
**Scientific Skills for Knowledge Transfer in Arable
Agriculture in England:
A Survey**

**Report to
The Board of the Rothamsted Research Association**

Professor Mark Tatchell

Mark Tatchell Consulting
Laurels Farmhouse
Osborne, Sherborne,
Dorset, DT9 4LA

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Executive Summary

1. It is generally acknowledged that there is a continuing need to transfer the knowledge emerging from biological and agricultural research to aid the decision making of arable farmers, land managers and their advisors.
2. The Board of the Rothamsted Research Association (RRA) has identified the emergence of a perceived gap in several specialist areas between those involved in research activities and the generalist agronomist who needs to access specialist knowledge to keep up-to-date and to respond to specific problems.
3. The RRA Board has commissioned a brief report aimed at quantifying the likely current and future shortfall in specialist extension skills accessible to arable agriculture in England. This report provides, for a range of specialisms the numbers of people involved, their age profile, broad career history and training, together with indications for succession.
4. Thirty three people from a cross section of individuals that included both generators and recipient of knowledge were identified by the RRA Board to be interviewed either face-to-face or over the phone.
5. A total of 233 specialists delivering knowledge across eleven primary specialist areas to arable land managers in England were identified. The overall numbers were considered by many to be a reflection of what the industry as a whole was prepared to pay for knowledge transfer. The results of interviews suggest that there may be sufficient specialists at the primary level, but a further division of these specialist areas identifies considerable fragility in the system.
6. The age profiles of individuals differed considerably between specialist areas. More than 50% in the categories of soil science/ agri-environment, application/engineering and storage were aged 50 or more. Thirty three percent of storage specialists were aged 60 or more.
7. Interviews revealed an immediate shortage of specialists in spray application and crop storage. A lack of succession suggests that there is likely to be a shortage of independent knowledge transfer specialists in soil science/ agri-environment, plant diseases, pests, weeds, crop nutrition and water utilization within a small number of years.
8. The newly emerging subject of habitat creation and farmland ecology is populated by young specialists with 38% aged 40 or less.
9. Efforts have been made in some organisations to put in place succession plans for specialists within the constraints of what the industry will pay for. The research institutes and universities are less well placed to deliver this succession due to the routes through which they receive their funding and the lack of encouragement given to young scientists to pursue knowledge transfer as a primary function.
10. Research scientists considered that knowledge transfer to land managers could only be delivered if it was funded in full within research and development projects.
11. Traditionally knowledge transfer specialists have had a strong grounding in agriculture with an understanding of agricultural production processes. The demise of the university departments and colleges that deliver this training, and the shift away from production orientated research has contributed to a considerable credibility gap emerging between scientists that do the research and the advisers and land managers that receive the knowledge and make decisions.

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12. Capabilities to identify pests diseases and weeds in the field have declined considerably. Plant clinics previously provided training in diagnostic skills, but the loss of plant clinics will make it difficult to train the next generation of specialists.
 13. All specialist areas will continue to be required. There will be an increasing need for more environmental specialists and those with an ability to deliver knowledge electronically. The results of interviews suggests that the increased numbers of environmental specialists has already been delivered, though their on-farm credibility is yet to be established fully.
 14. The long term sustainability of knowledge transfer expertise within research-based organisations is dependent on the maintenance of an adequate level of funding that can support knowledge transfer specialists, a greater recognition by funding agencies of the value and importance of knowledge transfer, and mechanisms by which young scientists can acquire agricultural knowledge so they have credibility with land managers.
 15. A complementary knowledge transfer model could be based around a cadre of advisers with a higher level of scientific training that would seek out the results of scientific research and present them in an agriculturally relevant format to land managers.

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1. Introduction

It is generally acknowledged that there is a continuing need to transfer the knowledge emerging from biological and agricultural research to aid the decision making of arable farmers, land managers and their advisors. During the last three decades there have been considerable changes in the routes by which knowledge is transferred from the outputs of research to the decision maker at the farm level. Up until the mid-1980s ADAS, as part of MAFF, provided a free and independent knowledge transfer (KT) function through liaison and interaction with both researchers and farmers.

