, targeted initiatives, community building, and continuous improvement through assessment and feedback.

The effectiveness of these initiatives will depend on customisation to the specific needs of soil advisors and the agricultural or environmental context of the local region and the specific demographics of the soil advisors within those regions, but we trust that this roadmap will serve as an effective starting point for the co-design and creation of the NBSOIL Academy, to upskill the next generation of soil advisors throughout 2023 – 2025.

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11 Conclusions

In conclusion, as the significance of soil health gains recognition throughout the EU and associated countries, the role of soil advisors becomes pivotal in restoring and protecting soil health. However, the current landscape presents challenges and barriers, as explored in this review.

The initial review involved diverse approaches, including researching existing upskilling courses, engaging stakeholders through workshops, and conducting individual interviews across multiple member states. The insights gathered have informed the creation of a suggested roadmap for the effective upskilling of soil health advisory services. This roadmap can not only guide our work across NBSOI''s six work packages, but also aims to benefit other stakeholders within the European Agricultural Knowledge and Innovation System (AKIS) seeking to enhance the capabilities of advisors and practitioners in soil health.

Key findings highlighted:

- The fragmentation of training and resources, coupled with the challenge of translating academic knowledge into practical advice, contributes to confusion among both advisors and users.
- Practical infield experience, essential for soil health advising, is often overlooked in existing courses, requiring attention to address this crucial aspect of experiential learning. It will also need to be built into (online) learning practices, utilising enhanced digital learning techniques, self-guided and peer to peer learning techniques to ensure practical in-field experience is a fully integrated part of soil advisory learning
- The lack of a formal pathway and clear accreditations for aspiring soil advisors, leading to a fragmented landscape with various entry-point courses. The absence of country-specific regulations further complicates the upskilling process, hindering confidence in the quality of courses.

Moving forward, the upskilling initiative must integrate input from all stakeholders, including farmers, advisors, academics, and advisory bodies across EU member states and associated countries. As we embark on the journey to enhance soil health advisory services, addressing these challenges will be instrumental in building a robust foundation for effective upskilling in the field of soil health.

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12 Appendix 1

(Note: a live version of the tables below is on the project SharePoint)

Extension to Table 1: Msc, MSre, Mphil, PhD Courses

Country	Institution	Name of Course	Accrediated
UK	Aberdeen University	Soil Science	Msc/MSre
UK	Institute for apprenticeship and technical Education	Soil Scientist	MSc
UK	Bangor University	Bangor University: Soil and Environmental Science	MSc/Mphil/PHD
UK	Edinburgh University	Soils and Sustainability	MSc/Mphil/PHD
Sweden	Swedish University of Agricultural sciences	Soil and Water Management	MSc/Mphil/PHD
Austria	BOKU	International Masters in Soil and Global Change	MSc
Switzeland	ZHAW	Environment and Natural Sciences/Regen Farming	Msc
Netherlands	Wageningen University	Soil Science Cluster	MSc
Spain	Upna	Masters in Soil and Water Management	Msc
Poland	The Institute of Soil Science + Plant Cultivation	Postgraduate Studies in Soil Science	MSc/Mphil/PHD

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Extension to Table 2: Internally Accredited Courses

Country	Institution	Name of Course	Accrediated
International	Soil Food Web	Soil Food Web	Internal
International	Interigty Soils	Create Coaching	Internal
international	BCA Biological Crop Advisors	Biome Makers	Internally

Extension to Table 3: Infield Technical Courses

Country	Institution	Delivery	Name of Course	Accrediated	Targeted Audience
UK	Farm ed	In person	Soil Health and Agricultural Regen Practices for farmers	N	Farmers
UK	Farm ed	In person	Improving soil health health in arable systems	N	Farmers
UK	Tom Knowles, TK Soil Services,	In person	The Soil Food Web and Equine Health	N	All - Equine
Ireland	National Organic Training Skill Set	In person	Growing healthy vegetables in healthy soil.	N	All
Belgium	Living Soil Academy	In person	Living Soil	N	Farmers
Belgium	House of Agrecology	In person	Farmer of the future	N	Farmers
France	Icosysteme	In person	AgroCursus	N	Farmers
Germany	Bioland	In person	The Soil Practioner	N	Farmers
Switzeland	FIBL	In person	Soil Practioner	N	Farmers

