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Do Agricultural Advisory Services in Europe Have the Capacity to Support the Transition to Healthy Soils?

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Abstract: The need to provide appropriate information, technical advice and facilitation to support farmers in transitioning towards healthy soils is increasingly clear, and the role of the Agricultural Advisory Services (AAS) in this is critical. However, the transformation of AAS (plurality, commercialisation, fragmentation, decentralisation) brings new challenges for delivering advice to support soil health management. This paper asks: To what extent do agricultural advisory services have the capacity to support the transition to healthy soils across Europe? Using the 'best fit' framework, analytical characteristics of the AAS relevant to the research question (governance structures, management, organisational and individual capacities) were identified. Analysis of 18 semi-structured expert interviews across 6 case study countries in Europe, selected to represent a range of contexts, was undertaken. Capacities to provide soil health management (SHM) advice are constrained by funding arrangements, limited adviser training and professional development, adviser motivations and professional cultures, all determined by institutional conditions. This has resulted in a narrowing down of access and content of soil advice and a reduced capacity to support the transition in farming to healthy soils. The extent to which emerging policy and market drivers incentivise enhanced capacities in AAS is an important area for future research.

Keywords: agricultural advisory services; soil health; governance; agricultural advisers; sustainable soil management; soil policy; advice

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Citation: Ingram, J.; Mills, J.; Black, J.E.; Chivers, C.-A.; Aznar-Sánchez, J.A.; Elsen, A.; Frac, M.; López-Felices, B.; Mayer-Gruner, P.; Skaalsveen, K.; et al. Do Agricultural Advisory Services in Europe Have the Capacity to Support the Transition to Healthy Soils? *Land* **2022**, *11*, 599. https://doi.org/10.3390/land11050599

Academic Editor: Amrakh I. Mamedov

Received: 9 March 2022
Accepted: 12 April 2022
Published: 19 April 2022

1. Introduction

Soil health has emerged as a priority for high level and national policy makers and for agricultural communities. This is linked to the recognition of the multiple functions that soils fulfil and the soil degradation processes closely linked to agriculture: erosion, organic carbon decline, soil biodiversity decline, compaction, contamination, salinisation and acidification [1,2]. Indeed, soil health is seen as "a key solution for our big challenges" in the newly launched European Union (EU) Soil Strategy, which builds on the European Green Deal and the Farm to Fork Strategy [3,4]. For agricultural soils, soil health and managing soil sustainably are regarded as central to food system transition pathways

such as agroecology and regenerative agriculture, managing carbon for climate change mitigation and adaptation and mitigating pollution for human wellbeing.

However, the soil governance landscape (formal and informal institutions related to soil-related decision-making processes) continues to be highly fragmented. It is characterised by multi-level and multi-actor decision making, with no single body responsible at the EU or national levels [5] and could be described as a network mode of governance [6]. A number of public and private mechanisms are applied that influence agricultural soil management decisions (directly or indirectly), reflecting the multiple functions (provisioning, filtering of nutrients, carbon storage, flood mitigation) and private and public good that soils provide [7]. These include public cross-sectoral policy instruments (regulatory and voluntary) at the EU, national and regional levels; market-led (food assurance schemes in the supply chain); and measures which are led by the farming industry and non-governmental organisations (NGO) (voluntary initiatives, partnerships and networks).

This emphasis on soil health and its complex governance arena brings new challenges both for land managers and those that support them. The need to provide appropriate information, technical advice and facilitation to support farmers in transitioning towards sustainable soil management [8] has been identified by a number of researchers and policy makers at the international, European and national levels [8–13].

Agricultural Advisory Services (AAS) have always constituted an important part of farmer decision making with respect to soil management [14,15]. However, the increasing complexities of managing different soil functions and soil health at the farm scale [9] places new demands on these services.

Soil health has been defined as the capacity of soil to function as a vital living system [16]; however, the concept, and how it is operationalised, is still evolving [17]. Consequently, there are many understandings of what constitutes good soil health management (SHM). There are multiple practices embodied in the soil health concept, such as the use of cover crops and residues and reduced tillage; however, there is no single message or set of advice that is relevant to all contexts. Emerging interest in soil health indicators, soil biological processes and soil carbon dynamics [18] and new farming approaches (e.g., regenerative agriculture, agroecology), requires increasingly specialist knowledge and understanding (metrics, sampling techniques and analysis, interpretation) [19–21] beyond the traditional territory of soil fertility and agronomy. Meeting famers' knowledge needs, building their capacity and facilitating shared learning for SHM presents new imperatives for advisers [22]. These challenges exist against a backdrop of a changing farming population operating in a volatile, competitive marketplace negotiating multiple drivers in the agri-food system.

AAS have themselves been in transition, with privatisation and decentralisation occurring to different extents across Europe over the past 30 years [23]. The diversity of actors, intermediaries and organisations from the private (The private farm advisory sector includes profit and non-profit enterprises. Prager et al. [24] distinguishes 'private' as the status of an organisation and 'commercial' as the activities carried out by the organisation (e.g., offering advisory services for a fee)) and public sectors and NGOs engaged in some way in offering advice that influences soil management has grown. In particular, there has been an increase in the number of private advisers (These include: commercial agronomists offering services as part of farm input sales; farm management consultants; independent advisers or technicians within the supply-chain, sector or industry body or employed by farmer-owned groups) [25] and those with commercial links to farmers [26,27]. There is debate about the impact of such diversity on governance with respect to the integration and fragmentation of advice, competition and cooperation and how on access to quality advice [24,28,29]. Arguments about the advantages and disadvantages of privatisation have also been well rehearsed [30–32]. The potentially negative impact of commercialisation on public goods advice [33] and the limited investment in updating environmental knowledge for advisers has been highlighted [34]. The powerful effect of new economic actors, such as those in the supply chain, on environmental objectives has also been demon-

strated [26,27,35] and noted specifically for soil management [10,36,37]. Private sector providers who support production goals can promote practices detrimental to soil health (e.g., multiple field operations with heavy machinery, a reliance on inorganic fertilizer, poor budgeting of organic inputs, harvesting in unsuitable conditions) [38]. Meanwhile, resources for public sector advice to farmers on the mitigation of soil degradation processes have also been shown to be inadequate [39].

Although there has been a requirement for all EU member states (since 2007) to establish a Farm Advisory System (FAS) (according to FAS, Regulation (EC) N° 73/2009) to support farmers in meeting cross-compliance requirements, including soil management though Good Agricultural and Environmental Conditions (GAEC), the singular advisory focus on compliance has been to the detriment of other soil functions and soil health outcomes [40].

The role of the individual adviser is also shifting, demanding greater professionalisation in increasingly specialised sectors, technical expertise (subject-matter knowledge), facilitation skills and awareness of a number of policy instruments, innovations, industry demands, certifications and environmental objectives. In such an environment, the assumption is that advisers will pursue different knowledge and strengthen and broaden their suite of professional practices to suit the 'new farming paradigm' [41,42]. At the same time advisers need to stay abreast of the farming community's growing informal soil knowledge networks, [43,44] and the different ways they negotiate their own microAKIS [27]. However, a body of evidence has been accumulating [10,14] suggesting a lack of specialist soil technical support and expertise in the advisory community, a poor understanding of the impact and externalities of their advice for soil, as well as varying motivations. Although studies show that farmers are deferring to advisers for their soil testing, largely in arable sectors [45,46], the lack of meaningful guidance for advisers regarding interpretation of these tests for soil health, especially for soil organic matter, and for specific farm conditions and management, is a concern [22,47]. There are a number of examples of effective soil advice across Europe [39]; however, it is clear that there are variable skill sets [11].

These insights raise questions about the capacity of advisory organisations and the constituent advisers for supporting SHM. This paper asks: To what extent do agricultural advisory services have the capacity to support the transition to healthy soils across Europe?

This addresses a recognised research gap, since understanding how the economic resources and strategies of advisory organisations determine the content of advice has received little (particularly for soil health) attention [26,30]. Equally, although soil literacy and societal engagement are central to the EU Soil Strategy and the implementation of the Mission for Soil and the European Soil Partnership, little has been done to understand the level of knowledge and expertise about soil health management in AAS.

This question is addressed using an analytical framework which positions AAS within the wider Agricultural Knowledge and Innovation System (AKIS), in which AAS are a subsystem. The framework implies that a range of organisations and stakeholders are involved in agricultural innovations along agricultural value chains, as well as agricultural research, agricultural extension and agricultural education [48]. Work conducted in the EU-funded SoilCare project underpins this analysis.