Up until the mid-1980s, there were some 40 ADAS Regional Specialists doing applied research and development (R&D) and KT in each of agronomy, entomology, mechanisation, plant pathology and soil science. New entrants all had a first degree and many had a doctorate and all were subjected to an intensive programme of additional training, including an understanding of farming, during their first two or three years in ADAS. Of these 200 or so specialists, the 30 or so that now remain focus on research and not the old combination of R&D and KT and in general have much less contact with farmers. Any new entrants to ADAS to these specialist disciplines do not have the benefit of the old-style training.

The Government decision in the mid-1980s that advice should be paid for at the point of use lead to charging for advisory services and the eventual privatisation of ADAS. This occurred at a time when arable agriculture was profitable and coincided with the emergence of a new breed of independent crop agronomists and consultants that developed the business opportunity of advising farmers for a fee. This development has led to the progressive de-coupling of advice from the sale of products. A number of ADAS specialists and advisors joined this cadre of independent crop consultants. The best estimate of the current position is that approximately 40% of arable land is advised by independent consultants, the remainder being divided approximately evenly between owner managers agrochemical distributors and manufacturers.

The Barnes Review in 1986 resulted in MAFF making a phased withdrawal of funding for near market R&D, leaving the levy bodies to fund such research. A coincident change in agricultural and biological research funding by Research Councils and Government Departments occurred at a similar time. The emergence of molecular genetics and the use of model plant systems have resulted in a shift away from whole organism research and field-based experimentation resulting in the generation of a different form of knowledge.

There is now a perception that many of the individuals trained within ADAS in the 1970s and 1980s and who then pursued their careers either inside or outside that organisation have now retired or are now reaching the mid or late stages of their careers and there is little evident succession or onward transfer of experience and expertise. The consequence is a perceived shortage of individuals in several specialist areas between those involved in research activities and the generalist agronomist who needs to access specialist independent knowledge to keep up-to-date and to respond to specific problems.

2. Objectives

This report aims to quantify the current and future number of people with specialist extension skills accessible to arable agriculture in England. It will provide, for a

range of specialisms, the numbers of people involved, their age profile, broad career history and training, together with indications for succession. The full brief developed by the RRA Board is at Appendix 1.

3. Approach

A preliminary meeting with a subgroup of the RRA Board (Alan Bide, Susannah Bolton, Mary-Louise Burnett and Colin Peters) was held in August 2005 to agree the approach, the specialisms to be considered and the people to be interviewed.

The specialisms to be considered are:

- soil science/ agri-environment
- plant diseases
- pests
- weeds
- plant breeding/cultivar selection
- nutrition
- water utilization
- husbandry/rotation/agronomy
- habitat creation/farmland ecology
- application/engineering
- storage.

Semi-structured interviews were done, either face-to-face or by phone based around a core questionnaire (Appendix 2). Thirty three people identified by the subgroup of the RRA Board, together with a few later additions, were interviewed representing both generators and recipients of knowledge (Appendix 3).

4. Number of specialist independent advisers

4.1 Meeting current demand

The transfer of knowledge from the results of research to land managers involves a diversity of people ranging from scientific specialists, to people with specialist skills in transferring knowledge to agronomists and advisors. This report is concerned only with those that are independent and not linked to merchanting and manufacturing organisations. It is also concerned primarily with scientific specialists who are involved with knowledge transfer. However, any analysis cannot ignore the important function played by independent agronomists and advisers in the transfer of knowledge to land managers and the numbers of these are given in Section 5 "Employment and career history of specialists".

The interviewees identified the names of independent specialists both within their own organisations and elsewhere in England. The interpretation of specialisms and the commodities on which individuals could comment varied a little between respondents and the author has attempted to standardise the responses.

The numbers of individuals in England for each specialism and commodity are given in table 1. The total number of individuals identified was 233, which is considerably fewer than the total of all cells in the table. Many individuals have multiple specialisms and are represented in more than one cell of the table. The total number

of specialists in England is probably a little larger than that identified, but the extent of the survey is thought to be sufficiently complete to enable trends to be identified.

The data in table 1 needs to be interpreted with caution as there are many linkages between elements of the table. Some specialisms were considered by interviewees to be commodity independent with the consequence that most names would be entered under each commodity. These included soil science/ agri-environment, weeds, husbandry/ rotation/ agronomy, habitat creation/ farmland ecology and application/engineering.

