Final Report

English Pilot Trial of EID/EDT in Sheep

Delivered by ADAS UK LTD

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ADAS

defra
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1 EXECUTIVE SUMMARY

1.1 Background

EU Council Regulation 21/2004, which took effect from 9 July 2005, provides for a double means of identification (double tagging) to be applied to sheep and goats; the UK has received a temporary derogation from this requirement. In addition it requires the electronic identification and individual tracing of animals from January 2008. While the new rules on electronic identification take effect on 1 January 2008, the Council is required to confirm or amend this date by June 2006.

Defra commissioned a Pilot Trial to evaluate systems the use of electronic identification devices (EIDs) and electronic data transfer (EDT) under English sheep farming conditions. While previous studies had mainly concentrated on evaluating the technology, the Pilot Trial focused on identifying aptitude and attitudinal factors as they relate to the use and potential uptake of EIDs, quantifying levels of training and support needed, and establishing any associated cost:benefit at farm, market or abattoir levels.

The trial was managed and delivered by ADAS UK Ltd, using two EID systems integrators (Allflex Europe (UK) Ltd and Earlsmere ID Ltd) as sub-contractors. An Industry Steering Group provided support and guidance for the trial.

1.2 Trial design

From a pool of 278 potential applicants 69 participants, drawn from three important sheep producing regions of England (North, Midlands and South West), were used for the trial. Selection was based on primary factors likely to affect the effectiveness and uptake of EID, such as attitude to EID, computer literacy, and previous experience of EID systems. The sample was then stratified for secondary parameters related to physical and flock management factors such as lambing date, production system, labour availability and gender to achieve a study population reflective of the English sheep industry.

The 69 participating sites were allocated to defined roles within the Pilot Trial:-

- 51 EID farms collected electronically the minimum information necessary to comply with the new legislation;
- 8 EID management farms collected the same basic information together with additional sheep management and performance data;
- 5 EID farms simulated a ‘bureau’ that collected the basic information but where data collection was serviced by a third party provider;
- 3 paper comparator farms collected the basic information, plus sheep management and performance data but used a paper-based system; and
- 2 EID reference farms located on ADAS Research Centres collected the same data as the commercial EID management farms.

To demonstrate the principle of electronic data transfer, captured data were initially downloaded to farm-based PCs, before being transferred via the Internet to a trial-specific central database. No attempt was made to transfer data to, or from, other existing databases.

Market and abattoir evaluations were also included. The scope of these was to demonstrate the principle of EID capture at appropriate points within market and abattoir environments, and did not include integration with any existing market and abattoir software. The abattoir evaluation was done on three sites representing low, medium and high throughput plants. For the auction markets, a three-phase approach was taken at a single site.

On-farm data collection commenced with a staggered start, between March 2004 and June 2004, and finished in May 2005.

1.3 Farmer training and support

Based on an initial assessment at the recruitment stage, as expected, approximately 90% of farmers required IT training. Farmer training and support was delivered either through ADAS Project Officers on a 'cascade' system, or alternatively, direct to farmers via the EID supplier. The 'cascade' model worked best, and underlined the potential pressure on industry resources if the service were to be provided by EID suppliers. Direct contact with Project Officers was the preferred method for receiving training and support. The comprehensive approach taken to training and support in the Pilot Trial is unlikely to be appropriate or effective for a UK-wide roll-out of EID, being too labour intensive and hence expensive.

As expected the training and support needs of individuals varied markedly, as did their ability to effectively implement the various tasks. It proved possible to train a high proportion of farmers, even those with no previous experience, to capture ID data and download it to the farm-based PC. However, at the end of the trial, despite considerable training input, relatively few farmers were confident in transferring data to the central database using the Internet.

Appropriately balanced legislation and simplification of EID systems could, significantly reduce the requirement for training and support, specifically the introduction of a basic entry level EID system that meets the minimum legislative requirement.

