SPRING 2018

Status of agricultural knowledge

Development and advice

DEVELOPING AGRICULTURAL KNOWLEDGE AND ADVICE

aic agricultural industries confederation

Contents

Executive summary ..... **i**

1. Introduction **1**

1.1 Value of Advice Report 2013 1

1.2 VAP Recommendations 1

1.3 Value of Advice Report Recommendations Delivery; Feed Advisers 1

2. Fit for purpose: supporting a future UK agricultural industry **3**

2.1. Productivity post EU Exit 3

2.2. Resource use efficiency 3

3. A strategy which recognises Industry's significant network of professional advisers **4**

3.1. Industry's network of professional advisers 4

3.2. Trusted and productive relationships 7

3.3. Proof of the relationship between face to face advice and changes in farming efficiencies 8

3.4. Industry supporting innovation 8

3.5. Investment in Innovation. 9

3.6. Training to deliver innovation and nationally recognised professional competence. 9

4. Agricultural research and development. **11**

4.1. Private sector investment in R&D. 11

4.2. Industry leading investment in near market innovation. 11

5. Conclusions and recommendations **14**

References 16

Appendix 1: Survey of AIC Members 18

Appendix 2: Professional Registers 20

Executive summary

"The whole is greater than the sum of its parts."

-Aristotle -

The UK's impending exit from the European Union may impact the agricultural sector more than any other. The opportunity for UK government to set its own agenda comes with the corresponding reality that UK farmers will face uncertainty due to political aspirations. Whatever form future agricultural policy takes, the industry must seek to improve efficiency, productivity, and environmental performance, mutually beneficial aspirations which should drive a more competitive UK agriculture.

For some years, the rate of increase in UK productivity has been slipping behind that of competing nations in Europe and further afield. Although productivity in the UK continues to grow we are not keeping pace with the improvements of others. This challenge has been recognised by both industry and government alike. Funding the sector through the Agri-Tech strategy and the introduction of policies promoting sustainable agriculture indicate a continuum for responsible and efficient resource use to ensure improved productivity and safeguarding the environment, with sound land management decisions**.** The recent 25 year environment plan (defra, 2018) confirms a clear direction for policies seeking to improve the efficient use of resources and to promote more integrated use of land, improvements in soil quality and environmental protection and recognition of natural capital in the future of land use policy.

The UK agri-supply chain has the practical knowledge base to narrow the competitive gap. However to regain UK farming's position as a world leader in agricultural technology the challenge is to ensure the whole research and knowledge chain - public and commercial – work cohesively towards shared outcomes. Although certainly there are areas of excellence within our research base e.g. agronomic and genomic expertise there are some areas, particularly within Livestock research, where our capabilities and capacity for high quality fundamental research have waned. To fill these gaps requires UK's political, academic and business leaders to have a clear view of the outcome needed, how parts of the chain fit and how to co-operate more effectively.

This report aims to illustrate the UK's inherent strategic capability, through updating the understanding of the added value of commercial research and knowledge, and the significant potential from forging effective partnerships between commercial and state-funded activity.

The commercial food chain stretches from breeding, the manufacture and supply of farm inputs through practical farming and processing to food retail and catering. It plays an important role in achieving national goals for food production, food security and environmental sustainability. In terms of farm inputs, AIC represents some 250 member companies involved in the supply of goods and services worth £9 billion at the farmgate (including supplies of fertilisers, crop protection products, seeds, livestock feed and crop marketing). These businesses offer technological and advisory solutions to farmers through a significant labour force of commercial professional advisers and representatives, with a cost of around £500 million annually.

Professional advisers range from agronomists to vets, from feed advisers to seed merchants and crop marketing advisers. All play a vital role in translating research and information into knowledge needed

for innovation. Advisers deliver practical advice tailored to each client's circumstances. Such advice helps businesses improve competitiveness, resource efficiency and delivers environmental improvements, all objectives of government policy. The value that the advisory community can bring to the implementation of innovation on farm cannot be underestimated. Advisers work with farmers daily to influence approximately 90% of the farmed land in Great Britain supporting both the daily management of thousands of SMEs to multinational agri-food businesses as well as supporting their clients in the strategic direction and innovations that ensure their businesses can grow. Commercial advisers develop long lasting relationships focused on the needs of their clients; their advice is well trusted as history has shown it to be sound, and has a high degree of influence on the practices on farm offering solutions that meet multiple objectives, integrated with their client's specific requirements. This is a key point of differentiation with the wider advisory community such as those from the third sector or government agencies, where the primary interests are behavioural change to meet objectives outside the direct interests of the farming business. Often this advice is generic and delivered to many individuals at once.

The relationship between professional advisers and their clients is one based on trust; farmers rely on the advice they receive and it supports their decisions. Advisers must be able to provide high quality bespoke advice that is able to respond to the ever changing political and climatic influences effecting agriculture in the UK. In order to ensure advice provided is credible and trusted, competent Agronomists and Feed Advisers participate in membership of professional registration and continuing professional development (CPD).

Professional advice is supported by comprehensive R&D programmes. For AIC members the investment is estimated at over £50 million a year (see appendix) with the majority, although not all, of this being focused on near market research and developmental trials. The link between this near market research and the advisers is critical to ensure investments made by AIC members translates into uptake of new technology and practices on farms for the farmer's benefit. Therefore the significant investment in R&D is correspondingly supported by a programme of adviser training that equates to over 800,000 hours per year.

In conclusion the agri-supply industry is perfectly placed to assist the drive for increasing productivity and sustainable land management through its part in existing coherent knowledge exchange. AIC members with its community of highly trained, well trusted advisers coupled with significant near market research and development support the majority of UK farmers and farming systems to make the gains required both in terms of improved productivity and efficiency and competing profitably with the rest of the world.

To realise the opportunities presented by the UK, investment in agri-tech and innovations a more strategic overview of the various research and knowledge exchange providers will be required. By working with government, academia and the levy bodies the agri-supply industry can contribute towards a more effective and outcome focused strategic approach to R&D and knowledge exchange. One led by a vision for the industry as opposed to fragmented and poorly coordinated activity often driven from academic preference rather than seeking to meet the challenges facing agriculture.

1. Introduction

AIC, the leading trade association in the agri-supply industry, promotes the benefits of modern, commercial, sustainable agriculture in the UK, and supports collaboration throughout the food chain. The sectors represented by AIC include animal feed, crop protection and agronomy, fertilisers, grain, pulses and oilseeds, and seed. The professional advisers who interact directly with farmers within AIC member companies include: crop advisers/agronomists (BASIS/FACTS qualified), farm traders, seed merchants, feed advisers and animal nutritionists

1.1 Value of Advice Report 2013

In 2013, AIC published a report entitled '*The Value of Advice Report*' (VOA) evaluating the role and influence of the 5,000 strong body of industry's professional farm advisers in knowledge exchange (KE) and in changing on-farm practice.