Table 1. The numbers of specialists by commodity who transfer knowledge to arable farm and land managers in England. Total number of specialists identified is 233. Note that an individual can occur in more than one cell of the table so totals of rows and columns do not equate to the sum of the cells.

Specialism	Cereals	Oilseed rape	Other crops (food)	Non-food crops	Total	Percentage unique to specialism
Soil science/ agri-environment	33	28	32	26	37	49
Plant diseases	32	16	18	1	51	57
Pests	17	15	22	11	30	53
Weeds	19	19	23	17	25	44
Plant breeding/ cv. selection	15	9	5	2	23	44
Nutrition	10	8	14	3	19	21
Water utilization	7	4	9	3	11	18
Husbandry/ rotation/ agronomy	36	37	48	22	50	40
Habitat creation/ farmland ecology	47	46	48	48	51	57
Application/ engineering	9	9	10	9	10	70
Storage	8	6	10	2	10	70
Total	187	156	173	110	233	65

Sixty five percent of individuals identified were specialists in a single subject. There were a few specialisms that were frequently linked. Twenty eight specialists in husbandry and agronomy also had at least one other specialism. Twenty three specialists in habitat creation and farmland ecology had one or more further specialism. Nine individuals were specialists in both soil science/ agri-environment and nutrition. A small number (7) were specialists in more than four subjects and were specialists in a single crop such as sugar beet or peas.

The specific numbers of specialists identified is not necessarily a direct indication of the over or under subscription to that subject. For example, 23 plant breeding specialists were identified yet the view of interviewees was that decision makers are well provided with information on cereal and oilseed rape varieties.

4.2 Areas of shortage

Interviewees were asked for their perception, based on their knowledge of arable agriculture in England, whether the demand for each specialism is satisfied adequately. Overall, 45% of interviewees considered the numbers of people available to be in line with demand either for their specialism or overall. Six percent considered there was a surplus of people compared to the monies available. The remainder of interviewees either felt unable to comment or there was a shortage of people. The primary criteria used by interviewees were on one side the ability of the industry to pay for knowledge transfer, and on the other side a view that “more” knowledge transfer should be taking place. Individual specialists tended to consider their own specialism as a whole was under subscribed, and such comments should perhaps be treated with caution. Conversely, those that operated in organisations that transferred knowledge as a larger proportion of their business considered the numbers to be adequate.

The preparedness to pay either through research funding or advisory fees was identified by interviewees as a strong driving force determining the numbers of specialists. Research scientists interviewed generally considered that they could only do knowledge transfer if it was budgeted fully within research projects. To develop the necessary farming knowledge to deliver effective knowledge transfer, such funding required continuity over a number of years. Organisations that specialise in the transfer of knowledge indicated that they will only employ people if they consider the market can support them.

In many specialisms the expertise was often thought to be only one person deep and hence very fragile. The numbers in table 1 do not support this, but all specialisms can be further sub-divided and it is perhaps at this secondary level that the fragility exists. An example would be the expertise in herbicide resistance in weeds where the skills reside in one or two people in the latter years of their careers.

Comment on possible future shortages of each specialism is given in Section 6.2 “The succession of specialists for the future”.

5. Employment and career history of specialists

A range of government-funded and private organisations employ independent knowledge transfer specialists. Some organisations employ many hundreds of people with a proportion involved with knowledge transfer, while others may be individuals operating independently. The numbers of knowledge transfer specialists in different groups of organisations are summarised in table 2.

Table 2. A summary of the employer groups of knowledge transfer specialists in arable agriculture in England.

Employer	Number
Research Institutes	67
University and College Departments	36
Government Agencies	25
Larger Consultancy Companies	55
NGOs	23
Levy Boards	8
Independent Consultants	19
Total	233

The specialists listed in tables 1 and 2 are complemented by crop agronomists and advisers who play a very important role in knowledge transfer to land managers. The BASIS Professional Register includes approximately 2,500 agronomists, of which about 9%, represented by the membership of the Association of Independent Crop Consultants and the consultants employed by The Arable Group (TAG), can be considered independent. The number of independent advisers is therefore approximately equal to the number of science specialists involved with independent knowledge transfer.

6. Training and succession of specialists

6.1 Current situation

Data on detailed early training and career history of individuals currently involved in knowledge transfer were difficult to obtain. However, during the course of the interviews a number of general themes emerged.