2. Concepts and Framework

AAS can be defined as sets of organisations that support and facilitate people engaged in agricultural production to solve problems and to obtain information, skills and technologies by enabling farmers to co-produce farm-level solutions by establishing service relationships with advisers [30,32,49]. AAS comprise traditional advice providers (chambers of agriculture, public bodies, research institutes), farmer-based organisations (FBOs) (unions, associations, cooperatives), non-governmental organisations (NGOs), independent consultants as well as advisers working in upstream or downstream industries, supply chains and high-tech sectors. However, these distinct categories do not fully capture the different arrangements and the new actors and roles emerging [23,26,27]. The term 'pluralistic'

is used to describe the diversity of institutional options in providing and financing AAS [50]. AAS are characterised by a range of approaches, including one-to-one advice, facilitated interactive group approaches to foster peer-to-peer learning and mass dissemination.

We have adapted the 'best fit' (Birner's [49] framework was proposed for identifying modes of providing and financing advisory services that 'best fit' the specific conditions and development priorities of specific countries) framework developed by Birner, Davis, Pender, Nkonya, Anandajayasekeram, Ekboir, Mbabu, Spielman, Horna and Benin [50] to analyse the capacity of AAS for supporting SHM (Figure 1). Due to the multiple interacting dimensions of the AKIS and the AAS, it is difficult to collect data to capture the full complexity and interdependence of the system [51]. This framework provides a means of disentangling the different dimensions within the system. Here, we use selected key analytical categories in the framework relevant to the research questions. We define SHM as 'where management maintains or enhances (and does not impair) the capacity of soil to function as a vital living system, and to provide supporting, provisioning, regulating cultural services'. SHM is underpinned by the following management principles identified in the SoilCare project: integrate crop rotation, maintain continuous soil cover, build organic matter, minimise soil disturbance, prevent soil compaction, manage water for soil, use soil-friendly weed/pest control and consider landscape-scale management. These were derived by scientific review [52] and experimentation [53], as documented in this Special Issue, and have proven soil health benefits [54,55].

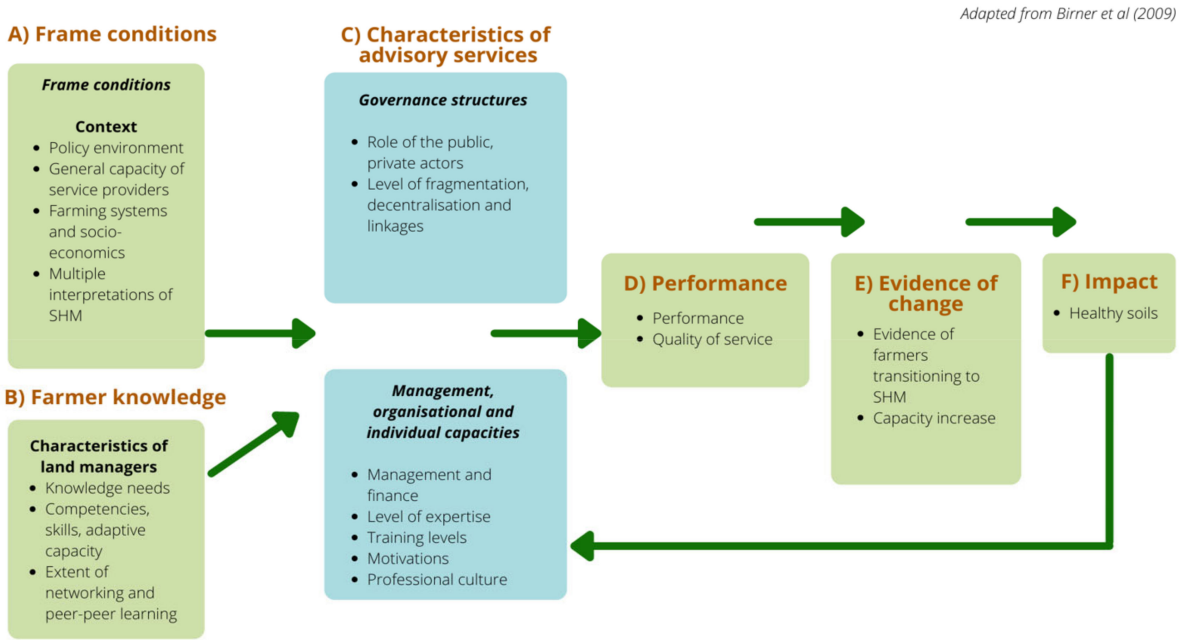

Figure 1. Framework—Blue shading represents the analytical characteristic investigated [50].

The focus of this study is on Characteristics of the system of agricultural advisory services (C in blue in Figure 1) and the implications for SHM. Specifically, according to Birner, Davis, Pender, Nkonya, Anandajayasekeram, Ekboir, Mbabu, Spielman, Horna and Benin [50], we include:

- Governance structures: the roles of the public and private sectors and civil society in providing and financing advisory services, the level of decentralisation and the linkages and partnerships among agents in the innovation system.
- Management, organisational and individual capacities: this refers to the expertise, training, motivations of the members of the advisory service as well as their incentives, professional and organisational culture.

These were translated into characteristics relevant to SHM and framed the data collection. We understand that *Governance* (Usually defined as the systems of institutional

rules, policies and processes which govern how roles and responsibilities are delegated, managed and coordinated) *structures* enable and constrain organisational activities, in particular, the institutional options available for financing and the extent of coordination, fragmentation and integration [56]. Regarding the AAS M*anagement, organisational and individual capacities* to deliver SHM advice, organisational capacity is usually defined in terms of the capacity to perform effectively or to fulfil a goal (e.g., as the set of processes, management practices or attributes that assist an organisation in fulfilling its mission [57]). This capacity also affects the individual. Previous work has shown, for example, that the back-office support such as training and the organisation's knowledge management impacts advisers' capabilities [58].

Regarding individuals, AAS studies recognise that certain individual competencies are necessary for organisations and their advisers to operate effectively, where competence is: to have sufficient knowledge and skills that enable a person to act in a wide variety of situations and the ability to perform something efficiently and effectively (i.e., successfully) [59,60]. These skills include technical skills, which relate to specialist understanding (knowledge, expertise), and process skills, which are soft skills and refer to the collective skills necessary for effective performance of the individual and their organisation. Technical skills with respect to SHM are foregrounded in this study; however, we recognise that the 'soft' skills of facilitators, intermediaries and network builders are important [61].

This infrastructural approach to assessing AAS, which focuses on the presence and interaction of actors and the infrastructures that govern the behaviour of actors [62] also draws on selected criteria that Prager, Creaney and Lorenzo-Arribas [30] identified for evaluating a functional advisory system.

This paper focuses its analysis on C to address the research question, and because these characteristics can be influenced directly by policy makers. However, data for Frame conditions (A), Characteristics of farmers/land managers and their knowledge needs (B), Characteristics in Performance (D), Evidence (E) and Impact (F) (Figure 1) were also collected and analysed. Frame conditions (A) are important contextual factors in shaping the AAS, particularly as these have implications for SHM, and these include: Policy environment; Capacity of potential service providers; Farming systems and socio-economic conditions. Equally, we acknowledge that Farmers' knowledge needs (B) (which we inserted into the framework) are important for assessing the adviser's role. It is not the intention here to follow an impact chain approach to analyse the performance of agricultural advisory services (D,E,F). Assessing (Performance, D) and the quality of advice is challenging, since its measure is the outcome for the farmer and there are multiple factors that affect this [23,50,63].

3. Methods

Countries in Europe are highly diversified in terms of their AAS and AKIS, reflecting the structure of agriculture, farming systems, soils and productivity [64] and the extent to which AKIS are embedded in national institutions, laws and cultures [27]. Six case studies (drawn from country partners in the SoilCare project) were selected to represent a range of AAS approaches and contexts: Norway, Belgium (Flanders) (Belgium (Flanders was the case study for Belgium) as Wallonia operates a different system), Spain, the UK (England) (As the UK's four countries have different political structures and agricultural policies, the focus was on England), Germany and Poland. The selection was based on three broad criteria: firstly, AAS organisations (to ensure the dominant ones were represented); secondly, characterisation of the AKIS, according to strength of national influence and level of integration/fragmentation (based on the the PROAKIS project); and thirdly, to include a range of biogeographical and pedoclimatic zones, as already determined in the SoilCare case study selection process [65].