The Value of Advice Report described the relationship between farmers and those who advise and support them and introduced the concept of inner and outer circles of influence. This is illustrated in the 'Ring of Confidence' (figure 1) with an inner circle of highly trusted advisers, who are often seen by business owners as 'part of the team', and have direct influence over the decision making on farm (AIC, 2013). This became well recognised and common parlance in Government circles and by key agricultural bodies involved in advising and listening to farmers.

The 2013 report findings remain as relevant now as when first published. The inner circle of advisers' role remains key to successful knowledge exchange (KE). Advisers are able to share and translate information efficiently making new innovation relevant to their clients' circumstances. This has been partially recognised by public bodies with KE events aimed specifically to keep commercial advisers up to date on changing legal requirements and technological advances. Recent examples include the evolving partnership between Government's Catchment Sensitive Farming advice programme and Farm Advisory Service adviser updates held in 2015/16. This capability is also recognised within AHDBs recent research and knowledge exchange strategy (AHDB, 2017) as well as by devolved governments.

1.2 VAP Recommendations

The 2013 report made several recommendations including recognising the growing network of professional advisers within any future advice delivery strategy offered by government. Although there has been some progress, we propose that further opportunities exist to better support farmers through more joined up knowledge exchange strategies.

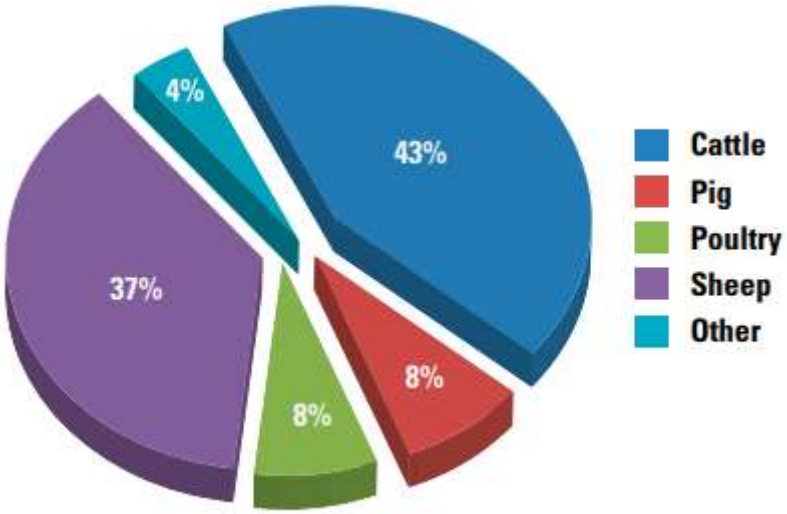
Although the report identified the support of feed advisers within the livestock sector it also identified a gap in the verification of the training and skills and the need for more integration of advice delivery to the grassland and livestock sector, especially co-ordinating advice on grass and forage nutrition with livestock nutrition.

To fill the gap in independent assessment of feed advisers, AIC developed the Feed Adviser Register (FAR) in 2013 to recognise competence within the sector to meet both industry and policy needs.

1.3 Value of Advice Report Recommendations Delivery; Feed Advisers

The Feed Adviser Register (FAR) developed since the Value of Advice Report means the capability to provide advice in the livestock sector can now be described and quantified.

Figure 1: Feed adviser registered by speciality.



(source: spring 2017 FAR newsletter. Note: some advisers hold more than one specialism)

Launched in 2013, FAR now has 1,100 active members, all of whom have undertaken three modules of foundation training in order to standardise a level of understanding of the link between achieving production efficiencies and environmental protection (FAR website). The content of the modules has been driven by both the supply industry's desire to help farmers plan for longer-term sustainability of production systems and by farmers' keenness to know what they can practically do to make a difference. Themes addressed include soil conservation and fertility through to grassland and forage crop production and manure management.

The enthusiasm for FAR training and willingness of advisers to roll out their new awareness and competence in matters such as how to reduce ammonia greenhouse gas emissions, alongside productivity gains, and to engage with farmers, is bound to bring significant change to livestock systems. Further, FAR is keen to investigate complementary working relationships such as with FACTS on crop nutrition and the current 80+ Catchment Sensitive Farming advisers.

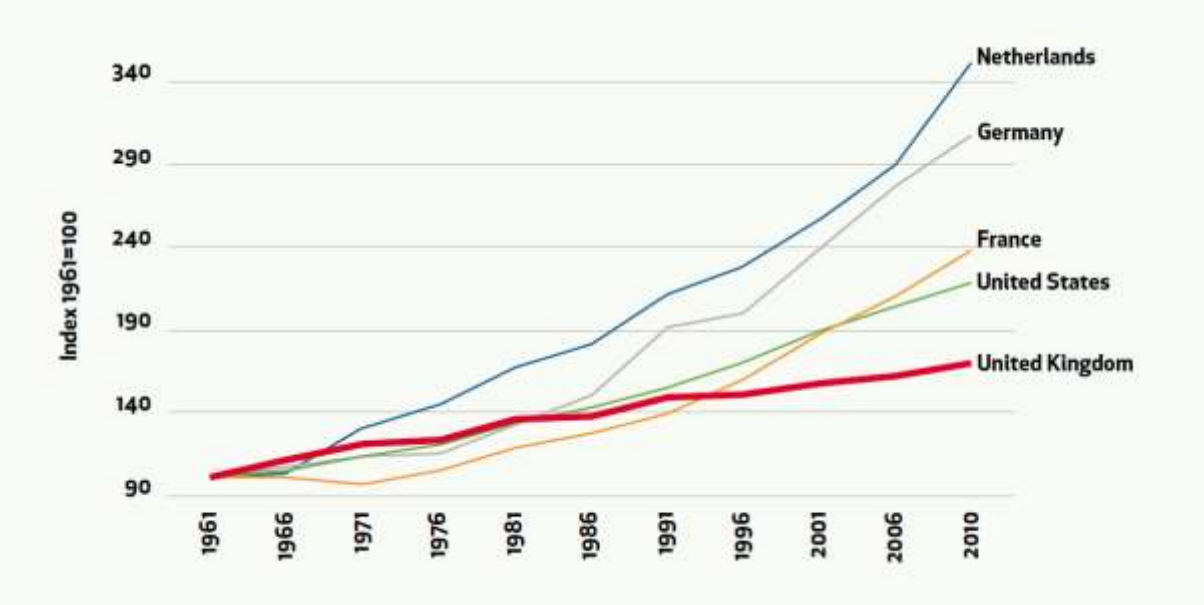
These are important steps in improving the overall competence of advice in the grassland and livestock sector and begin to ensure that farmers receive an increasingly integrated service. This should help to manage systems more sustainably in every respect.