Current specialists:

The early training of current specialists is varied and the impression was gained that it was obtained from a wide range of institutions. A very large proportion of experienced specialists under all headings (with the possible exception of pests and plant diseases) have a long standing association with agriculture. Many read subjects such as Agriculture, Agricultural Botany or Agricultural Engineering at university, or obtained an Agriculture qualification from one of the major agriculture colleges and came from farming or farm-associated families. These individuals

developed research and knowledge transfer careers and use this background knowledge of agriculture to good effect in their knowledge transfer activities. Individuals closer to the decision maker than the research interface may not have a degree. Those giving advice have BASIS and FACTS qualifications.

New entrants:

The demise of Agriculture Departments in universities means that very few new specialists have a core agriculture training. Additionally, fewer sons and daughters of farmers are pursuing careers in agricultural research and knowledge transfer. One interviewee even commented that farmers were actively discouraging their sons and daughters from entering farming-related careers.

It is now difficult for young scientists to develop a career in agricultural research. There is little funding for applied and production-based research. Therefore new entrants will receive their early training in more basic biological sciences with little direct relevance to arable agriculture. In the past MAFF-funded PhD studentships did provide a route for new entrants, but this ceased some years ago. The Morley Agriculture Foundation are now supporting a limited number of studentships on production-based subjects. On the job training will be received during the course of projects if they have a strong production focus and involve industry partners. The LINK scheme was cited as a good example of such projects. Such projects are however short term and it can be difficult for new entrants to work on a series of such projects and acquire significant experience to make individuals credible to advisers and land managers.

A view held by 55% of interviewees was that the gaining of agricultural and farming credibility was the single most important skill at risk of being lost. This was exacerbated by the loss of agriculture-related courses in English universities and colleges. Considerably more on the job training was now required for specialists to have the credibility with advisers and decision makers on farms. This is increasingly difficult to obtain as less production-based research is funded and fewer individuals have a core background and training in agriculture. In addition, knowledge transfer specialists need to be fully conversant with a diversity of regulations as well as technical aspects of their specialism.

During interviews it was proposed by three interviewees that adequate training of specialists was continuing in other European countries and this may provide a supply of relevant skills to England in future. However, a similar number of interviewees did not consider that these people would have knowledge of UK conditions and would not be credible to land managers.

6.2 The succession of specialists for the future

During interviews an attempt was made to obtain the approximate ages of specialists as a broad indication of succession in the industry (table 3). The qualifications on numbers applies as much in this category as it does for the numbers of specialists by commodity (table 1). It did prove difficult to obtain data on ages so the information contained in table 3 must be considered as approximate.

Table 3. The age profile of knowledge transfer specialists in arable agriculture in England. Note that an individual can occur under more than one specialism within the table. Total number of specialists is 233.

Specialism	30 - 40	41 - 50	51 - 60	60+	Unclassified	Total
Soil science/ agri-environment	4	11	16	3	3	37
Plant diseases	10	22	12	2	5	51
Pests	6	12	13	0	1	32
Weeds	5	7	8	0	5	25
Plant breeding/ cv. selection	7	5	4	0	0	16
Nutrition	2	10	9	1	0	22
Water utilization	1	5	4	0	1	11
Husbandry/ rotation/ agronomy	15	20	10	3	5	53
Habitat creation/ farmland ecology	16	17	8	1	9	51
Application/ engineering	4	0	5	1	0	10
Storage	2	1	5	4	0	12
Total	55	74	60	12	37	

A number of observations arise from table 3 and from the interviews regarding the age profile of specialists as follows:

- Individuals who have left research institutes and ADAS and other such organisations in the past continue to play a significant role within the industry. However, it is expected that the supply of such people will decline as the spectrum of research funded within institutes is less production orientated so fewer people will leave with relevant knowledge to transfer. One interviewee considered that the presence of “retirees” hindered the recruitment of new entrants as their charges undercut those of more established organisations.
- Some organisations, particularly those with broader agronomic skills, have taken positive steps to put in place succession plans and have recruited younger specialists for training within their organisation. These organisations now have a reasonable age spectrum of staff involved with knowledge transfer.
- Research institutes and universities are finding it less easy to put succession plans for knowledge transfer expertise as employment is dependent on the availability of research and development funding. Comment has already been made on how the emphasis of this funding has changed in recent years.
- There is a shortage of expertise to identify diseases, pests and weeds both in the field and in the plant clinic. This has been exacerbated by the demise of plant clinics, which have provided a very powerful training for specialists in the past. Plant health legislation has enabled the retention of taxonomic and diagnostic expertise in some disciplines and commodities e.g. potato diseases.