This selection was informed by detailed AKIS descriptions for each of these countries from a range of sources, including PROAKIS [66] and i2connect [67] project country reports [23,30,32,68–70], and previous reviews for soil [39]. The dominant AAS are repre-

sented in the case studies: Spain FBO; England (Private); Germany (Public/Private/FBO); Poland (Public); Norway (Private); and Flanders (Public) according to previous studies [23]. The pedoclimatic zones represented are: Atlantic Central (Flanders, Germany, England), Nemoral/Boreal (Norway), Continental (Poland) and Mediterranean South (Spain).

Semi-structured interviews (2–4) were conducted in each case study (a total of 18). Selection procedures and interviews were carried out in each case study by project partners using standardised guidance and protocols. Respondents were selected were: representatives of decision/policy makers at national and regional level or of AAS organisations who were knowledgeable about SHM. As this was a very limited pool of experts, a purposive sampling strategy was employed. Table 1 lists the respondents and their roles and affiliation and shows the range of AAS organisations represented.

Table 1. The case study respondents and their roles and affiliations.

Norway	**Flanders (Belgium)**	**Spain**	**England (UK)**	**Germany**	**Poland**
N1 Representative of NLR (Norsk Landbruksrådgivning) Norwegian Agricultural Advisory *Private independent/ FBO*	BE1 Researcher and extension worker at Flemish Research Station *Public*	ES1 Technical director of agriculture and research at association of farmers and livestock breeders *FBO*	UK1 Independent agricultural consultant *Private independent*	GR1 Representative from the district administration, Agricultural Office Baden-Württemberg *Public*	PL1 Professor of Agriculture Science (fruit and veg sector) *Public*
N2 Representative of NLR *Private independent/ FBO*	BE2 Adviser at the Soil Service of Belgium *Private independent*	ES2 Professor of soil science and agricultural chemistry *Public*	UK2 National farm advice manager for a consultancy *Private commercial*	GR2 Representative from the district administration, Agricultural office, Baden-Württemberg *Public*	PL2 Company producing micro-organisms and organic grower *Private commercial*
N3 Representative of NLR *Private independent/ FBO*	BE3 Representative of Flemish Land Agency *Public*	ES3 Research coordinator at research and transfer centre *Private commercial*		GR3 Board member of agricultural cooperative, Brandenburg *FBO*	P3 Company adviser for horticultural sector *Private commercial*
		ES4 Researcher in agricultural research and transfer centre *Private commercial*			

The analytical categories (Figure 1) were translated into interview questions and topics as shown in Table 2. Interviews were recoded, transcribed and translated into English, then analysed thematically using Nvivo 12. The coding structure followed the analytical categories of the interview but was extended where other themes emerged inductively. In total, 18 interviews provided in-depth analysis of AAS capacities for supporting SHM. A list of abbreviations is provided. A full interview schedule is provided as Supplementary Materials.

Table 2. Analytical categories translated into interview topics: example questions.

Characteristics of AAS for Supporting SHM
Governance Structures
With respect to advice that supports or impacts soil management: • the key actors and organisations providing advice; the key influencers; • the roles of the public and private sectors and civil society in providing and financing advisory services; • the level of diversity, decentralisation, coordination, integration or fragmentation of these services; • the extent of linkages and partnerships among actors.
Management, organisational and individual capacities
• the extent of organisation/management/resourcing of advisory services for delivering advice on soil and the impact on advisers' ability to provide soil advice; • different advisers' expertise for delivering SHM advice, quality of advice, level of soil management training; • the attitudes and motivations of the different sorts of advisers and organisational cultures.

4. Results

Where quotes are provided, the code refers to the notation in Table 1. A summary of the results is provided in Table 3.

Table 3. Summary of AAS characteristics for case studies.

Governance Structure	**Norway**	**Flanders (Belgium)**	**Spain**	**England (UK)**	**Germany**	**Poland**
Integration/ fragmentation	Private or FBOs cooperate and obtain support from public bodies for SHM	Research institutes collaborate to address soil topics	Synergies exist, but some conflict and tensions at farm level	Horizontally fragmented, but partnerships work with shared goal	Synergies exist, but some tensions between individuals	Synergies between public ODRs and private sector but some tensions
AAS capacity						
Management and organisation for SHM advice	Good competence and capacity to deliver SHM advice in NRL Staff recruitment and retention is a problem	Reliance on short-term project funding reduces continuity in SHM advice	Good organisation and management in FBOs but limited in others Culture of short-term projects limits outlook	Absence of planning for the necessary SHM skills and staff	Consultation services are well equipped, good resources; public provision has staffing limitations (Brandenburg)	Public sector under-resourced

Table 3. *Cont.*

Governance Structure	Norway	Flanders (Belgium)	Spain	England (UK)	Germany	Poland
Level of advisers' SHM knowledge *Knowledge and practical experience* *Soil fertility focus* *Environmental shift* *Heterogeneity*	Public bodies not very competent or up to date, main role in supporting fertilizer plans and subsidies, but high standard of soil management in the independent NRL	Good knowledge where advice linked to research institutes and independent services but commercial advisers have fertilizer focus	Unequal distribution of quality SHM advice Commercial and technical advisers emphasise fertilizers Big range in SHM advice quality, poor quality linked to new untrained advisers, good quality in organic sector	Some shift in private adviser activities to environmental and soil advice Large range, some excellent advisers (independent and in non-commercial initiatives) but commercial advisers have limited SHM knowledge	Good quality advice in consultation services, but scope could be wider Commercial advisers' emphasis on fertilization conflicts with advice for other soil functions but some shift to supplying environmental advice	Commercial advisers more active than public advisers but 'locked-in' by company goals Knowledgeable public advisers move to private sector Organic sector provides high-quality SHM advice
Advisers' training for SHM advice	Time and resources for soil training are often limited	Good attendance at dissemination events Limited time and resources for soil training in all sectors	Limited SHM training of technical advisers Need continuing education, as college training inadequate No unified certification	Good attendance at dissemination events Good quality CPD courses but could be more integrated	Large range of training courses, with more offered in recent years	In-service training in ODRs All sectors need continuing education to update college training
Attitudes and motivations of advisers and AAS	Positive NRL adviser attitudes towards the soil	High level of personal commitment to SHM needed	Horticulture advisers' commercial motivations can lead to low social value	A range of attitudes linked to advisers' objectives	High level of personal commitment to SHM needed	Balancing commercial advantage and farmer respect is important

4.1. Framing Conditions

The case studies represent a range of biophysical, political, socio-economic and farming contexts which determine the nature of the agri-food system, the distribution and intensity of production systems, the risk to the soil under agricultural management and public/private support. For example, in Norway, limited areas of arable land coupled with heavy rainfall, constrain timely tillage operations and has led to a national policy prioritising the reduction in the area under autumn ploughing in regions susceptible to soil erosion. In contrast, in Spain, low rainfall areas present challenges for farmers dealing with droughty soils. In Germany (Brandenburg), weather extremes mean water storage capacity, and water-saving cultivation methods are a priority. In both Flanders and Spain, specialised horticultural production systems put pressure on farmers' businesses and, consequently, the soil, while elsewhere, extensive crops such as 'soil friendly' wheat have lower profit margins. In England, arable farmers have expanded with more powerful machinery often implemented by contractors who do not always take account of soil conditions.

With respect to the political context, in Norway and England, there are, to some extent, shared goals between the government and the farming industry (farmer unions and cooperatives) which allow farms to deliver on a range of policies including food production and environmental goals (water, biodiversity, climate, soil). In Spain, a dual system results where intensive horticulture is mainly driven by commercial interests while political interests of soil conservation are more present in extensive agriculture. In Germany, public district and regional offices identified a lack of direction about soil management from the federal government.

From a socio-economic perspective, labour is expensive in Norway, and this affects farm profitability; in Flanders, seasonal land leases hamper any investment in SHM, while strong manure regulations have implications for managing organic matter. Land leasing in Poland leads to exhausted soils, while in Germany (Brandenburg), the large number of cooperatives are well managed by expert agricultural scientists, although the farms themselves are struggling with liquidity. In family-based, non-horticultural farms in Spain, traditional knowledge about and habits concerning soil management continue to be passed on through generations. These variable contextual factors act as framing conditions for AAS for SHM.

4.2. Governance Structures

4.2.1. Governance Arrangements

The six case-study countries have each evolved distinct AAS (and AKIS) in response to a range of framing conditions, with a different mix of public, private and farmer-based organisations (FBOs); non-governmental organisations (NGOs); and research institutes delivering advice that influences and impacts soil management in each (summarised in Box 1 from analysis of interviewee responses). The hybrid and dynamic nature of partnering and funding arrangements is notable across all the case studies. Consequently, there is a diversity and complexity of influencers on farmers' decisions about soil management.