2. Fit for purpose: supporting a future UK agricultural industry

2.1. Productivity post EU Exit

Agricultural policy, in the wake of the UK's EU exit vote, will increasingly focus on the combination of the market needs, efficiency and protecting the environment. UK agricultural productivity, while continuing to grow, has been widely quoted as falling behind our major competitors (BIS 2013, AHDB 2017). The Agri-Tech Strategy (BIS, 2013) identified the growing gap between the UK and some international competitors (figure2).

Figure 2: Agricultural Productivity, source OECD, Office of National Statistics.

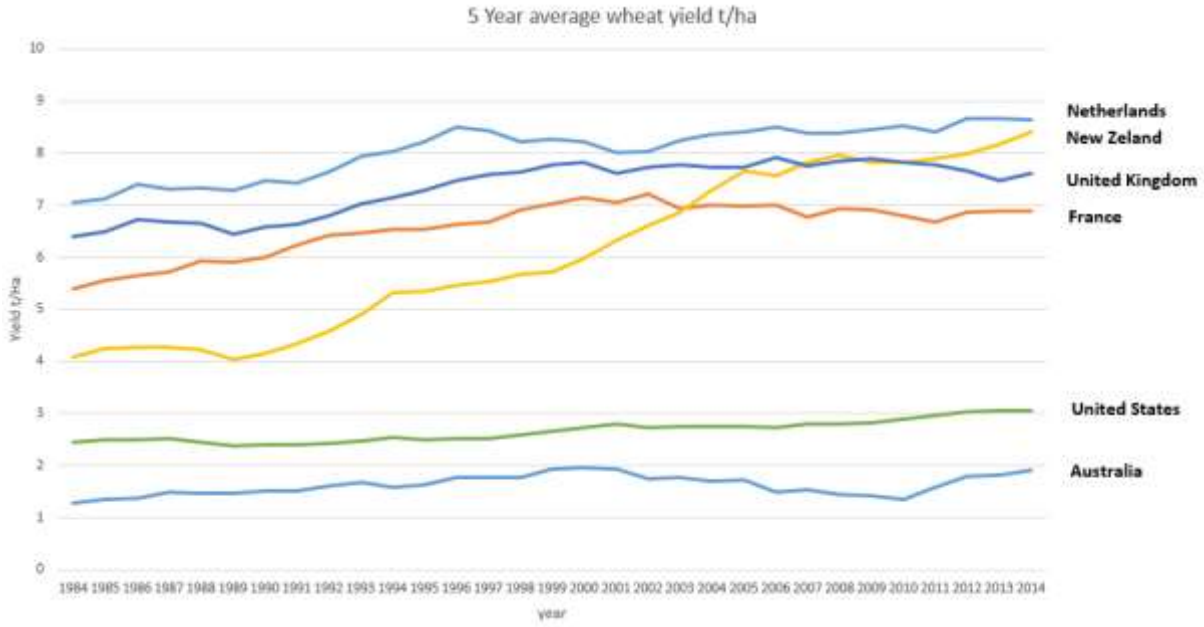


A future UK agricultural policy outside the EU will need to reflect the UK's position in a larger and more competitive market place. Issues of yield plateaus have been cited as a potential barrier to achieving targets for sufficient food to feed a growing world population into the 2030s and beyond (figure 3). By driving productivity and redressing the yield plateau, the UK has an opportunity to both compete with world markets and also to export innovations to reinvigorate improvement in yield growth/productivity in other markets.

2.2. Resource use efficiency

By improving efficiency in production the agricultural sector will make significant contributions to improving its impact on the environment while at the same time also improving the profitability of farming businesses. Important to this are current industry-led commitments such as Continuing Professional Development (CPD) and advisory partnerships between Government and industry, delivering agreed messages and desired outcomes. The Campaign for the Farmed Environment (CFE), Catchment Sensitive Farming (CSF), delivery of Scotland's Climate Change plans and Northern Ireland's Sustainable Land Management Strategy are all examples of such support and demonstrate how a coherent advisory strategy can deliver policy outcomes as well as improving farm productivity and profitability through more efficient use of resources.

Figure 3: Five year rolling average wheat yield neighbour and international examples.



Data source: © FAO 2017, http://www.fao.org/faostat/en/#data/QC.

The National Farmers Union (NFU) explicitly identifies the need for improving productivity associated with R&D, skills and innovation and leading resource efficiency through its vision for a future British Agricultural Policy (NFU, 2017). The industry is already promoting these values with initiatives such as the Campaign for the Farmed Environment (CFE, 2017), the Greenhouse Gas Action Plan (GHGAP) (AIC, 2017) and Tried and Tested (T&T, 2017)

Food, farming and environmental policies are interconnected as is highlighted in the 25 year environment plan. The ambition set out in the Industrial Strategy and 25 year environment plan seeking UK farming to become more competitive, more productive, more resilient to plant and animal disease and better at protecting the natural environment is shared by governments and industry.

The introduction of the Agri-Tech Centres of Excellence reflected governments' desire and willingness to invest in solutions to support these outcomes. For these initiatives to succeed it will be crucial that their existing working format is completely altered and that the roles of advisers and agri-supply companies in innovation and knowledge exchange is recognised. Government and industry investment in innovation and the value of advice should be coupled to create an overarching strategy for R&D and advice which will improve the performance and efficiency of UK agriculture.