The data presented in tables 1 and 3 can provide the basis for an assessment of potential shortages in each specialism in the near future. If it is assumed that specialists will retire at aged 60, there is limited new recruitment and the demand for each remains unchanged. A summary of the position for each specialism is as follows:

Soil science/ agri-environment: Fifty six percent of soil scientists are aged over 50 years with three over 60. Only 11% are aged under 40. Soil science/ agri-environment was considered by interviewees to be independent of commodity. A shortage of soil scientists is expected in a few years.

Plant disease: Thirty percent of plant disease specialists are aged over 50 years with two aged over 60. Twenty two percent are aged under 40. Plant pathologists are generally commodity specific and specialise in groups of diseases e.g. fungi, viruses, bacteria. Therefore at a secondary level there will be a shortage of plant pathologists in a few years. Expertise in potato diseases and bacterial diseases in general were mentioned by interviewees as being at risk.

Pests: Forty two percent of specialists are over 50 years and 19% are aged under 40. Ten percent of interviewees identified a current shortage of pest specialists. A shortage of pest specialists is expected in a few years. Entomologists are commodity specific, but possibly less so than plant pathologists.

Weeds: There are already a relatively small number of weed specialists and recent research funding decisions have placed some of these positions at risk. Forty percent of weed specialists are aged over 50 and 25% are aged under 40. Weed scientists were considered independent of commodity. The relatively small number of weed specialists and their age profile indicate there will be a shortage of weed specialists in a few years. A shortage of expertise in herbicide resistance was identified by interviewees as particularly pressing.

Plant breeding/ cv. selection: Twenty five percent of specialists in plant breeding and cultivar selection are aged over 50 years and 44% are aged under 40. Though the number of specialists is relatively small, interviewees considered the industry was well supplied with information on variety choice. There is unlikely to be a shortage of specialists in the next few years.

Nutrition: Forty five percent of crop nutrition specialists are aged over 50 years and only 9% are aged under 40. Nutrition specialists were often (41%) also soil science/ agri-environment specialists. A shortage of nutrition specialists is expected in a few years.

Water utilization: A small number of water utilization specialists were identified of which 40% were aged 50 years and over and only 10% aged under 40. A shortage of water utilization specialists is expected in a few years.

Husbandry/ rotation/ agronomy: Specialists in crop husbandry and agronomy were the most abundant of all specialisms. Twenty seven percent were aged over 50 years and 31% were aged under 40. The age profile of this group indicates that a shortage is not expected in the next few years.

Habitat creation/ farmland ecology: Specialists in habitat creation and farmland ecology were the second most numerous and only 21% are aged over 50 years. Thirty eight percent are aged under 40. There is not a shortage in this specialism.

Application/ engineering: There are a very small number of spray application and engineering specialists, 60% of whom are aged 50 years and over. The 40% aged 40 and under are predominantly engineers. There is an immediate shortage of spray application specialists.

Storage: There are a very small number of specialists in crop storage with 75% aged over 50 and 33% aged over 60 years. There is an immediate shortage of storage specialists.

7. Drivers for change

The key changes in arable agriculture identified by interviewees that will impact on the specialisms required to transfer knowledge to arable farming businesses are:

7.1 Farm structure

- The declining numbers of arable farms with the concomitant increase in farm size are being managed by individuals with higher levels of agriculture and science training and expertise than in the past. These land managers are requiring a higher level of knowledge to manage their businesses effectively. Twenty percent of interviewees held the view that the smaller number of businesses required fewer specialists to transfer knowledge to them. This contrasted with the desire for even more specialised knowledge which supports comments that there may only be one or two people who can generate and transfer that knowledge. Those that believed that more detailed information was required tended to be the more business aware individuals.
- Arable farms are increasingly producing for a market rather than producing a commodity and therefore require greater attention to detail and technical knowledge to deliver.
- Independent consultants and agronomists play an important role in both the tactical and strategic decision making on many farms. In line with the increasing levels of technical training of farmers, it should be expected that the consultants and agronomists will be better trained and will therefore be able to interact and understand research scientists better and so play a stronger role in knowledge transfer.