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Extension to Table 4: Online Interest Courses

Country	Institution	Delivery	Name of Course	Accrediated	Targeted Audience
UK	The British Society of soil Science	Online	Working with Soil	N	Proffesional
International	Cornell University	Online	Soil Science	N	All
UK	Open University	Online	Sorting out soils	N	All
International	FAO	Online	Climate Smart Soil and Land Management	N	All
International	Alison	Online	Soil Science	N	All
UK	Lancaster University	Online	Soils: The World Beneath our Feet	N	All
UK	ARTIS	Online	Soil and Water	N	All
Sweden	Sweden Carbon Institution	Online	Regenerative Agriculture	N	All
Germany	German Soil Science Society	Online	Various Soil Courses	N	All
Belgium	EIT Food	Online	Various - MOOC	N	All
EU	EU Academy	Online	Soil a burst of life - the hidden world beneath our feet	N	All
EU	Transfer	Online	Fertilisation, technical knowledge and irrigation	N	All
France	Earth Worm Production	Online	Agroecology living of soils	N	All
France	Agreenium	Online	Various - MOOC	N	All
Austria	Bodenpraktiker by LFI!	Online	Soil Practioner for Farmland	N	Farmers
EU	European Association for Agroecology	Online	Agroecology Europe	N	All

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13 Appendix 2

Links to named Organisations

Country	Institution	Link
UK	Farm ed	Practical training for farmers & land managers on regenerative agriculture (nielscorfield.com)
UK	Farm ed	Practical training for farmers & land managers on regenerative agriculture (nielscorfield.com)
UK	The British Society of soil Science	WWS-Complete-Competencies.pdf (soils.org.uk)
International	Cornell University	(887) PLSCS 2600 - Soil Science w/ Jonathan Russell-Anelli, Cornell University - YouTube
UK	Open University	The OpenScience Laboratory: Sorting out soils
International	FAO	Course: Climate-smart soil and land management (fao.org)
International	Alison	Free Online Soil Science Courses (alison.com)
UK	Lancaster University	Soils: The World Beneath Our Feet - Online Course - FutureLearn
UK	ARTIS	Soil and Water | ARTIS - Agri-tech Register and Training for Innovation and Skills (artistraining.com)
Sweden	Sweden Carbon Institution	Gratis onlinekurs Regenerativt Jordbruk: Svensk Kolinlagring
Germany	German Soil Science Society	German Soil Science Society (DBG) | The DBG website (dbges.de)
UK	Tom Knowles, TK Soil Services,	The Soil Food Web and Equine Health via Zoom CPD - Rose Therapy (rose-therapy.co.uk)
France	Ludi Soil Association	Living Soils Workshop (ateliersolsvivants.org)
Ireland	National Organic Training Skill Set	Growing Healthy Vegetables in Healthy Soil – NOTS
Belgium	Living Soil Academy	Living Soil Academy
Belgium	House of Agroecology	Academy - House of Agroecology
Belgium	EIT Food	What We Do - EIT Food
EU	EU Academy	academy.europa.eu/courses/soil-a-burst-of-life-the-hidden-world-beneath-our-feet
EU	Transfer	About us – Transfer Agua del Ebro
France	Earth Worm Production	https://formation.verdeterreprod.fr/

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France	Icosysteme	AgroCursus - Icosystème (icosysteme.com)
France	Agreenium	Agreemiumhttps://www.agreenium.fr/u/se-former/nos-plateformes-e-learning
Austria	Bodenpraktiker by LFI!	Soil Practitioner for Farmland | LFI Upper Austria
Germany	Bioland	Bioland
EU	European Association for Agroecology	Study programmes and trainings • Agroecology Europe (agroecology-europe.org)
Switzerland	FIBL	FiBL - Soil Practitioner pilot course
UK	Cranfield	Soil Systems (cranfield.ac.uk)

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