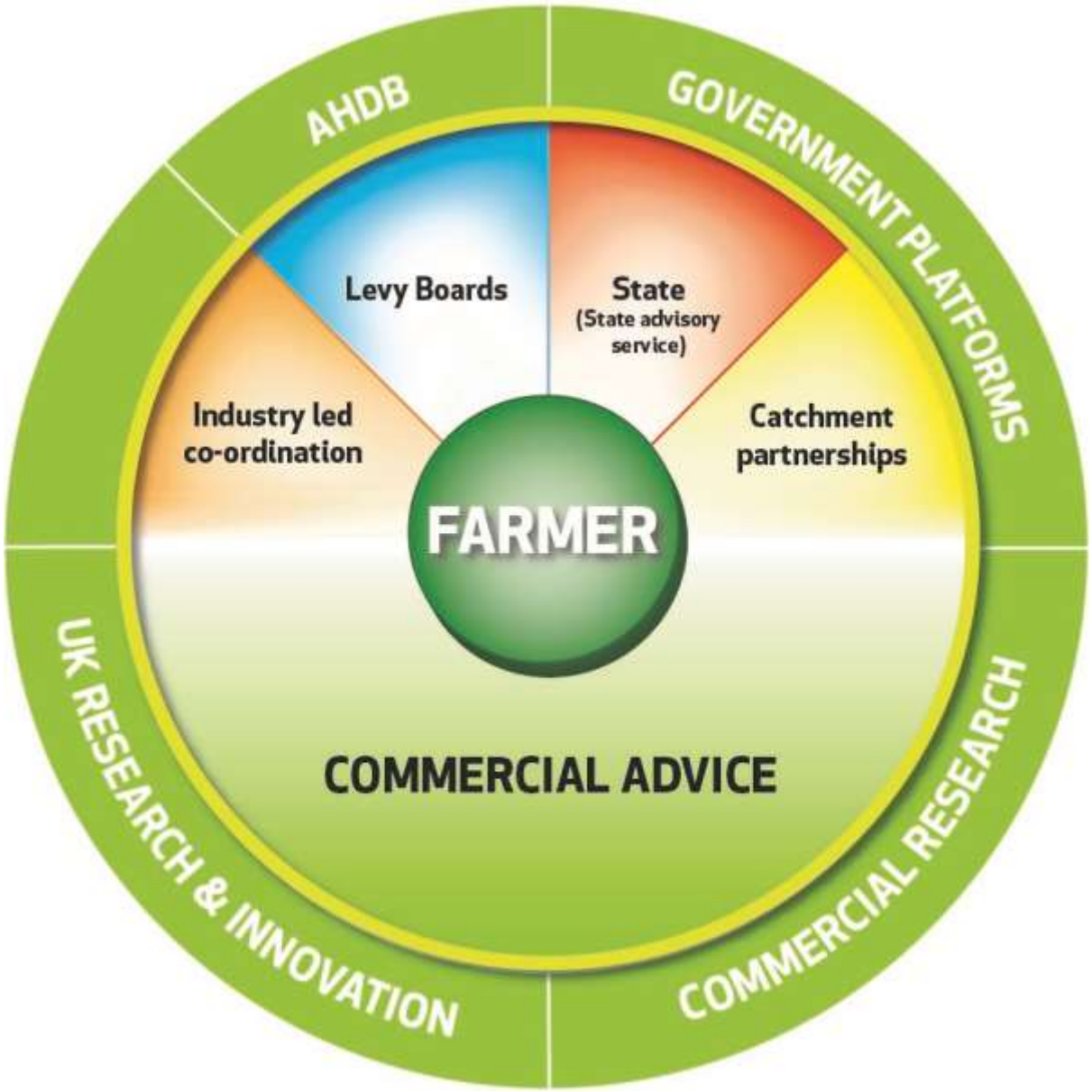
3. A strategy which recognises Industry's significant network of professional advisers

3.1. Industry's network of professional advisers

After the privatisation of the government advisory extension service in the early 90's, commercial advisers continued to develop more bespoke and targeted services for their clients, focused on supporting farmers with production and the challenges of profitability (Phillipson et.al. 2016).

Remaining government-funded advice sources, e.g. the Farming Advice Service and Defra agencies focus on more generic advice that is often associated with legal compliance and environmental protection (figure 4). Delivery is frequently via workshops and events designed to inform farmers rather than support specific application within their particular farms. Delivery of tailored advice depends on the close relationships between commercial advisers and their farmer clients.

Figure 4: UK Knowledge development and exchange model.



Shrinking government budgets leads to reductions in the level and scope of state-funded extension services. The budget of the Farming Advice Service has fallen 80% over the past five years. Similarly, since 2014 government's contribution to CFE has reduced by over 85%. The loss of funding to these initiatives has led to a direct reduction of support for farmers on regulatory compliance and environmental options outside stewardship. The agricultural sector remains committed to CFE but has been forced to seek alternative funding. Increasingly, government policy seeks to deliver impact

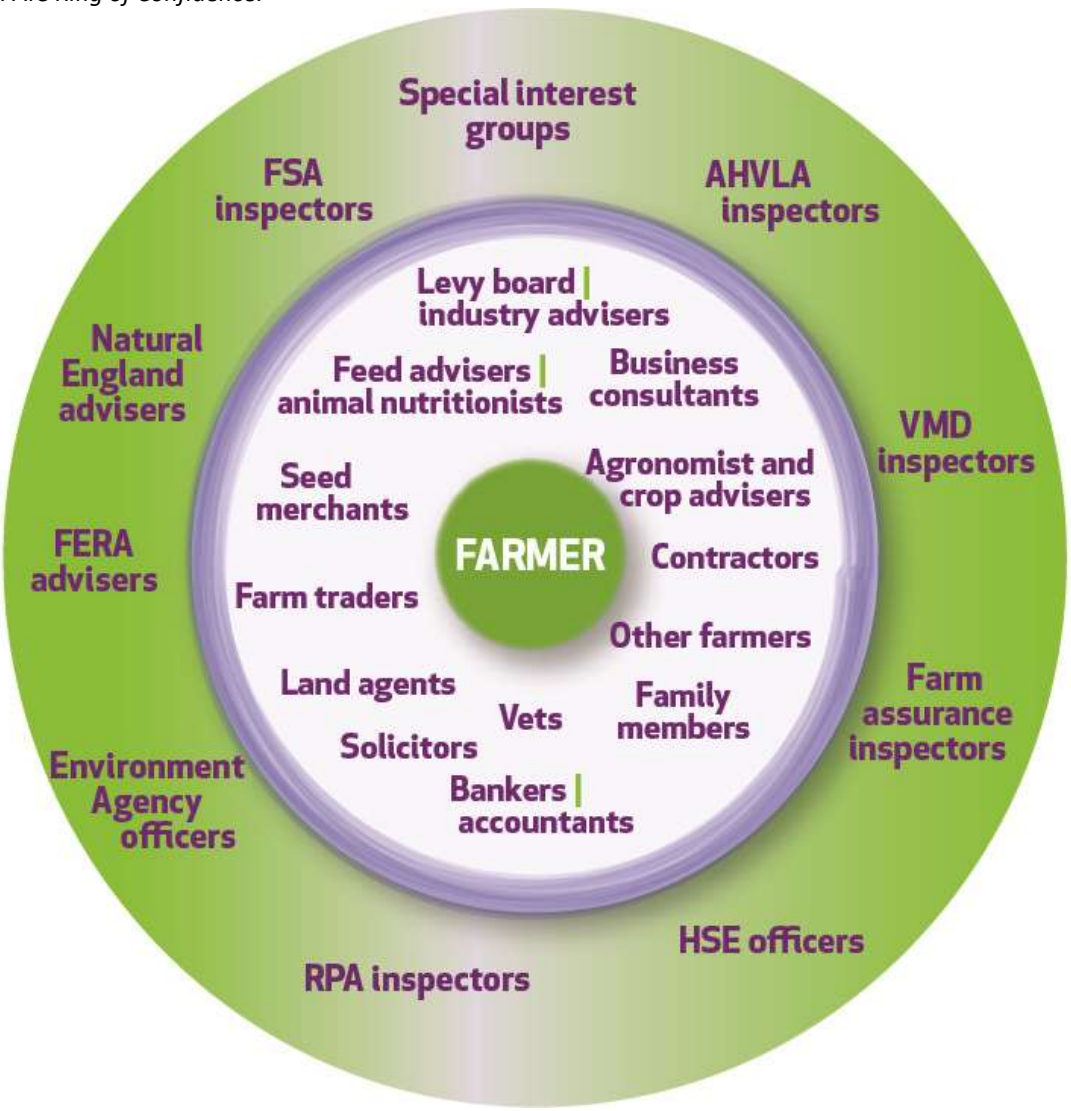
through industry led action. However, sustaining such activity requires continued commitment from all sides and a long term strategy.