7.2 Environmental and other regulations

- The change in policy within the UK and European agricultural regime from production to the delivery of environmental benefits will require more environmental specialists who can interpret both the regulatory requirements and the environmental knowledge and present it in a farming and production context. Table 1 suggests that this shift in emphasis among specialists has already occurred for those involved with habitat creation and farmland ecology, though more than half the interviewees indicated that very few of these people were able to translate the environmental information into the context of production at the farm level. In contrast, the succession planning for soil scientists and agri-environment specialists suggests there will be a shortage of these skills in a few years time.
- The increase and changing regulatory environment is demanding knowledge transfer that enables land managers to comply with regulations as well as be profitable.

7.3 IT

- The electronic delivery of knowledge was identified by four interviewees as having potential to, in part, overcome the shortage of specialists. It was acknowledged that it was a specific skill to put the information in the appropriate format to enable business specific decisions to be made.

8. General points emerging from interviews.

During the course of the interviews a number of recurring points were raised. These are summarised below.

The structure of ADAS twenty years ago enabled specialists to do their own research, interact with scientists in other organisations and to transfer knowledge to decision makers by working closely with ADAS advisers. This structure provided a very rounded training for knowledge transfer with individuals gaining knowledge and experience from both the research and farming ends of the spectrum and hence to bridge the gap from “white coat to welly boot”. Additionally, this service was free at the point of use. Since the decision was taken that knowledge and advice was to be paid for there has been an increasing polarisation of activity into generalist agricultural production advice delivered by crop consultants and consultancy groups represented by organisations such as the Association of Independent Crop Consultants (AICC) and The Arable Group (TAG). There has been a corresponding decline in the number of specialists within the now privatised ADAS. For example in 1985 there were more than 200 specialists in ADAS, now there are about 30 covering all commodities.

The career of individual research scientists is driven increasingly by the need to secure and deliver short-term research projects and to write up the results in high-impact peer-reviewed publications. It is the delivery of these publications that in recent years has been the primary determinant of the score received by research institutes and university departments in Institute and Research Assessment Exercises which in turn determines the core research funding they receive. Knowledge transfer to advisers and land managers is considered a distraction from producing publications and is seen of little benefit to the individual unless they are highly motivated also to deliver knowledge transfer. This process was identified by 25% of interviewees as a major disincentive for young scientists to do knowledge transfer.

In recent years there has also been a change in emphasis in the research funded by the Biotechnology and Biological Sciences Research Council (BBSRC) and the Department for Environment, Food and Rural Affairs (Defra). The BBSRC funds research of international quality, but only a small proportion of this research is now of direct relevance to agricultural production. Defra have changed their emphasis from support for agricultural production to one of sustainability with greater focus on the environment. The latter is frequently at the landscape and catchment scale which can be difficult to interpret at the farm scale. Defra now fund production-orientated research primarily through the LINK programme. It is therefore primarily through LINK and the Levy Boards that research relevant to production agriculture is funded. These changes in funding patterns are leading to the generation of fewer results from production-relevant research to be transferred to land managers. However, there is a continuing need for the results of older research to be placed in the context of modern production processes.

The general decline in agriculture, and the corresponding decline in the number of universities and colleges offering an agricultural training, has resulted in fewer individuals with a background in agriculture developing research careers. The consequence is that many research scientists have little understanding of how the results of their research might impact on agricultural production and therefore loose

credibility with land managers. This was identified by 55% of interviewees as a major issue for the future of knowledge transfer.

The decline in the number of institutions providing agricultural training also raises the concern over where the next generation of land managers will come from.

9. Discussion.

There is a continuing need for transfer of the emerging results of research to advisers and land managers to assist in the long-term sustainability of arable agriculture in England. Interviews revealed an immediate shortage of specialists in spray application and crop storage. A lack of succession suggests that there is likely to be a shortage of independent knowledge transfer specialists in soil science/ agri-environment, plant diseases, pests, weeds, crop nutrition and water utilization within a small number of years. The numbers of individual specialists currently available reflects the preparedness of the industry to pay.