The role of the public support varies across case studies. For most countries, the regional or district agricultural offices have been re-oriented away from technical advice towards administration of subsidies and regulations, where the emphasis is on cross-compliance (GAEC) or supporting scheme applications. For example, in Baden-Württemberg (Germany), the soil service from district administration indirectly controls handling of soils according to the law. Other advice which directly or indirectly impacts SHM tends to be offered through a number of channels; it is often contracted out by the government to private companies, independent companies, FBOs and NGOs and focuses on aspects such as nutrient management and cross-compliance. Only the Soil Service of Belgium, an independent non-profit organisation, is specifically dedicated to soil management. Notably, a public face-to-face advisory service for soil is largely absent or very limited across the case studies. FBOs are significant in Spain, where they are linked with technical soil advice in the production of high-value crops; in Germany, farmer associations are strong, and in Norway, which has a large independent membership organisation (NRL), soil advice is demand-led.

The emergence and influence of the private sector is notable across the case studies. This encompasses a range of advisers working for input suppliers or independently. These advisers play an important on-farm role, where they support day-to-day farming operations. The powerful advisory role of private companies linked to input sales was characterised in some countries as the 'commodification of knowledge', as one Polish respondent (PL3) remarked, "*advice becomes more and more important, and knowledge becomes a commodity that can be bought or sold*". The role of FBOs and the private sector has implications for SHM advice as they respond to farmers' production-oriented needs rather than public goods per se.

Box 1. A summary of the main AAS governance arrangements relevant to SHM in each case study.

Norway's pluralistic advisory system comprises FBOs, public and commercial services. The Norwegian Advisory Service (Norsk landbruksrådgiving NLR) is a decentralised service which provides independent farm, phone and group advice through membership (most large cereal producers are members). NLR also receives subsidies for the organisation's regional and local units to support public good objectives such as soil management and widening access. Other advice comes from advisers working for input companies, independent private consultants and agricultural business cooperatives (input and buyers). Governmental bodies, especially at the local and county levels, have a role in supporting fertilizer plans and subsidies, but there is limited governmental support and responsibility for advisory services.

In **Flanders**, there are different forms of AAS and different sources of funding (regional and provincial funds, farmers' contributions, industry). Public support is still important through funding of regionally embedded Research Stations (RS) which focus on physical and biological soil aspects and act as practical advisory centres, with group dissemination events linking research to farmers and advisors. The Soil Service of Belgium, an independent research and advisory institution, is the main RS for soil. Advisory services subsidised by the government include the CVBB (Coordination centre for education and guidance to sustainable fertilisation), with a focus on nutrient management, now replaced by B3W (Coaching service for a better soil and water quality), with a focus on improvement of soil and water quality. Provincial and regional offices manage administrative issues. FBOs (unions and associations, cooperatives), private consulting companies, Dutch advisors and upstream and downstream industries are a main AAS component and their attention is mainly on crop nutrition and fertilizers.

In **Spain**, there are no public services that specifically provide soil advice on farm, although Agricultural and Fisheries Research and Training Centres hold field events for crop nutrition advice, and regional agricultural offices offer technical advice and training to farmers but are mainly concerned with managing subsidies. Agricultural unions, universities, RDP and operational groups are also involved in advice initiatives. The dominant type of AAS in Spain is the FBOs, the OPAs and the Agro-Food Cooperatives, which are linked to high-value crops and hire their own agricultural technicians, supply companies, certification bodies and have large and established structures. They also have innovation and development centres and provide training to farmers. Farmers with extensive low profit systems (cereals and woody crops) have less access to technical soil advice at farm level.

In **England**, the AAS is diversified and highly fragmented following privatisation. For on-farm advice, agronomists/consultants (independent or commercial) tend to dominate. Where there are commercial interests, historically the emphasis has been on fertilizer recommendations; however, consultants also provide agri-environmental services. Levy bodies (independent/FBOs) offer knowledge exchange for sector production support. Public supported advice has been linked to agri-environment schemes and catchment-based initiatives (soil management to manage diffuse pollution), where cross compliance was a key objective, delivered in partnership with government agencies, water companies and contractors through on-farm and group advice. The government is prioritising supporting public goods (with an emphasis on soil) post-Brexit. A range of NGOs have become increasingly important in facilitating initiatives relevant to all soil health functions.

In **Germany**, there is a heterogeneous and decentralised governance structure where the Federal Government and the 16 Länder take an active role. Due to limited funds, most state services are becoming privatised. These are: (i) the state agricultural offices (free public extension providers) that engage in rural development and regulatory issues, and they also attend to local soil issues; (ii) the chambers of agriculture that offer free and charged advice, education and training; (iii) private consulting and advisory companies offer fee-based advice on specialised topics such as production and business management; (iv) numerous upstream and downstream companies also contribute, as do a broad range of actors who belong to FBOs (boundaries between private organisations and FBO are often fluid). Privatised advisory companies play a key role in the eastern German states.

In **Poland**, advisory services are provided by the state (Agricultural Advice Centres (ODRs)), agricultural chambers, private advisory organisations, companies and NGOs. The ODRs are in Brwinów (centre), branches and Voivodships and are responsible for the education, certification and registration of advisers in Poland. They offer financial and economic advice, while technological advice is limited, as well as organise training courses for farmers. Private agricultural organisations operate in the scope of the publicly funded measures under RDP and other national programmes. Commercial firms, which are extensive, supply advice as part of inputs sales and interact with ODRs. There are a large number of certified individual agricultural advisers who work for various institutions, private companies and farming communities under contract. There are also a large number of active FBOs, and Poland has a long history of agricultural production cooperatives.

4.2.2. Integration/Fragmentation

None of the case studies could be described as having an integrated framework for delivering soil advice. They exhibit different extents of integration and fragmentation in the AAS, which can be characterised by both cooperation and competition (for farmer clients and for project funds) between organisations.

With respect to inter-organisational cooperation, in Norway, private or FBOs cooperate and receive support from public bodies for topics relevant to SHM which do not lend themselves to commercial services. In Flanders, increasing collaboration between the CVBB and B3W advisory services provides a good example of the joint effort of several research institutes to address soil topics. Meanwhile, in England, although the AAS is horizontally fragmented, with multiple uncoordinated actors, organisations and delivery activities concerned with advice for different soil functions, there are a number of partnerships and initiatives where organisations work together towards a shared goal for SHM and water quality (for example, Catchment Sensitive Farming initiative). Synergies were identified in Poland, where the public ODRs host training events which bring together large numbers of farmers and invite private-sector companies, who are knowledgeable about the technologies or products, to participate. However, in Spain, a duality of advice was described with a clear distinction between public and private services, which has implications for soil advice.

There were different perspectives in Germany depending on experiences in the respective states: One respondent described few links between providers and competition between the different consultants and large companies. However, for another respondent (for Baden-Württemberg), the interaction between the state and private consultants at the agriculture office level was a strong point, and they agreed that synergies definitely exist, while there may be tensions between individuals.

In line with this viewpoint, the fragmented landscape and different objectives of public and private providers can have consequences for SHM at the farm level. In Spain, although most respondents did not identify tensions or conflicts in advisory service delivery, one respondent acknowledged that contradictions arise when there are commercial interests:

> *The system is not fully integrated, this affects sustainable soil management negatively because conflicting advice is given, or conflicting objectives are pursued [. . . .] when there are commercial interests, we do find contradiction.* ES2

As with Spain, in England, while advice is *"theoretically joined up"* (for example, a partnership will have shared goals), what actually matters is at an individual farm level, where farmers can be contacted by a number of advisers or projects officers. One respondent (UK2) said, *"I wouldn't say that there's contradictory advice now, but duplication"*, and also noted that farmers have been advised to do things by a commercial company which are questionable with respect to SHM.