The Catchment Sensitive Farming programme has successfully retained an important, effective role thanks to on-going government - at least for the short term. Delivering face-to-face advice alongside a monitoring programme is seen by farmers and the wider supply chain as an example of successful farmer engagement which is highly respected by professional farm advisers.

Services provided by the agri-supply chain continue to expand to cover most areas of farm management. This large community now includes at least 3,900 active advisers on the BASIS Professional Register and more recently 1,100 advisers recognised through the Feed Adviser Register. These professionals have spent many years developing relationships with their clients and are considered part of the farm business management team, supporting the integration and adoption of the methods and innovation onto farm (AIC, 2013). It is estimated that every week, advisers have up to 44,000 meaningful conversation with farming clients.

The AHDB has recognised the significant capacity for knowledge exchange within its new Research and Knowledge Exchange Strategy (AHDB 2017). The role of commercial advisers is recognised as an intrinsic part of the knowledge exchange continuum. As an independent, industry funded levy body with an annual budget in the region of £60 million, AHDB has a significant influence on farming practice along with a budget to support innovation and changing practice. In common with commercial advisers, farmers trust and respect levy-funded advice, as identified within the ring of confidence model (figure 5). The role of AHDB as a leader in communicating change is an important part of the wider sphere of those who support and influence farmers. The Strategy recognises the benefits of the levy board working with the extensive network of commercial advisers. Successful collaboration can support greater gains in productivity and resource efficiency and adoption of new practices, often the work of AHBD is supported by and supports those within the commercial advisory network.

Figure 5: AIC Ring of Confidence.



3.2. Trusted and productive relationships

Farm advisory professionals play a key role in both strategic and operational decision making on farm. This role has been recognised as critical within both the Agri-Tech strategy (LWEC, 2014) and sustainable intensification (Landbridge, 2017) to improve farming performance.

Managing a farm is complex and few businesses can invest in in-house specialist knowledge and training. The agricultural sector is characterised by small enterprises, 95% of business in the sector employ fewer than 10 individuals and 85% fewer than 5 (LANTRA, 2014). As numbers on farm decline, the role of farmers will shift to that of managing and overseeing actions recommended by specialist advisers and implementing practice (LANTRA, 2012).

The AIC Ring of Confidence model (figure 5) describes how farm businesses rely heavily on the support of professional advisers who understand – and engage with – the increasing complexity of technical, legal and political issues affecting farm businesses. The professional adviser, operating within the inner circle has to deliver proven results to earn, gain and retain the farmer's trust.

Advisers provide specific recommendations for crops, field, animals or business management systems. This level of detail and application distinguishes this group from those who provide more generic information. Advisers support farmers in implementing new practices which may have come to a farmer's attention from sources such as the farming media, peers or open meetings and events.
There is an increasing provision of data that requires insight, often provided by the commercial adviser, if that data is to provide value.

3.3. Proof of the relationship between face to face advice and changes in farming efficiencies

AIC working with the Defra Statistics team explored the relationship between professional advisers and farmers as well as influence of advice provided. Supplementary questions, included in the British Survey of Fertiliser Practice (BSFP) (Defra, 2016), sought to understand the roles of accreditation and continuing professional development in providing advice for both arable, grassland and livestock systems in Great Britain. This research identified that over 80% of farmers (equivalent to 89% of the farmed area) in Great Britain receive advice from at least one professional advice source, with agronomists, (crop protection and nutrient) feed advisers and vets delivering the most significant coverage on farm (Table 1).

Table 1: Professional advice sources by farm area, Great Britain 2016.

Professional advice sources	All farms		Farms with tillage		Farms with grass	
	Received advice area	Received advice & area	Received advice area	Received advice % area	Received advice area	Received advice % area
Crop protection agronomist	6,593,801	64	4,177,373	90	2,416,428	43
Fertiliser advisor	4,549,143	44	2,621,519	57	1,927,624	34
Feed Advisor	2,796,377	27	845,317	18	1,951,060	34
Veterinary surgeon	5,363,383	52	1,713,036	37	3,650,347	64
Countryside or wildlife advisor	2,275,826	22	1,294,826	28	980,713	17
Land agent	2,109,058	20	1,135,936	25	973,123	17
Business advisor	1,711,706	17	795,256	17	916,451	16
Water advisor	1,695,364	16	937,620	20	757,743	13
None of the above	1,130,322	11	184,131	4	946,191	17
Other	475,128	5	134,521	3	340,607	6
Total	10,292,341		4,619,130		5,673,211	

Source: British Survey of Fertiliser Practice 2016.

3.4. Industry supporting innovation

Farm advisers are in contact with the overwhelming majority of Great Britain's farmers and growers. They are critical to leading innovation on-farm. The impact of advisers on farmers' decisions is demonstrated in the level of influence and areas in which the professional advisory network offer support in Table 2.

Such advice is well respected. Some 70% of farmers report that advice received has a significant influence on their decisions to implement changes (table 2). Areas where farmers seek advice includes: aspects of innovation including, crop establishment, soil management, crop protection strategies and application, and animal nutrition and diet formulation.

Table 2: Areas of expertise of professional advice: Advice received and its impact by number of farms, Great Britain 2016

Professional advice areas of expertise	Received advice or gained knowledge *no. of farms*	Received advice or gained knowledge *% of all farms*	Advised and implemented change *no. of farms*	Advised and implemented change *% farms*	Level of influence of advice		
					High *% farms*	Medium *% farms*	Low *% farms*
Soil management or protection	29,908	40	19,104	64	41	50	9
Crop nutrient management	31,100	42	20,976	67	44	51	5
Crop planning or land use	19,998	27	12,654	63	43	48	9
Fertiliser application methods	18,187	25	11,043	61	30	48	21
Crop protection (agrochemicals)	38,393	52	26,844	70	59	37	4
Integrated pest management	16,632	22	10,859	65	46	43	11
Animal nutrition or diet formulation	20,748	28	16,051	77	43	49	9
Manure storage	6,732	9	4,319	64	41	47	12
Manure application method	4,387	6	3,095	71	30	54	16
None of the Above	14,721	20					

Source: British Survey of Fertiliser Practice 2016.

Such advisers are well placed to interpret the varied requirements of the farming system and changing policy through advice tailored to each specific farming business and situation. Often it is professional advisers who take innovative ideas from third party sources onto farms. The trusted relationship between farmers and their advisers supports two way inquisitive discussion that leads to innovation and changing practice. The many and varied sources of information available to farmers (e.g. government, commercial practice and farming media) all support implementation on farm, and are critical in influencing changing farming practice in the future.