A large number of specialists with the ability to transfer knowledge reside in research institutes where the research is done. However, research institutes, together with university departments are finding it difficult to sustain these personnel for two reasons. Firstly, recent scientific advances, together with the policy of funding agencies, have resulted in less production-based research being done with the consequence that there is less new knowledge to be transferred. Secondly, the outputs of production-based research does not score highly in the metrics used to determine the core funding to institutes and universities.

A further critical issue is the lack of credibility that many knowledge transfer specialists have with advisers and land managers. This has come about in part by the lack of core agricultural training available in the country and the limited understanding of agriculture now obtained by scientists involved in knowledge transfer.

The key to sustaining knowledge transfer expertise resides in:

- Maintaining an adequate level of funding for production orientated research over a longer period than three years that can fully support knowledge transfer specialists. This could in part be delivered through LINK-type schemes with the appropriate level of funding. Projects would best be located in larger programmes of research to facilitate continuity of employment and wider training.
- Primary funding agencies such as the BBSRC and HEFCE should place greater weight on effective knowledge transfer in Research and Institute Assessment Exercises so giving greater incentive for scientists and their employer organisations to do knowledge transfer.
- The introduction of funding mechanisms that enable young scientists starting their research careers to obtain the necessary agricultural knowledge to give them credibility when talking to land managers. The old MAFF studentship scheme provided some of this as long as projects were located with groups that had a strong interest in knowledge transfer. Agricultural Trusts also could contribute to such a mechanism, and the Morley Agriculture Foundation is already doing so.

There is an apparent assumption that knowledge transfer is a linear process from fundamental scientist to applied scientist to knowledge transfer specialist to adviser and decision maker. A new model could emerge in an economic climate with fewer but larger farms demanding a higher level of knowledge to remain competitive. In such a model the adviser could play a much more active role in seeking out knowledge from the research base and delivering it in an appropriate format to the land manager. This would require a higher level of science training amongst the advisers, but would place more emphasis on the adviser as the knowledge transfer specialist.

10. Acknowledgements

I would like to thank all interviewees for giving of their time so willingly and for the most constructive discussions.

APPENDIX 1

The Brief

Scientific skills shortages for KT in arable agriculture: quantifying the problem

Background

The Board of the Rothamsted Research Association has decided that it wishes to make a contribution to ensuring that the requirements of arable agriculture for specialist capability in scientific extension and knowledge transfer (KT) will continue to be met in the future. It expects annually to allocate a modest amount of funding to innovations that will assist in meeting this objective and hopes in due course to partner with other organisations who share the same concerns about declining expertise. As a first step, the Board wishes to commission a short study to provide some data on the scale of the deficiency in skills that may already be apparent or will emerge with time. This document provides some background and suggests the data that need to be assembled in support of the contention that there is a serious emerging skills deficit.

It is generally acknowledged that there is a continuing need for KT specialists to serve the requirements of the arable farming industry. Many individuals who trained within ADAS in the 1970s and 1980s and then pursued their careers either inside or outside that organisation are now reaching the mid / late stages of their careers and there is little evident succession or onward transfer of experience and expertise. There are several specialist areas where it is perceived that a gap exists between those involved in research activities and the generalist agronomist (who would hope to be able to access specialist advice in response to specific problems). The areas about which concern has been expressed are:

- crop husbandry/rotation and nutrition;
- soil management;
- pest, disease and weed management;
- farmland ecology and habitat management.

The brief

The Board of RRA wishes to receive a short report, by the end of 2005. This report should provide some verified quantification of the likely current and future shortfall in specialist extension skills accessible to the arable farming sector in England. The data will include the numbers of individuals providing specialist advice to the industry in specific areas (eg plant pathology, entomology, weed science, crop nutrition, habitat creation etc.); their employment position (who employs them and how long before they retire); and any active plans for training and succession. In addition, information on the career history and educational/training background of those currently in post would be valuable. The report should also attempt to address the following key questions:

- Is the demand for independent specialist advice/extension in the areas above being met satisfactorily at present?
- If so, for how long will this be the case?
- If not, what is the scale of demand in terms of personnel and regional requirements?
- Are the specialist areas identified above actually those where the need for skills are greatest?
- What other areas of skills deficit can be identified?
- Are any of these areas better or less well served than others?