1.4 Device performance

Over 122,000 electronic devices were provided for insertion in sheep, distributed across the range of available technologies (HDX, FDX-B; tags and boluses). Within the Pilot Trial, where boluses were used farmers tended to bolus ewes and to tag lambs. However, the number of boluses used was low and represented 12% of the total devices inserted. The requirement in the trial for an additional ear tag to signify an animal had been bolused, probably skewed farmer preferences away from boluses.

In ewes, average tag losses ranged from 2% to almost 9%, but reached 42% in one instance. Tag losses were most likely exacerbated by the time of year they had to be inserted (early summer) to meet the requirements of the trial. Average tag losses in lambs were much lower (less than 0.5%), mainly because the majority were tagged for a relatively short period before sale, in common with current commercial practice. While the retention rate of boluses appeared to be high, this could not be proved categorically in the Pilot Trial.

The percentage of non-reading devices (both tags and bolus) ranged from 0.15% to 0.78%, peaking at 3% on one site. Most failures were recorded shortly after insertion.

Evidence from the Pilot Trial supports the initiative for an approval system for sheep tags in the UK, and indicates that more research is required to understand better those factors affecting the loss of tags and boluses. Technical performance should not be limited to component parts, but the whole device in its final configuration.

1.5 Reading equipment

The results from the trial have demonstrated that the electronic capture of sheep identification information (IDs) was possible in a commercial farm environment using commercially available ISO-compliant equipment. However, the overall robustness and performance of hand readers needs to be improved if a UK wide roll-out of EID is to be fully effective. There were also installation and performance issues with some of the electronic weigh crates supplied. A consistent view of participants was that the equipment was not best adapted to a farm environment, and that greater robustness and reliability, reduction in leads and cables, and improvements in battery performance were needed to make the equipment better suited to on-farm use. A separate ergonomic evaluation also highlighted a number of design aspects that required improvement, for example, lack of transparency and feedback during operation, poor screen visibility, and audibility against background noise. Experience from the Pilot Trial would indicate that developing technologies such as ‘Bluetooth’ and slight design modifications such as to weigh crate systems could help improve the performance of on-farm reading equipment.

Demanding targets were set for market-based equipment, in terms of speed of read, accuracy and the ability to segregate non-reading or non-EID animals. The results of the market trials were encouraging, where ultimately 98% accuracy was achieved in a speed-read that encompassed the full range of technologies. The results indicated the potential application of EID in market environments. Further development of the technology is required to realise this potential.

The abattoir evaluation indicated that a robust and accurate lairage reading system, or ‘Bluetooth’ stick reading system could be developed for use in abattoirs. Panel reading post-kill would be the least invasive in terms of impinging on existing abattoir operations, but technically this might prove the more challenging option. The poorest reading performance for the whole of the Pilot Trial was obtained from the Midlands abattoir test, where IDs were captured using a panel reader at the end of the drip bath. However, it must be recognised that the equipment was not set up as a permanent installation, and that the test was carried out in an old and electromagnetically ‘noisy’ site. The results emphasise the need for a thorough site survey, a permanent installation and a period of commissioning and refinement to meet the greater challenge of reading in adverse environments.

1.6 Electronic data transfer/project database

The Pilot Trial demonstrated that the accurate transfer of electronic data from the farm to the Project database via the Internet was possible, but also emphasised the considerable potential for such a system to fail. A number of risk factors were identified, any one of which has the potential to compromise the accuracy of the database. These included technical (hardware and software), communications (Internet connection), database design, and human error. It must be acknowledged that the project database was developed quickly and did not have the luxury of extensive testing before use. However, the difficulties experienced in the Pilot Trial, even in achieving simple data transactions, confirm the scale of the task involved in constructing and pre-testing a real-time national livestock register.

1.7 Paper comparators

Three farms used a paper-based system to assess the feasibility of manual data collection. As expected times taken to manually capture sheep IDs and various management tasks varied considerably, depending on the facilities, task undertaken and number of staff involved. All three farmers maintained reasonably accurate records. However, they opted to record either a three or four digit management number, and not the full official individual number. Reading a six-digit or twelve-digit number will slow recording, and increase error rates considerably. Despite being well disposed to flock recording, all three farmers were sceptical that accurate manually recorded flock data could be maintained in the long-term. On occasions the fallibility of a paper-based system was highlighted, for example, during periods of heavy rain.