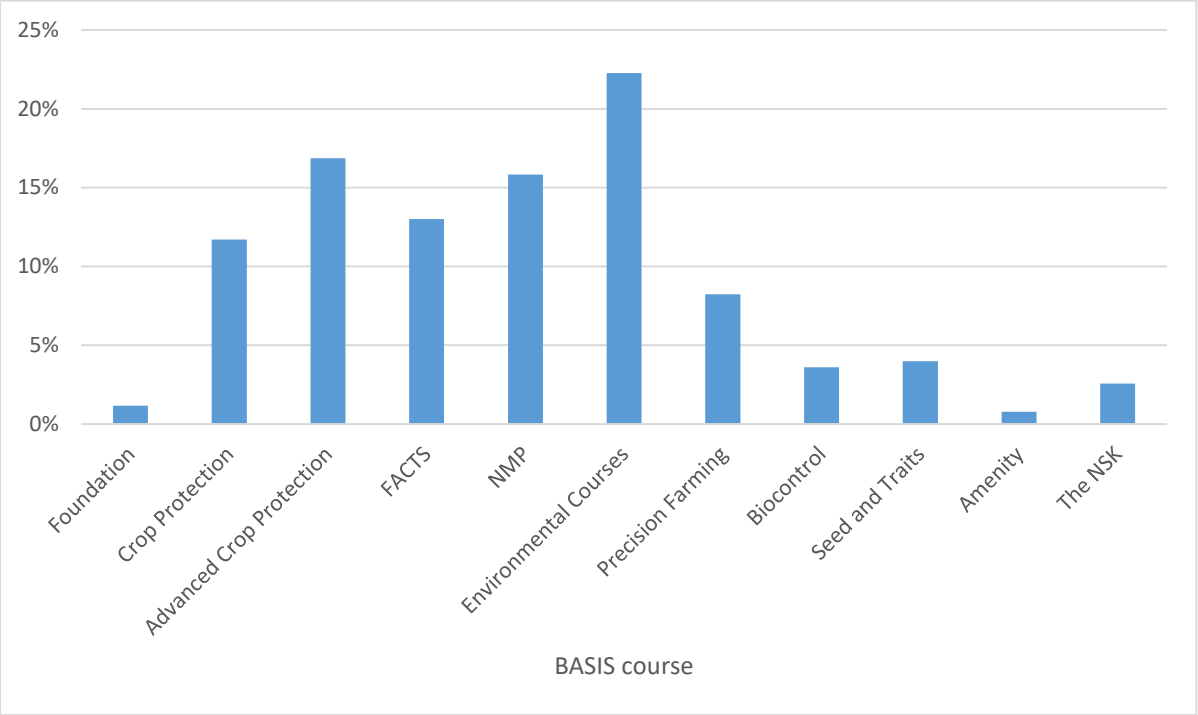
3.5. Investment in Innovation

However, the scale of investment in innovation – both research and training - among agri-supply companies who are members of AIC is less well appreciated across the public sector. Improving the level of understanding of what already exists in totality is important rather than turning back to outdated centralised advice mechanisms.

3.6. Training to deliver innovation and nationally recognised professional competence

Substantial investment in time and money is required to ensure that advisers are competent to provide sound, accurate and trustworthy advice. Every farm business is unique, and advisers must give bespoke advice tailored to each farm's specific requirements. This is a clear differentiation from most advice from those in the outer ring, where messages focus on the aims of the advisers' employers. In most circumstances messages are generic providing general advice to a wide audience.

Figure 6: Intentions for further study, BASIS Professional Register members (2015).



Source: BASIS Registration Ltd.

Each year businesses involved in livestock nutrition, plant protection and crop nutrition invest in ensuring their farm advisory teams are up to date with the latest innovations as well as technical and legislative requirements. As part of their professional competence on livestock and crop production, advisers are expected to guide farmers on aspects of environmental protection that is fully integrated with a farm's production potential or to refer to other advisers for specific land management goals.

In order to provide the best services possible to their clients all active field advisers are expected to be able to demonstrate their competence and continued enhancement of their capabilities. Those involved in crop and grass production, and livestock nutrition generally belong to either the BASIS Professional Register for crop production or the Feed Adviser Register for animal nutrition. Both of the professional registers require the demonstration of continuing professional development (CPD). Each year approximately £9 million are invested by advisers in maintaining their CPD, this provides a minimum assurance in the competence of individual advisers. Maintaining technical competence plus awareness of changing policy for advisers goes beyond a CPD requirement, in order to ensure full awareness of innovation and legislative requirements advisers engage in over 800,000 hours of training each year; equivalent to 20 days per adviser annually. This is a significant investment both in time and money. Cumulatively, it is estimated to be equivalent to some £42 million each year.

In many cases individuals go well beyond the minimum requirement and take additional courses in relevant subjects such as advanced crop protection or the BASIS diploma in crop nutrient management (figure 6). These courses require a significant commitment from the learner and successful completion awards significant academic recognition. The BASIS diploma includes study equivalent to that expected at the level of a final year honours degree (BASIS, 2016).

4. Agricultural research and development

The publication of the Agri-Tech Strategy in July 2013 and subsequent investment in Agri-Tech Centres of Excellence provided a much-needed injection of funding to support private: public collaboration. More recently the Industrial Strategy Green Paper (Building our Industrial Strategy: green paper, 2017) encouraged further investment in agri-tech innovation. These welcome investments come in response to the challenge of the UK agricultural production falling behind that of its neighbours (figure 3). Although it is unfortunate that all the outcomes intended are not being delivered currently.

Post-Brexit there will be increased focus on domestic manufacturing, seeking to ensure we have an industrial base that supports the national economy. Food and farming is our largest manufacturing sector (BEIS, 2017) this increased focus will mean policy shaped on becoming more competitive and efficient and environmentally aware. The next few years offer a real opportunity for the UK agri-food sector to invest in innovation and technology, and to work with both public and private funding on true collaborations to address both strategic challenges and more reactive short term needs.

4.1. Private sector investment in R&D

Manufacturers of crop protection products, fertilisers and animal feed/ingredients as well as companies providing agronomic and nutritional services undertake R&D programmes as part of their product development and efficacy trials. AIC members report an annual investment of at least £50 million in near market R&D across all sectors of AIC membership ranging from genomic research into animal and crop traits to crop storage technology, cultivation practices, crop protection and diet formulations. The high investment in training (£42 million annually) discussed earlier goes hand in hand with this investment in R&D providing the facility to translate R&D findings into practical on-farm implementation.

Investment by AIC member companies is significant. In terms of total expenditure within the UK, this industry-funded R&D is second only to BBSRC which invests approximately £100 million in agricultural R&D (Beis, 2016).

4.2. Industry leading investment in near market innovation

A key characteristic of the investment made by AIC members is the type of research delivered. The majority of private funded R&D is focused on bringing innovation to the market. Investment is focused on near market and developmental research translating technological advances into practice that can be applied to UK farms (AIC, 2017).