A Polish respondent (PL3) also described tension and competition between companies providing agricultural products. Although, as another respondent explained, this depends on the company:

> *There are companies whose approach is to sell their products, and there are companies that act for example together with associations promoting the welfare of the natural environment recommending the use a range of suitable products.* PL2

Regarding vertical research–practice linkages in the soil context, these are considered strong for NLR in Norway which has good links with research; forexample, it is quite common for NLR and the research institute (NIBIO) to be cooperating in projects. This ensures good dissemination but also that projects are relevant to farmers. Researchers, farmers and advisers are also linked in Flanders, where research stations have strong outreach programmes, and in some states in Germany, where district agricultural office carry out practical trials with farmers. In Spain, in the horticulture cooperative sector, there are strong links from research to farmers providing a comprehensive service to these particular farmers. In England, the perception is that research and practice are disconnected,

and as the respondent UK2 said, *"It's actually the translation of that [research] into current farming practices, which is where the gap is".*

4.3. Advisory Services Capacity

4.3.1. Management and Organisation for Delivering Advice on SHM

Some respondents considered that there is good organisation and management of AAS but that other limitations prevent effective delivery of SHM advice. For example, in Germany (Brandenburg), the AAS are thought to be well equipped and prepared in terms of technical capacity, with an excellent research infrastructure around Berlin, but lacking political guidance about soil from the federal government. In Spain, some respondents agreed that despite good organisation and management of advice, more information and knowledge transfer are needed for effective SHM advice to be achieved. In Norway, there was consensus from all three NRL (farmer membership organisation) respondents that they have both competence and capacity to deliver advice on SHM. Furthermore, they were optimistic that advice will improve as public funding is now available to increase the focus on soils.

The capacity of public services, where they are provided, tend to be limited by resource constraints, namely, staff and financial. In Germany, there was a sense of good capacity and resourcing in the consultation services hosted by the state agricultural office in Germany (e.g., Baden-Württemberg); however, respondents noted the staffing limitations of public provision and the need for strong personal commitment. This is reiterated later in the analysis:

> *From the public side, we in the agricultural administration are mostly limited by the staff capacities. That is an aspect, which has deteriorated dramatically everywhere in recent years, so if we want to work towards [soil] sustainability, it's only possible through increased commitment beyond the actual working hours.* GR1

Furthermore, the emphasis on inspection and regulation by state bodies in Germany limits their time and scope of work with a focus on inspection. As a consequence, farmers supplement public advice with consultations by private companies.

The Polish state Agricultural Advisory Centres were described as working well to provide advisory services but not yet properly prepared to advise on soil protection, still being stuck in the *"old structures and treatments"* (PL1). They are also constrained by funding and often lose their best advisers to the private sector. The potential of private companies to fill the gap left by public services was identified in Poland. There was consensus that private companies are more visible and accessible and able to meet market demand. Referring to horticultural crops and crop- and soil-borne diseases, this respondent (PL3) remarked:

> *There are private companies that have appeared in the market and provide these services at a good level [. . . . .].. The institutes [public] have the potential, equipment, experience and knowledge, but it seems that due to financial and personnel constraints as well as other obligations, they are unable to respond to the very high market demand, and it is very large, while possibilities for conducting research are limited. Private companies, which are more and more visible on the market, are trying to fill this gap, which is good, because such companies can provide services as part of, for example, soil or plant research projects.* PL3

However, for private services, the business model is not always commensurate with building capacity. In England, privatisation of the advisory services has introduced a profit incentive which impacts resourcing, as one respondent, who works for a consultancy, explained:

> *We have to be a profitable organisation, which means that we haven't the luxury of an infinite amount of time [. . . ..] we do the very best we can with the resources we've got, but that some of the expectations of what it actually costs to deliver service are unrealistic.* UK2

This is also a factor in Germany, where dealing with new issues, such as supporting the necessary transition to new cultivation systems or meeting the state policy requirements for environmental programmes, represents an added effort for the consultation services in terms of costs, time and energy. However, adaptation is seen to be essential to ensure future services:

> *And every consultation service is required to adapt, to continuously improve, and to be up to date with the latest science and technology. I think that's actually a very positive development [. . . .]. But it is clear to them that if they do not consult their farms in the direction of sustainability, they will lose them completely in 10–20 years.* GR1

This need to build capacity for the future is reiterated by a respondent (GR3) who works with large cooperatives south of Berlin, where the long-term nature of soil health has become the focus of attention amongst the scientists who advise on the farms.

Private organisations also find that they have to compete for project funding. In Flanders, although the quality of advice is good for soil in the government research institutes and the independent Soil Service, the resourcing of activities is seen to be constrained by a reliance on short-term project funding, reducing the chance to build strong and enduring relationships with farmers. The remark "*True sustainable soil management advice does not exist to my knowledge, the Soil Service provide such integrated advices only as part of projects*" (BE3) is insightful in that it indicates poor continuity, as well as a dependence of projects for funding.

Staff recruitment and retention has implications for advisers' expertise and experience in SHM and was mentioned across a number of countries. In Norway, it can be difficult to recruit advisers who possess sufficient knowledge about soil if, for example, an experienced adviser retires. High turnover of advisers due to a lack of job satisfaction or progression and financial motivations exacerbates this. In Spain, advisers who belong to technical departments in FBOs (companies/associations) are seen to have more room for manoeuvre and are more organised and professionalised compared to commercial advisers. The absence of planning for the necessary skills and staff which may be needed in 2–4 years' time was also raised as a limitation for SHM advice in England.

Regarding an organisation's culture, there was also recognition that advisory organisations themselves have some responsibility to rethink how they advise farmers who are overburdened, face severe economic pressures and are constrained in terms of investing in new equipment, new crop rotations or new fertilization methods. In this respect, the culture of the organisation is seen to be important in Germany, where every consultation service has a specific philosophy that is shaped by the organisations' decision makers.

4.3.2. Level of Advisers' Knowledge about SHM

In the pluralistic advisory systems described here, it is difficult to characterise the expertise or the quality of advice for soil overall and SHM specifically, as this can depend on the sector and systems they support. However, the following provides some insights.

Knowledge and Practical Experience

Practical experience is seen as indicative of good quality advice and private advisers are more likely to acquire this, compared to public advisers, due to their regular on-farm activities. For example, the quality of advice is considered high in consultation services in Germany, although the focus is limited, and wider aspects of SHM advice are not covered:

> *I think, the quality of consultation is high [. . . .] many of the consultants are running agricultural businesses themselves, so they have a certain practical background, or they have simply been working at an agricultural office for many years, so they have a very high level of knowledge [. . . .] so far,[this] has mostly been on crop protection and, I think, especially in terms of sustainability, sustainable soil management, crop rotation, intercropping, things like that—there is still room for improvement.* GR2

Similarly, in Poland, private advisers were regarded as more effective and active than state advisers who, although knowledgeable, lack practical experience and the ability to follow up on advice to keep farmers up to date:

> *A strong point of commercial services is that they have capable advisers. With regard to government institutions, their strong point is certainly their infrastructure and the preparation of speakers, i.e., advisors, who are very knowledgeable, but then somehow nothing happens. And this is the weak point, that there is a lack of continuity, on-site continuity, during on-site workshops. Often these advisers lack practical experience and [. . . .] are unable to keep up with these new solutions and products.* PL2

Another Polish respondent (PL3) noted that, with the loss of good quality government advisers to the private sector, their expert knowledge now only reaches farmers who are customers of private companies. This unequal distribution of quality advice (including SHM) was also identified in Spain, where technicians with a good level of specialist expertise in horticultural production support intensive crop growers, but family-based businesses with extensive systems in other sectors in Spain have limited access to good quality advice on soil. Furthermore, pockets of high-quality SHM advice were described for advisers in the organic sector, as mentioned in Poland and in Spain, and for advisers selling products related to, for example, organic or sustainable management who "*provide information about the nature of living soil, biodiversity or soil quality*" (PL2).

In Norway, governmental and public bodies, especially at the local and county levels, were described as not very competent or up to date, with a main role in supporting fertilizer plans and subsidies. However, the respondents all agreed that the standard of advice for soil management is high in the independent NRL, where the advisers are knowledgeable and have an increasing focus on soil health and environment.