Limited ergonomic studies were conducted separately at one reference site, which compared directly the performance of manual and electronic systems for data capture and transfer. For small groups of sheep (less than 50), with experienced staff reading three-digit management numbers, the time taken to capture IDs manually was not dissimilar to the time taken to read electronically. However, this unexpected result is unlikely to hold true as group size and complexity of numbering system increases.

1.8 Bureau model

Across 5000 sheep in a Bureau, where information was collected by a third party service provider, technical performance of reading equipment, and retention rates of electronic tags, were consistent with results obtained from the EID farms using the same technology.

The greatest limitations to a bureau approach were logistics and lack of flexibility when the service provider was located some distance from the farms. Non-bureau participants felt that a bureau-style option would be required for the wider implementation of individual animal identification across the English sheep industry. In particular, this service was anticipated as likely to meet the needs of both the computer-averse and smaller producers who could not justify the capital investment. Conversely, bureau participants themselves thought the approach to be unworkable in practice. Better directed, the bureau approach could still have potential application, for example to cater for an annual flock gather, where timeliness and logistics may be less critical, and for smaller and hobby sheep keepers.

1.9 Abattoirs

Three sites were chosen to represent a large single species slaughtering plant, a medium sized multi-species operation, and a smaller multi-species abattoir.

As with the auction market, the reading position chosen by the abattoir operator will ultimately reflect the legislation. Definitive protocols will be required as to how to deal with non-reading or non-EID animals on the line. If the Regulation states that only animals with a reading EID device can be slaughtered, this would pose major problems.

Overall, 92% of standard boluses were recovered manually by abattoir staff following the abattoir tests, compared with 76% recovery for the smaller midi bolus; 19% of all boluses got through the system.

While full EID would be more straightforward, rather than dealing with EID and non-EID animals, the abattoir sector are very aware of the potential adverse impact of EID regulation by adding more cost to their supplier base.

1.10 Markets

The Livestock Auctioneers Association (LAA) believe that an EID system is the only option for the auction marts, if individual recording is required for sheep movements. From a position of no commercially available market EID systems for sheep, a number of systems were put together for use during the Pilot Trial. The ability to accurately read groups of sheep carrying mixed technologies (tag/bolus; HDX/FDX-B), at a throughput equivalent to 1200 per hour, and to automatically shed out those carrying non-reading devices or carrying no EID device, was successfully demonstrated using an electronic race system. As a further proof of principle, a stick reading system, using 'Bluetooth' technology was also successfully demonstrated as an alternative to a race reader. The results obtained indicate that with further development and refinement, EID technology should not be the limiting factor in markets.

Of greater concern to the LAA was the prospect of having to deal with a combination of EID and non-EID animals coming into the same market. The logistics, associated costs and potential for error in individually reading visual and electronic tags would put the markets at a serious competitive disadvantage relative to the abattoir sector.

1.11 Animal welfare

In terms of animal welfare, there was only one recorded loss (of a ewe), in over 11,000 animals bolused. A further small proportion of individual ewes could not be bolused due to breed/size effects, or individual anatomical differences.

Within the trial, the biggest impact on health and welfare was associated with tagging. The timing of the Pilot Trial, and especially the period during which animals (particularly breeding stock) had to be identified, were a significant contributory factor to the level of ear infection experienced. Infection rates varied markedly from farm to farm, and in some circumstances reached very high levels, to the extent it seriously impacted on animal welfare. The results indicate that tag design is likely to have a major affect on infection rates, and ultimately tag losses.

Tagging young lambs to establish a dam:lamb link is often required, if data are to be used for management purposes. In the Pilot Trial, the risks of ear damage when tagging very young lambs, was evident both from EID farms and the paper comparators. Two severe outbreaks of joint-ill occurred on participating farms in the South West. The evidence suggests that further work is required to understand better whether or not tagging lambs less than four weeks of age poses an additional health risk, from any other disease or condition affecting peri-natal lambs.