AIC members report that their investment in R&D is primarily led by customer needs, increasingly this means integrating all aspects of production, stewardship and compliance into systems that perform within carefully planned and managed environments. The investment is focused on meeting the challenges and opportunities facing farmers and growers. Conversely, investments in publicly-funded R&D is focused on more fundamental research often seeking to answer more strategic challenges faced by both the government and agricultural sector. The research landscape in the UK is strong with highly skilled researchers in most areas, although still requiring additional capacity particularly in livestock specialities where the UK's R&D infrastructure and skills base now lags behind, whereby necessity much R&D is now based outside of the UK. Publicly funded research continues to be allocated through competitive bids directed by current academic interests rather than meeting the

needs of the agricultural sector. There is a high level of fragmentation meaning the coordination and strategic alignment of innovation delivery is inefficient (Pro-Akis, 2015).

Commentators have expressed the view that the demise of the government funded agricultural advisory services has disadvantaged innovation. However, evidence suggests that investment in innovation continues and the services once delivered through government advisory services have been expanded upon and subsumed into the private sector. Although anecdotally many commentators criticise the investment of public funds into basic research evidence suggests a different trend (BEIS, 2016). It is more likely the case that investment in agricultural R&D is poorly connected with broken linear translation of the various research projects (figure 7) at the transition between research stages. Again the agreed consensus is that much of the research led through public funding fails to seek integration and impact and unfortunately the measures of success are focused on the quality of the research and associated papers rather than the impact on innovation and change on farm.

Historical differences in the mechanisms for identifying and prioritising agricultural R&D has in part acted to shift public investment in agricultural R&D more towards basic and applied research driven by government policy and academics own interests and capabilities. This shift from developmental investment in on farm practice has contributed to the scattered and confused nature of agricultural R&D. Although there remains commitment to fund agricultural R&D the focus and coordination of this scattered and fragmented funding landscape needs greater clarity and cohesion in order to make the best use of the investment and to really drive UK agricultural productivity.

Figure 7: Continuum of Research and knowledge transfer

As identified above, considerable amounts of private and public funds are being invested in R&D at various stages. However, work and funding is fragmented and there is a lack of a strategic continuum which discovers innovative concepts for industry needs which are then translated into on-farm improvements through the more applied development which is undertaken by agronomy and feed companies.

For the UK to regain its position as a world leading agricultural producer, there is a need to bring public and industry-funded R&D into closer collaboration. The intention set by the agri-tech and industrial strategies was to bring this cohesion to satisfy the ambition of both government and industry. However much has to change if the outcome is to be delivered. Investment in the Agri-Tech Centres is welcomed however the implementation and initiation of these initiatives feels too slow and laboured and does not reflect the original intention. Continued investment should seek improved collaboration between the soon-to-be established UK Research and Innovation organisation and relevant strategies of both Beis and Defra should help deliver greater efficiency and productivity. Aligning success criteria with objectives set out in a clear strategy will deliver greater focus on the projects gaining funding and the design of research programmes being relevant. Collaboration can integrate the UK's potentially world class science establishments with the agri-supply industry expertise in translating ground breaking innovation into practical solutions which drive up productivity and sustainable resource use. Creating a joined-up pipeline for knowledge from first concept to

practical application as proposed in figure 7 will ensure that UK farmers have access to adequate advice to help their transition to more sustainable production systems.

5. Conclusions and recommendations

The UK's vote to leave the European Union has brought agricultural production into stark focus for policy makers. Agriculture is a critical part of the wider food and drink supply chain, which together represents the UK's single biggest manufacturing industry representing 19% of total production. It is also the sector most likely to be impacted by the UK's exit. What is clear, however, and is now increasingly apparent is that UK agricultural productivity will need to change if we are to compete with a more challenging international trading environment.

The benefits of increasing UK productivity go hand in hand with current policies for improving agriculture's impact on air, water and soil quality through effective and efficient use of resources.

To meet the challenge of improving competitiveness for UK agriculture high quality R&D leading to relevant and impactful innovation will be more crucial now than ever.

Advisers from the supply chain, supported by R&D, can interpret concepts for farmers into tangible action on-farm to meet changing demands of legal frameworks and/or markets.

Agricultural policy post the UK exit from the European Union will seek to support and foster greater resource use efficiency, the 25 year environment plan and the Industrial Strategy provide clear indications of government ambition and expectations for the sector. Improving productivity, competitiveness as well as delivering public goods and ecosystem services will form the core of future policy influencing UK agriculture. Key to achieving these goals is enhanced knowledge transfer that ensures farmers receive effective on farm advice. The advisory community as a whole is well placed to provide a cost effective, highly capable conduit for knowledge transfer.

The potential of the UK's trained agricultural advisers has still not been fully recognised by policies seeking to enact change in countryside and land management. Policies seeking to increase productivity while making better use of resources and providing for the environment must recognise the critical role of the advisory community in transferring advances in knowledge and technology to farm.

Many studies have examined the mechanisms needed to achieve effective behavioural change, influencing individuals and businesses is complex and must recognise the diversity in attitudes, skills and personal preferences. Progress has been made and the successful partnership between government, agriculture and other invested groups have made progress. However, the sector's full potential has not yet been realised, better alignment of R&D is needed in order to ensure that public/private investment is:

1. focused on the needs of UK farmers
2. targeted to innovations with clear application to the UK
3. efficient in bringing innovation to market
4. widely taken up through both government, voluntary, industry and third sector initiatives as well as through commercial integrated advice.

Collaborations between the UK research base and the agri-supply industry are increasing but again there is still greater potential to be unlocked. The UK has a strong knowledge base across most areas

relevant to UK agriculture - comparable with many other European models in terms of investment and quality of research. However, this research is very fragmented, leading to many of the perceived inefficiencies (Pro AKIS, 2015). Many competitors within Europe recognise the need to integrate both public and private R&D and KE to ensure that best value is gained. Recognition of this fragmentation and moving to greater integration will require leadership right across the supply chain with a coherent strategy supporting the full integration of world class research delivering tangible benefits to farmers through a well-connected and aligned continuum of R&D and knowledge transfer.

For effective change to occur farmers will need support through many forms of engagement and communication. There are clear roles for advisers from both the inner and outer rings of confidence, beyond this however there is a need for leadership from policy makers and the industry.

Through collaborative working with shared objectives and clear outcomes, greater cohesion should be possible in research, development and knowledge exchange. This can ensure greater efficiency in the translation of research into innovation and changing practice on-farm. To achieve the objectives of driving increased productivity, more sustainable farming businesses and an improving environment all those involved in developing policy, innovation and influencing changes at farm level need to work together. The competence of the professional advisory community is well defined and understood by the agricultural sector and farmers rely on the specialist advice. If we are to see a thriving and successful agricultural sector in the coming years it will be essential that the private sector is recognised and engaged in supporting and leading the development and implementation of innovation in British agriculture.