The Board of RRA intends to use the content of the report to develop a case for initiatives to be taken to redress any skills shortage that is clearly identified. This may involve initiatives by RRA alone or in partnership with other organisations. It is likely that the report will be used to inform the Defra Research Priorities Group of the position.

The Board of RRA will provide a list of those individuals, from a range of organisations, whose input and views should be sought in the process of compiling the report. However, this list should not be considered exhaustive.

The first draft of the report should be provided to the following two individuals for scrutiny, review and comment:

Dr Mike Griffin (ex Head of Science, ADAS)
Dr Paul Biscoe (HGCA)

John Sherlock
Alan Bide
(on behalf of the Board of RRA)
22 April 2005

Storage				
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B. How long will this position be sustained? In other words, what is the current age spectrum of specialist, when might individuals retire, and what are the succession plans.

Your organisation:

Specialism	30 - 40	41 - 45	46 - 50	51 - 55	56 - 60	60+
Soil science/ agri- environment						
Plant diseases						
Pests						
Weeds						
Plant breeding/ cv. selection						
Nutrition						
Water utilization						
Husbandry/ rotation/ agronomy						
Habitat creation/ farmland ecology						
Application/ engineering						
Storage						

Elsewhere:

Specialism	30 - 40	41 - 45	46 - 50	51 - 55	56 - 60	60+
Soil science/ agri- environment						
Plant diseases						
Pests						
Weeds						
Plant breeding/ cv. selection						
Nutrition						
Water utilization						
Husbandry/ rotation/ agronomy						
Habitat creation/ farmland ecology						
Application/ engineering						
Storage						

C. Where are new "recruits" to the various specialisms coming from?

Which universities/colleges provide appropriate courses?

Or is on the job training more important?Yes/No

What on the job training is important?

D. Will the types of skills required in future be the same as those needed currently

As arable agriculture evolves, are the skills mentioned those of greatest need for the future?
Yes/No

If No, what skills are in deficit?

Which of these are better or less well served than others?

Do you have any further thoughts or comments?

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Mark Tatchell
August 2005

APPENDIX 3

Individuals interviewed

Name	Organisation
Andy Barker	Rothamsted Research
Ian Barker	Central Science Laboratory
Anthony Biddle	PGRO
Alan Bide	Hampshire Arable Systems
Nigel Boatman	Central Science Laboratory
David Brightman	Centaur Grain Ltd
Phil Brookes	Rothamsted Research
Bill Clark	ADAS
James Clarke	ADAS
Alan Dewar	Brooms Barn
Caroline Drummond	LEAF
Peter Gladders	ADAS
Steve Glass	Central Science Laboratory
Dick Godwin	Cranfield University
Keith Goulding	Rothamsted Research
Chris Green	Crop Management Information Ltd
Stuart Knight	The Arable Group
Alistair Leak	The Allerton Educational Trust
John Lucas	Rothamsted Research
Mike May	Brooms Barn
Jim McVittie	HGCA
Paul Miller	The Arable Group
Stephen Moss	Rothamsted Research
Marek Nowakowski	Farmed Environment Company
Jon Oakley	ADAS
Sue Ogilvy	ADAS
Frank Oldfield	Home Farm, West Raynham
Steve Parker	Central Science Laboratory
Richard Pywell	Centre for Ecology and Hydrology
Ian Richards	ECOPT
Debbie Sparks	University of Nottingham
Nicola Spence	Central Science Laboratory
Keith Walters	Central Science Laboratory

APPENDIX 4

List of Abbreviations

ADAS	ADAS
AICC	Association of Independent Crop Consultants
BTO	British Trust for Ornithology
CABI	CAB International Biosciences
CEH	Centre for Ecology and Hydrology
CSL	Central Science Laboratory
HGCA	Home-Grown Cereals Authority
IGER	Institute of Grassland and Environmental Research
JIC	John Innes Centre
LEAF	Linking Environment and Farming
NIAB	National Institute of Agricultural Botany
PGRO	Processors and Growers Research Organisation
RRes	Rothamsted Research
RSPB	Royal Society for the Protection of Birds
SRI	Silsoe Research Institute
TAG	The Arable Group