Tag design and testing, related to size, weight, quality of finish and locking action, as they potentially impact on animal welfare, should be given high priority. A formal tag approval system should be introduced not only to demonstrate conformance with a technical standard, but also to validate performance under field conditions. More scientific information is required to provide definitive guidelines on best practice in tagging and bolusing procedures.

1.12 Industry feedback

From participant discussion groups and an interim evaluation exercise it was evident that the on-farm performance of the electronic systems generally fell below participants' expectations. This result may in part have been influenced by the fact that participants had no prior input to defining user requirements, as these were off-the-shelf systems, without any modification to address specific applications. Nevertheless, participants described the equipment as complicated (particularly the data-management systems), too slow to operate and generally perceived it as unreliable. Despite these perceived shortcomings it was accepted that a paper-based system was not a practical alternative to accurately maintain individual animal ID records. Participants stressed the importance, that if EID were introduced, it had to work first time.

A major factor that affects the industry view of EID is how legislation will evolve. Current uncertainty over the specific application of the Regulation strongly affects perceptions of how feasible the introduction of EID is likely to be for the English sheep industry. These concerns applied equally across the primary production chain at producer, market and abattoir levels.

If the legislation is too demanding it was felt that a proportion of producers might choose to leave the industry with adverse knock-on effects for market and abattoir sectors.

Pre- and post-trial industry opinion surveys of the wider sheep farming community showed that the majority (76%) of respondents wanted identification of sheep at flock level only. Respondents lacked confidence that accurate tracing of individual sheep could be achieved throughout the supply chain, even using EID systems. In common with the participant farmers, the wider industry view was that paper-based systems could not deliver traceability at an individual animal level. This opinion was not counterbalanced by confidence in the ability of electronic systems.

1.13 Cost:benefit

Given the start date and duration of the Pilot Trial identifying, demonstrating and quantifying cost:benefit was expected to be difficult. In addition, costs and benefits are likely to change with market conditions, technology costs and future legislative requirements.

The limited ergonomic studies, which directly compared manual and electronic systems indicated no real advantage in the accuracy and speed of data collection, when reading three and four digit management numbers. In addition, this finding partly reflected the usability and robustness of the EID reading systems tested. If the basis of recording was an official twelve-digit number, the potential for transcription errors would increase, as would the time taken to read the tags manually.

Any benefit of improving the speed of data collection *per se* is limited, unless the data are used subsequently to influence management decisions. Many participants recognised the potential for cost:benefit, if not for themselves then for others within the industry who would use accurate data collection to influence management decisions. Participants felt they were constrained in this respect by the performance of the equipment, and the relatively underdeveloped flock management software. Farmers at present are not required to read individual numbers and therefore benchmark against current practice, rather than view the potential benefits of EID (which could include costs in labour saved) against the impending requirement to read a twelve-digit number. This has the potential to underestimate the potential benefits of using EID.

For the auction market sector the relative cost of adopting EID will depend greatly on the current operation of individual sites and on what precisely is required under the new legislation. There may be theoretical benefits, again depending on the legislation, if EID data collection can be harnessed to produce statutory outputs (e.g. movement records) from the auction office in digital format rather than relying on paper systems. Likewise, the abattoir and multiple retailer sectors currently see little scope to add value to the volume retail trade by providing traceability on an individual animal basis. Demonstrating the provenance of each animal may provide some additional market value in specific, low volume outlets such as butchery shops and selected export markets. There could be wider economic benefit in providing an effective individual tracking and monitoring system to potentially improve disease control measures in the national flock.

It is very unlikely that the additional costs of EID incurred on-farm can be passed up the food chain. If EID provides a more efficient mechanism for the feedback of carcass information from the abattoir, individual producers may achieve technical and financial gains. As yet, it appears that there has not been much consideration given to the new Food Hygiene Regulations by many in the production chain, which might place greater emphasis, and hence perceived benefit, on the traceability of individual animals.