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Appendix 1: Survey of AIC Members

AIC undertook a survey of members during 2017 with the objective of identifying investment in R&D and the training of staff involved in supporting farmer and grower clients. Face to face interviews were conducted with member companies, using a structured questionnaire to ensure the definitions of activities and in order to facilitate aggregation and collation of survey results. The questions (see below) sought to not only identify the investment in R&D and training but also to understand how, why and where investments are made.

1) What are the primary areas of investment in R&D?
2) What is the annual investment in R&D in each primary area?
    i) agronomy
    ii) Livestock Feed and Nutrition
    iii) Crop Nutrition
    iv) Seed
    v) Grain
3) Research and Development identification and delivery.
    a) How are the areas of need/priority identified in developing R&D programmes?
    b) How is the R&D undertaken?
        i) In house
        ii) External
            - Universities
            - Consultants
            - Research Institutes
            - Other
        iii) In collaboration
            - government
            - other companies
            - research stations
            - universities
    c) Is investment UK based, EU or international?
4) How are R&D programme findings implemented within your business?
5) How much do you invest in training each year?
        a) Staff hours
        b) Resources
        c) Directed learning

In support of the survey AIC have defined the context of R&D, and described the type of activities to be included in the survey. These definitions were provided to interviewees:-

What is 'Research and Development - R&D'

> "Research and development (R&D) consists of any activities that a business chooses to conduct which can either lead to the development of new products, procedures or knowledge, or to improve existing products or procedures. Research and development is one way for a business to achieve future growth by developing new products, services or processes to improve and

expand operations. In addition R&D can support the ongoing process of ensuring services are continually improved with the introduction of new technology and knowledge.

Areas that members have previously identified as contributing to their R&D interest, within each sector which AIC services include:-

Agronomy:

Seed trials, cultivation methods, seed and variety choice, crop nutrition, crop/variety choice, crop protection (including weed, pest and disease control) and spray application techniques.

Feed:

Feed efficiencies- feed alternatives, nitrogen and phosphorus utilisation, genomics, feed conversion efficiency.

Fertilisers:

Crop nutrition and fertiliser efficiency, crop trials, cultivation methods, fertiliser rates and trace elements, soil testing, precision technology.

Seed:

Seed trials – development/trailing of new varieties and mixtures, genomics, seed treatments.

Data collected through this survey are confidential to the individual members, therefore the information has been collated and aggregated into AIC figures as presented within this report.

Appendix 2: Professional Registers

The quality of advice available to Britain's farmers is of a very high professional standard. Advisers are trained and have to demonstrate their knowledge before being accredited; then they need to provide proof of having undertaken a sufficient amount of Continuing Professional Development ever year to maintain their status.

1. Qualifications
   Advisers working in agronomy are required to achieve a BASIS qualification to advise on crop protection, whilst those advising on crop nutrition are required to become FACTS qualified. The BASIS qualification has been established as the industry standard for 26 years. Both qualification require formal training and are assessed by written and oral examination. Both qualifications are Level 6 in academic equivalent and are accredited by Harper Adams University. Candidates achieving either or both of these qualifications are entitled to be Members of the BASIS Professional Register.
   More recently (2013) a new Register has been created for feed advisers. The Feed Adviser Register sets out to help advisers demonstrate competency in livestock nutrition and their training also includes topics aimed at reducing greenhouse emissions from livestock units – a key policy objective. FAR members have to demonstrate their competence via online assessments.
2. Continuing Professional Development.
   Both schemes require an ongoing commitment to professional development, those on the BASIS Register are required to undertake structured maintenance, improvement and broadening of the knowledge and skill required as a professional working in the crop protection and agronomy. Those involved in the FAR are required to undertake directed learning and pass annual assessments on aspects associated with livestock nutrition and management.

BASIS Professional Register

The BASIS Professional Register (PR) was set up in 1992 to demonstrate the professionalism of advisers within the pesticide and allied industries. BASIS was developed as an independent standard setting and auditing organisation.

The BASIS PR now consists of advisers qualified to deliver advice on pesticides and plant nutrition and they hold the legal qualifications of a BASIS Certificate (in Crop Protection) and/or a FACTS certificate in Crop Nutrition. They have agreed to abide by a Code of Professional Ethics and can provide evidence that their technical knowledge is up to date. The Register is updated annually and to remain on the Professional Register members must demonstrate that they have participated in relevant activities throughout the previous year. Members need to demonstrate that they have achieved a minimum number of CPD points each year. In the past 12 months 50% of members of the BASIS Professional Register undertook formal training beyond continued professional development (beyond the standard requirement) again showing the commitment of this community to ensuring professionalism. The most often taken course in order were-

1. Environmental
2. Crop Protection
3. Advanced crop protection
4. Facts
5. Nutrient Management Planning.

Feed Adviser Register

The feed adviser Register was established in 2013 a new accredited scheme of professional competence just after the publication of the 1st value of advice report. The development of this relatively new scheme came in response to a gap identified into training and skills within the feed sector (AIC 2013). In response AIC launched the Feed Adviser Register which has quickly gained a reputation for providing high quality training and assurance, giving confidence in the advisers supporting livestock enterprises and assuring their competence.

The feed adviser Register has attracted over 1100 advisers from across the UK and is now providing training and assurance in the ongoing development and with the challenge of industry commitments to drive greater efficiency and reduce wider environmental impacts such as greenhouse gas emissions. The FAR requires participants to demonstrate their knowledge in areas of animal nutrition, welfare, feeding efficiency, and animal health.

Data from the Feed Adviser Register (2017, FeedAdviserRegister.org.uk) show that not only is there a large appetite from the advisory community but this community is a highly qualified and capable group, over 75% of those registered hold a formal qualification at level 5 (HND or above).

Joining the Feed adviser register requires participants to demonstrate commitment to ongoing training and development. The scheme implements a minimum level of competence, within a year of joining the scheme participants must be able to demonstrate that they have achieved this via completion of assessments.

As the science of animal production develops and new responses to regulation and market pressure influence the sector it is more important than ever that the livestock sector is supported by highly knowledgeable and qualified advisers. For this reason in order to maintain membership of the scheme participants will be required to demonstrate applicable and relevant CPD, this is achieved by the completion of training and assessment in the core competencies specified by the scheme.

These core competencies are

Module 1: Fundamentals of Whole Farm Feed Planning for Ruminants/Monogastrics.

Module 2: The Nutritional Link to Animal Health and Fertility Ruminants/Monogastrics.

Module 3: Overview of Environmental Policy.

Module 4: Feed and Nutrition to mitigate environmental impacts

Once the four fundamental modules are completed, advisers are expected to commit to ongoing development. Relevant material will be made available via online training modules and literature accessed through the Feed Adviser Register support.