Soil Fertility Focus

In all case studies, there was agreement that private advisers (working for input companies or as independents) are generally trained to advise on soil from the perspective of fertilization and crop nutrition and tend to look at crop management in the shorter term. This emphasis was noted by a respondent (PL3) in Poland who said, "*My impression is that most advisers focus only on the composition of the soil, on just the chemical factors, but they ignore and totally undervalue the importance of soil microbiology".*

A number of respondents called for a change in the mindset of advisers away from production-orientated to more holistic advice, with a shift in thinking from soil chemistry to a microbiological approach required, to show that *"living soil can achieve more".*

This focus on soil fertility and crop nutrition can have some negative implications. For example, in Flanders, commercial advisers were known to advise maximum fertiliser recommendations irrespective of crop requirements, which is contrary to good practice recommended by research organisations. This was also noted in Germany, where an emphasis on fertilization as part of an overall crop care package can lead to conflicts with advice for other soil functions. This respondent in Poland highlighted how some advisers are 'locked-in' by their company's commercial imperatives despite being knowledgeable:

> *Many advisers are enslaved by receiving payment from the company, so they have to advise according to the company's offer, and this limits their freedom to act; they have the knowledge but they will necessarily be focused on bonuses, on a raise, on finances, and this restricts them.* PL3

However, respondents did not think commercial advisers purposely provide negative advice, although they may be slightly less inclined to look at the environment or at soil quality, soil biology, etc. In Spain, where consultants are often influenced by their employers, one respondent suggested that there is no intention to damage soil; however, they may not be aware of the externalities of their advice:

> *I don't think there is one main advisory service that has either a positive or negative impact. Normally advisers have the objective of increasing overall production. The adviser does*

> *not go against soil sustainability or soil quality, but [. . .] the use of these technologies continuously without other guidelines in the end leads to an overall degradation of the system, mainly of the soil.* ES2

Environmental Shift

The Green Deal and the demands from supply chain companies and retailers to meet food and farming standards and gain a market advantage were considered by many respondents to be driving advisers towards SHM advice. However, there is some cynicism in Poland that advisers and input-sellers are using slogans related to environmental and soil protection issues but, fundamentally, are still largely dependent on the producers of chemical agents for their income.

In England and Germany, there has been a shift in commercial adviser activities towards supplying environmental advice (supporting agri-environment scheme applications, as well as practices for good soil management), and for agronomists linked to input sales to sell cover crop and, pollinator seeds and biosolutions. A German respondent described the growing demand:

> *In recent years companies have emerged that strive towards sustainability, selling crop fortifiers, soil additives and so on. Active local consultants and some farms use these products in their cultivation. This is of course due to the fact that, in the last few years, little has been done in terms of soil fertility and sustainability on many farms. They are now reaching their limits in terms of plant cultivation, they have problems with diseases, with the soil, etc., and companies, which offer the appropriate products, have been in greater demand in recent years.* GR1

This situation is replicated in Poland where more companies are entering the market with 'natural products' aiming to meet farmer demands.

Heterogeneity

One common factor across all case studies was the heterogeneity in the quality of advisers with respect to soil advice, with a spectrum of very good to very bad commonly being described. In Spain, a range from very good agricultural technicians to others who do not have the necessary knowledge was linked to the number of untrained advisers emerging to meet the increasing demand for sustainability and ecological advice. Similarly, in England, a respondent (UK1) referring to agronomists said, *"I think the good are very good, but I don't think we've got many very good ones, I think a lot of us are in the category of willing triers"*. However, he acknowledged that there are excellent pockets of SHM advice amongst independent advisers and non-commercial initiatives. This range is echoed in another comment by a respondent from England who described the value of long-term experience:

> *Some of them are extremely knowledgeable and interested [about soil] and have been in their post for quite a long time. Some of them are on short term contracts. And some of them who are less good than others, in terms of their understanding of the technicalities of what they're talking about, and what they're being asked to do.* UK2

The same sentiment was expressed by respondents in other case studies, where advisers develop a very good reputation because they have been in the profession for many years. A range of abilities and interests was also described in Germany, where the ease of substituting SHM principles with agrochemicals was blamed on a lack of attention to soil by some advisers:

> *There are consultation services, or even individual consultants on the part of the industry, who attach importance to the topic [soil]. But there are also people who have never bothered with the subject, because it is still possible to achieve good yields with the use of mineral fertilizers or chemical-synthetic pesticides.* GR1

The distinction between the role of the advisers as generalists or experts was widely discussed. There are very few agricultural advisers across the case studies who focus

specifically on the soil or get the opportunity to become experts. Some take the view that soil experts can be consulted when necessary, but that wider skills are needed at farm level, as this respondent explained:

> *Rather than being experts on that particular aspect, we reflect the farming community, in the sense that we are people with a wide range of skills, but an expert in nothing. An expert—he's talking purely about the soil, and the health of the soil, we will be talking about it on the profitability of the rotation, the control of various injurious weeds, diseases and pests, and then looking at a rotation that is sustainable, which then comes back to the soil. However, we know where to go to get expert [soil] advice.* UK1

Differing perspectives on the value of experts versus generalists were picked up in the Spanish interviews. One respondent agreed that a historical focus on supporting production has led to fragmentation where an agricultural technician may know a lot about tillage or agricultural equipment but does not have a general vision of sustainable soil management. The other two respondents in Spain, however, argued that advice to farmers on soil management is too general and the level of expertise low; one (ES4) identified "*A strong need for the participation of people who are soil specialists—soil scientists, biotechnologists with application to soil microbiology*".

4.3.3. Advisers' Training for Delivering SHM Advice

There are a number of opportunities through multiple talks and events for all advisers to expand and update their SHM knowledge, mentioned for all case studies. In Flanders and England, for example, large numbers of advisers reportedly attend dissemination events and demonstration days, and for many, this is important for networking. In addition, there is now comprehensive information about soil topics on the internet and social media and opportunities for peer-to-peer learning and exchange. However, as noted already, poor attention by advisers to SHM has been attributed to the absence of good training.

Time and resources for soil training are a concern for some. As one respondent (N2) in Norway noted, "*unfortunately we have to prioritise covering our hourly rate as employees, so that can affect how much time we have to educate ourselves, go to conferences, seminars*", illustrating the fact that advisers (from all organisations) are often under financial targets and pressures to the detriment of their training and upskilling in SHM. This imperative steers organisations' decisions about training as well. In Flanders, for example, obtaining a certificate (Flemish Land Agency certification or other quality control procedures) is costly both in terms of time and money, and as a consequence, certification is profitable for only a few advisory institutes/services.

There are a large number of options for in-service training in Poland with ODRs taking on a key role for farmers and advisers. Advisers within the commercial sector in Poland are also considered well trained but only within the sphere of their operations and products:

> *It seems to me that every commercial business tries to train its advisers so that they do at least have this information as regards their own products, how they affect the soil and therefore they must have prior knowledge or learn about the soil, its quality, the processes that take place in the soil environment.* PL3

In Spain, the nature of skills and training depends on the type of agricultural technicians (cooperative, input company or independent). Most respondents agreed that the level of SHM training of technical advisers in Spain is low overall, as one remarked (ES2): "*Advisers do not have sufficient skills and experience to give advice on sustainable soil management [, . . .] because they have not had sufficient training during their studies*". As such, these agricultural technicians need to seek out further training to enable them to meet changing demands. These points were reiterated for Poland, where the notion of continuing education was raised:

> *Every adviser needs to participate in continuing education, as the knowledge gained when graduating from college is not enough [. . . .]. It is necessary to educate, educate and*

> *again educate advisers and farmers, and to provide this new knowledge about sustainable soil management, which is completely different from the information provided before.* PL1

Another respondent from Poland (PL3) supported this, remarking that studies are only the basis and a good adviser has to train for the 'rest of their life', otherwise, they quickly lose touch with reality. In Spain, respondents noted that there is no unified certification validating the agricultural technicians' knowledge. In Germany, large differences in the range of training courses were described, with more being offered in recent years. In England, there is an established continuing professional development (CPD) scheme for advisers (FACTS, BASIS) which offers courses on soil and water management. While acknowledged to be outstanding compared to other European countries, a respondent pointed to the inadequacy of these courses in terms of SHM:

> *In terms of sustainability, I think they're both useless. They've evolved out of a commercial requirement. So it wasn't evolved to deliver good, independent, impartial information [. . .] they do provide a level of professionalism.* UK1

Another respondent from England thought that a FACTS-qualified adviser would understand about nutrient management but argued that BASIS is too technical and academic and that the modular training does not prepare advisers to deliver integrated advice, considering soils, nutrients, water management together, nor help them understand the underlying principles of SHM:

> *So as far as, is the training fit for purpose for the next generation of advisors? One of the problems that we and the whole industry has got to know that there's plenty of advisers who are qualified, but not necessarily have a good understanding of the principles[. . .] you need to be able to understand what you're doing. And why are you doing it.* UK2

There was also agreement that capabilities need to be expanded to beyond a focus on production objectives and soil fertility and crop nutrition advice, to meet new demands, reinforcing the points made earlier. This respondent from Spain noted that this was a key limitation for SHM advice:

> *From my point of view, there is enough organisation to provide advice on sustainable soil management and there are enough people capable of providing basic guidelines for sustainable soil management but there is a lack of general training on what is the true nature of soil quality beyond nutrient fertility.* ES3

The extent of informal learning through adviser networking was mentioned by some respondents but did not emerge as a particularly strong aspect in the interviews.