1.14 Conclusions and Recommendations

The aim of the Pilot Trial was to identify issues surrounding the practical application, roll-out and implementation of EID, not to provide all the solutions to problems faced by the sheep industry in adopting the EU Regulation.

The results from the Pilot Trial have demonstrated the potential for EID in farm, market and abattoir environments. However, further development and refinement of EID systems is required to better meet a range of user requirements. Early clarification of how the Regulation is to be interpreted will be fundamentally important to the successful UK-wide introduction of EID. Many of the lessons learned from the Pilot Trial will be invaluable in identifying and pre-empting some of the challenges likely to face the industry in planning for a national roll-out of EID.

The magnitude of the task involved in supplying the quantities of EID devices required should not be underestimated. Clear signals from legislators and an adequate lead in time are essential, so that suppliers have the confidence and direction to organise the provision of sufficient tags and boluses.

Based on the results of the Pilot Trial, and other ongoing related work, which clearly identify a need for further improvement and refinement of EID systems policy makers and the sheep industry need to begin a definitive planning process. This needs to involve some innovative thinking, as to how EID could be practically deployed in the UK to meet initially the spirit of the EU Regulation.

A 'gold plating' approach to the application of the Regulation could lead to an unworkable system, with the potential to reduce co-operation from within the sheep industry, increase the likelihood of individual breaches, and encourage some to give up sheep farming.

The objectives set need to be proportionate, in balancing the principles of the Regulation and what is feasible in practice. The impracticality of rolling out a complete, integrated EID system, complete with support infrastructure, for every sheep producer in the UK in 2008 should be recognised. Defra, the Devolved Administrations, and their European counterparts should give serious consideration to a phased approach towards achieving the principles behind the Regulation over a defined time period. The proposed tolerance of 7%, requested by the Irish Farmers Association for sheep producers in Southern Ireland, provides an interesting negotiating precedent.

The EID system adopted initially should be at the most basic and flexible level necessary to comply with the Regulation. Market forces will encourage the development of data management and feedback systems, if required, at each level within the industry. A widespread view within the industry is that 2008 is too optimistic for the delivery of an effective National Register Database (first release of the database is planned for early 2007). Without an effective live database, the real time traceability of animals is lost. Therefore the option for a limited -paper recording system of individual movements should not be ruled out as an interim measure for some primary producers. At its most basic level, this could involve a producer recording the sequence of the tags he is about to put into lambs, as they leave the farm.

Follow-on work is planned drawing from the same participant base, focusing on quantifying cost:benefit, and contributing to Defra's Regulatory Impact Assessment for the introduction of EID in sheep.

2 INTRODUCTION

The Foot and Mouth Disease outbreak, which occurred in the UK in 2001, demonstrated a clear need for improvements to the existing identification and traceability rules that apply to sheep and goats [(1)]. Since then, enhancements have already been made to domestic requirements following discussions with industry and these go some way to meeting the objectives of new European legislation which took effect on 9 July 2005. The new EU Regulation requires, amongst other things, a double means of identification (double tagging) to be applied to sheep and goats from 9 July 2005 and for electronic identification and individual animal identification from 1 January 2008.

The UK has applied for a derogation from the requirement to double tag sheep and goats, and has received temporary approval from the European Commission to maintain our current system of identification using UK and S tags. One of the basic objectives of the new Regulation is the identification and tracing of individual sheep and goats for veterinary purposes, from 1 January 2008. The new rules on electronic identification take effect on 1 January 2008, but the Council is required to confirm or amend this date by June 2006.

Currently, the new Regulation requires sheep and goats to be individually identified within 6 or 9 months of birth, depending on whether the keeper farms intensively or extensively, or when they move off the holding, whichever is the sooner. Producers must keep accurate and up to date movement records for each batch moved, and complete a movement document for all sheep leaving the holding. Owners of the receiving flock must send a copy of movement documents to the local authority within three days of receipt. This information is then transferred to the AMLS computerised database. In addition, there is a further requirement to identify sheep moving from a holding, other than that on which they were born, by an 'S' tag[(2)]. The current alternative to the use of 'S' tags is to record the individual details of the sheep moved in flock books and movement records.