4.3.4. Attitudes and Motivations of Different Advisers and AAS

Positive adviser attitudes towards the soil were described by a number of respondents, however, there is still a range of attitudes linked to economic motivations. Fundamental differences in motivations between advisers were identified in Spain and this aligned to their organisations' objectives:

> *An adviser who belongs to a trade union or a regional agricultural office has a different vocation than an adviser who belongs to a commercial company or to a research centre; their motivations are very different, which means that their inclinations are also very different.* ES1

This can have implications for advisers' reputation and credibility. According to respondents, for example, in the horticulture sector in Almeria, agricultural technicians do not always have high social value and may even start to have a bad reputation. This is echoed in Poland, where the balance between commercial advantage and gaining farmers' respect was seen to be important: *"There is no doubt that an advisor's motivation is influenced both by economics and by the desire to be respected by farmers, it really depends on the person"* (PL1). Many agreed that farmers are able to quickly discern any 'shortermism' and the commitment and motivation of advisers.

For many respondents the different motivations and attitudes of the individual adviser were regarded as more important than the type of organisation they belong to. The high level of personal commitment required by some advisers to pursue their interests in, and deliver, SHM advice was mentioned by respondents. Consultants in Spain, for example, are often limited by specific short-term projects or task forces. When these are finished, if they want to continue with the topic, this has to be done in their own time. Similarly, in Germany, personal effort is linked to quality advice:

> *Yes, well, there are advisers who are just all-around good advisers who really give their best and try to constantly educate themselves in order to be able to provide the best possible consultation to the farmers . . . I think most of the vocational counsellors actually—and yes, I think that of the ones that I know, most really put their full effort into it.* GR2

5. Discussion

5.1. Governance Structures

This analysis confirms the picture painted by previous researchers of considerable AAS diversity between, and pluralism within, European countries [71]. This translates into a diverse landscape for SHM advice with different governance, funding and delivery mechanisms and no evidence of any integrated advisory frameworks for delivering advice for soil management. The analysis shows that institutional options available for financing and the level of coordination are limited with respect to delivering advice for soil management, as observed elsewhere for AAS more generally [50,56]. A reduced central organisational role of government agencies in AAS and an emerging 'knowledge market' [33] has led to a continued decline in the public sector's role in delivering on-farm soil advice for all case studies, with the diversion of their resources and staff towards compliance regulation and scheme/grant administration. Conversely, the prominent role of the private sector, independent organisations, FBOs and NGOs is apparent in filling the gap in delivering on-farm advice that influences and impacts soil management, either through contracts (projects) to fulfil government objectives (e.g., FAS, grants) or commercially in a more market-led environment, as described in other AAS studies [33]. When state and private advisors are incentivised to administer regulations and grant applications, this narrows down choices and limits broader understanding of 'know-why' soil processes [14,72]. New services are also emerging, and overall, the number of advisers with commercial links to economic actors (input suppliers, consultants) is increasing [26].

Fragmentation means competition for clients and project funding, and soil advice at farm level can be compromised by conflicting delivery or duplicating advice in multi-partner approaches, as reported by others [73]. However, many hybrid and dynamic arrangements for partnering and funding for delivering SHM advice are notable. These 'creative alliances' provide opportunities for the effective integration of delivery of soil advice at programme level. This ability of pluralistic advisory services to overcome constraints (shortages in funding, staffing, etc.) through increased cooperation, collaboration and partnerships has been observed elsewhere [29,71,74,75]. Individual relationships of both competition and cooperation, described by Compagnone and Simon [24], were not shown in this analysis.

5.2. Advisory Services Capacity

These governance arrangements provide a backdrop to understanding different organisational arrangements and capacity to provide SHM.

5.2.1. Management and Organisation Capacities for SHM Advice

The analysis identified organisational constraints in resources, funding and staffing, notably in the public services, which are not always able to meet demands, and this impacts the capacity to deliver SHM advice. There are inherent frustrations concerning reliance on short-term project funding for developing and continuing with advice streams, as previously described for environmental advice [31,76]. This often means only committed

advisers continue with the SHM advice when the project ends. Poor staff retention [24], with the loss of advisers' knowledgeable about SHM to the private sector, reduces farmer access to SHM advice. Although farmers might look outside of formal advice in such circumstances [72], their options for benefiting from high-quality soil advice are diminished. Other commentators have noted that commercialisation threatens the extension capacity of government agencies [77], however, technical expertise has not been considered.

Investment in staff capacity for SHM advice (training and field days) is restricted in both public and private sector organisations by limited time and resources and the competitive business environment. Small firms also struggle to meet new environmental requirements, corresponding with previous observations [34,42]. Furthermore, in some commercial organisations, economic drivers can lead to an organisational culture that values input sales over expertise in SHM.

These organisational capacities affect individual advisers' capacity to operate effectively, their objectives and motivations, their professional culture and the support they are offered to deliver SHM. As observed by Klerkx and Jansen [34], this wider set of institutional conditions, and the relationship with the 'back-offices' which supports them professionally, is critical for enabling advisers to develop and deliver specialist and professional advice. Furthermore, maintaining a stable or increasing workforce as well as diversifying the expertise and increasing the competence of staff are seen to be critical for AAS [29].

5.2.2. Individual Capacities for SHM Advice

Individual capacity results from a combination of attributes: quality of advice; training; and motivations in relation to SHM. Firstly, regarding advice quality, heterogeneity in levels of advisers' soil knowledge was observed across all cases and across all AAS types, with few advisers considered to be delivering all-round high-quality advice to support SHM. This adds to the emerging body of evidence showing that advice on soil management is suboptimal. What constitutes 'good quality advice' with respect to soil management was understood differently due to advisers' varying goals and their clients' needs. It was generally characterised by, not only extensive on-farm practical experience and a good level of subject-matter knowledge or expertise [67], but also critically by an understanding of soil chemical, biological and physical processes and principles [78]. Private advisers (commercial consultants, technicians and agronomists), while being credible with respect to providing high-quality technical advice, are limited in scope to soil fertility and crop nutrition. This observation is supported by studies showing the predominance of advice based on nutrient testing and interpretation to support farmers' short-term production decisions, e.g., [45]. This limits opportunities to incorporate soil health perspectives into advice, which are critical to understanding the capacity of soil to function as a vital living system [16,17]. Only very few advisers are taking a holistic approach, accounting for non-linear mechanistic relationships between various physical, chemical and biological soil properties considered important for soil health [19].

The significance attributed to practical experience, however, should not be overlooked. This allows advisers to provide localised advice and meet the fine resolution of soil information and data that farmers require [9]. This highlights the value of experiential learning (and co-learning with farmers), which has a particular significance for soil management due to the in-field observations and sensory experiences required [79,80] and is highly appreciated by peers and the practitioner community [78].

Equally, whilst expertise in soil science and management (demonstrated by some individual advisers) is valued, the role for the generalist agronomic adviser who takes a whole farm perspective is seen as important. Interestingly, advisers have been shown to be capable systems thinkers [74] and positioning SHM within the wider farm business and environment is in itself an important skill. Further specialisation, in, for example, soil microbiology was called for by some respondents, in line with emerging farmer interest in soil health, but how such specialists would position themselves in the AAS

landscape was not elaborated. Landini [41] suggested that not all individual advisers can hold the same knowledge and capabilities but instead can act in groups to enrich their work. This professional distribution of advisers' SHM roles, skills and specialisms and the way they interact, complement and learn from each other, is an interesting area for future research [24,79]. Furthermore, the changing role of the technical 'expert' needs consideration [81].

Secondly, with respect to training, poor investment in training and particularly in continuing education in SHM in both private and public spheres was seen to be a key reason for the limited scope of advisers' expertise. Training and professional development courses on soil topics, whilst considered to be at a high standard in certain countries, do not always provide an understanding of the principles and processes of SHM. A number of studies have shown that advisers are increasingly relying on each other for sharing soil expertise through professional networking [82]; however, this was not identified in this analysis as an alternative to training. These findings are inconsistent with previous studies [30], although the focus was not SHM.

Thirdly, regarding motivations, personal intrinsic interest in soil was a further facet demonstrated by a few public and independent advisers. The economic motivations of private sector advisers' (linked to input sales) observed here are widely reported in studies that concern soil [10,36,83]. The image of advisers as 'locked into' supporting intensive agriculture pathways has been also described for high-input production systems [26,84], as has the power of supply chain actors [36]. However, analysis here suggests a more nuanced picture, with many private advisers balancing economic motivations with the need to retain respect, social value and trust in the farming community. This loyalty dilemma between private good (what the farmer demands and pays for) and public good (issues of broader importance for society as a whole) [29], may need to be re-examined in a future context when incentives for providing SHM become available (e.g., carbon farming, Environmental Land Management Schemes in England). Organisations are already responding to the market and offering a range of environmental services, and supporting sales of 'natural' biological products. However, the depth of understanding and commitment that accompanies these was queried, and there were calls for a more fundamental shift in advisers' mindsets.

Professional culture is closely connected to individual advisers' motivations and mindsets, accepted norms and values, how they perceive and execute their tasks [34], and their performance rationale and economic strategies [26]. However, adviser roles are not set: Nettle, Crawford and Brightling [42] describe the fluid nature of adviser professional identities and opportunities for evaluating their roles through reflective practice [41,85], which, if organisations were more flexible, could lead to reorientation of soil management advice.

5.2.3. Narrowing Down

Although it was not the intention here to assess the performance characteristic of the framework, some observations can be made. The needs and opportunities, which characterise performance [50] that have been steering advice in relation to soil are: policy (cross-compliance regulation and grant administration support) and markets (farmer demands for crop production advice). As a result, there has been a narrowing down of soil advice, both with respect to content and access, as depicted in Figure 2.

However, the increasing interest in soil health from both farmers, in part due to the recognition of soil degradation [18,86], and policy makers, will provide the new drive and opportunities to widen the scope of advice to cover physical and biological, as well as chemical, processes. To achieve this, AAS organisations will need to invest in adviser training and capacity building and aim to shift professional cultures and mindsets at organisation and individual level. This will require incentivisation, and Dhiab, Labarthe and Laurent [26] identified a need for public policy intervention to support this. This could be through, for example, strengthening national FAS with requirements for member states to provide standardised and certified adviser training and continuing professional development in SHM. Ultimately, however, AAS are shaped by the framing conditions,

the priorities within the agricultural sector strategies (high-value commodities or environmental sustainability) which are beyond the direct influence of policy makers and advisory services managers [50]. In turn, these determine the governance structures and the relative capacities of public, private or NGO AAS and the services offered. As Knierim, Labarthe, Laurent, Prager, Kania, Madureira and Ndah [23] point out, the historically grown, path-dependent institutions and institutional constellations in each EU member state play an important role in AAS.

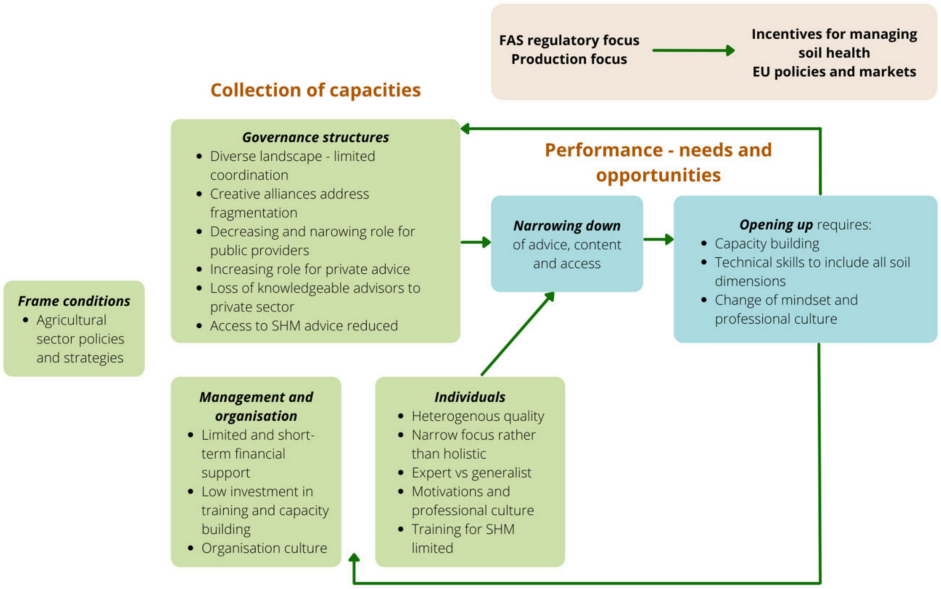

Figure 2. This figure shows how the collection of capacities act to narrow down the nature and extent of advice for soil. Changing needs and opportunities will open up the scope of advice for delivering SHM.

There have been calls for capacity building in knowledge systems at individual, organisational and AKIS levels [42]. This encompasses adviser training and professional development and more back-office support [28,85] as well as the need to understand the varying roles of professional advisers [87]. However, the focus has often been on process skills, the (new) intermediary, advisory styles and facilitatory skills that advisers should master to support and empower farmers in networks of interactive learning [88]. Adviser technical or specialist roles have received less attention, notably for soil, despite the growing demands placed on them for understanding and supporting land managers in the management of complex soil functions.

6. Conclusions

The framework employed allows the collective capacities (governance structures; organisational and individual capacities) of AAS for SHM advice to be revealed. It shows that advisers' competences and skills should not be seen in isolation. As such, the recommendations for expanding the scope of content and access to SHM advice include addressing deficiencies in training and capacity building, shifting professional culture as well as addressing more deep-seated institutional conditions and governance structures. Incentivising such changes will require changes in both policy and market drivers. These insights show that AAS can play a central role in the transformation of food systems more widely [89].

The method based on in-depth interviews (18 experts) provides insights for a cross-section of European countries offering a range of perspectives, as well as common themes with respect to capacities which affect the nature and extent of SHM advice. However, the results can only be indicative for Europe as a whole and further qualitative and quantitative research will be needed to provide a more comprehensive picture. In particular the results

show how different advisory services that influence and impact soil evolve in specific country contexts. This suggests that the model of identifying systems that best fit context-specific conditions is suitable for future support of national AAS with respect to SHM. Critically, the methodology did not explore the complexities of the relationship between advisers and farmers/land managers, nor capacities in terms of the soft skills required for co-producing technical soil knowledge or the changing mature of the 'expert' role of advisers.

With the accelerated move towards the integration of soil health issues in a number of European Commission strategies and the actions and ambitious targets set for soil health within the Soil Mission 'A Soil Deal for Europe', the requirements for building capacities and a knowledge base for soil health enhancing practices in agriculture will increase [13]. This will require member states to significantly enhance their AAS capacities to achieve this desired transition, with implications for both European and national level policies.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/land11050599/s1, SoilCare advice review Interview schedule.

Author Contributions: Conceptualization, J.I., J.M. and C.-A.C.; formal analysis, J.I. and C.-A.C.; investigation, J.M., J.E.B., C.-A.C., J.A.A.-S., A.E., M.F., B.L.-F., P.M.-G., K.S., J.S. and M.T.; methodology, J.I. and J.M.; project administration, J.M.; resources, J.M.; supervision, J.M.; writing—original draft, J.I.; writing—review and editing, J.I., J.M., J.E.B., C.-A.C., J.A.A.-S., A.E., M.F., B.L.-F., P.M.-G., K.S., J.S. and M.T. All authors have read and agreed to the published version of the manuscript.

Funding: This work was part of SoilCare (Soil care for profitable and sustainable crop production in Europe). Grant Agreement 677407 funded by the European Union's Horizon 2020 research and innovation programme. www.Soilcare-project.eu (accessed on 20 September 2021). 2016–2021. This funder had no role to play in the design, data collection, analysis or interpretation of results presented here.

Informed Consent Statement: Ethical standards and guidelines have been applied to the collection, processing and storage of data about persons, in accordance with the agreed project ethical statement. All subjects gave their informed consent for inclusion before they participated in the study.

Data Availability Statement: Data are confidential and not available.

Acknowledgments: We acknowledge the support given by other partners and stakeholders in the SoilCare project and in particular the interview respondents.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Abbreviations

AAS	Agricultural Advisory Service
AKIS	Agricultural Knowledge and Innovation System
FAS	Farm Advisory System
FBO	Farmer based organisation
NGO	Non-governmental organisation
EU	European Union
GAEC	Good Agricultural and Environmental Condition
PROAKIS	Prospects for Farmers' Support: Advisory Services in European AKIS
NRL	Norwegian Advisory Service (Norsk landbruksrådgiving)
SHM	Soil Health Management
SSM	Sustainable Soil Management
CVBB	Coordination centre for education and guidance to sustainable fertilisation, Belgium
B3W	Coaching service for a better soil and water quality, Belgium
OPAs	Professional farmer's organisations and Agri Food cooperatives, Spain
ODRs	Agricultural Advice Centres, Poland
NIBIO	Norwegian Institute of Bioeconomy Research

UK	United Kingdom
CPD	Continuing Professional Development

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