In the UK, an estimated 36 million sheep are maintained on approximately 85,000 holdings [(3)] with hill, upland and lowland sheep being traded through an estimated 277 livestock markets [(4)] and 244 and 146 full-throughput and low-throughput slaughterhouses [(5)] respectively. Given the size and complexity of the sheep industry, the accurate individual identification and tracing of all sheep will only be logistically feasible if harmonised systems of EID are introduced in the UK.

The introduction of EID should make the recording of individual sheep more feasible, but the cost is likely to be high. It has been estimated that the additional cost of moving from the current sheep tagging system to EID would be approximately £90m initially and £44m per annum thereafter. These figures are however being reviewed to take account of technological improvements and a significant reduction to these original estimates is expected [(6)]. To offset this additional cost the expectation is that there will be a number of benefits associated with EID. These include improved flock performance [(6)], better disease control and increased consumer confidence in UK-produced lamb leading to improved export opportunities. Before committing this level of expenditure, it is important to demonstrate that EID systems are practicable and effective under the wide range of UK sheep farming conditions.

Some trial work has already been completed or is on-going, both within the EU [(7, 8, 9)] and the UK [(10, 11,12)]. Previous studies have tended to focus on evaluating EID equipment, however the attitude and aptitude of farmers to using EID technology and their level of IT competency might have a greater impact on the take up of EID for sheep than the availability of workable EID systems *per se*. The attitude of sheep farmers to IT generally, and EID specifically, is not fully known and should be established before any widespread roll-out of EID is implemented. Better understanding of attitudinal and socio-economic constraints and the provision of possible solutions should assist in the roll-out and take up of EID by sheep farmers.

Electronic identification uses radio frequency identification (RFID) chips (transponders) to uniquely allocate random electronic numbers to the animal identified. RFID is a fully proven technology and is in widespread use in many industries. However applying RFID to animal identification is a significantly more difficult technical and logistical challenge.

The ISO standards 11784 and 11785 “Radio-frequency identification of animals” were published in 1996 to address some of these issues, and to provide an internationally recognised system of RFID in animals, that is transferable across nations. Most official EID systems across the world are using the ISO standard, and it is likely that the EU will also adopt this system. ISO 11785 provides for two parallel technologies operating on the same activation frequency, known as HDX (half duplex) and FDX-B (full duplex). Further variations are provided by the choice of carrier for the chip, in practice by the various types of ear tag and sizes of rumen bolus available. The ISO standards are measures of conformance, rather than performance under field conditions.

Against this background Defra commissioned in March 2004 an independent Pilot Trial for Sheep EID/EDT which aimed to evaluate EID under English sheep farming conditions, and provide insight and information on possible take up issues. The results of this Defra-funded trial will provide information for use in EU negotiations on EID in 2006. The trial was contract managed and delivered on behalf of Defra by ADAS UK Limited who used two leading EID systems integrators as sub-contractors. Support and guidance for the trial was provided by an Industry Steering Group, which comprised representation from the National Sheep Association (NSA), National Farmers Union (NFU), British Meat Processors Association (BMPA), Livestock Auctioneers Association (LAA) and Assured British Meat (ABM).

3 TRIAL DESIGN

In terms of the trial design, a high level overview of the objectives, scope, and approaches taken, is given below. The specific parameters that applied to each component of the trial are reported separately under each section.

3.1 Overall objectives

The overall aim of the Pilot Trial was to assess the effectiveness of systems of EID/EDT under commercial working conditions.

The specific objectives were to:-

- test the effectiveness of EID and electronic tracing systems in a live working environment;
- analyse take up issues on the use of electronic tracing in England;
- identify, and help prove, the benefits of EID and electronic tracing; and
- demonstrate and promote EID and electronic tracing systems.

Priorities were to identify and quantify the levels of training and support needed to provide participant farmers with a working knowledge of EID/EDT, identify attitudinal factors as they related to the potential uptake and effectiveness of EID, and establish any associated cost:benefit.

3.2 Farm based evaluations

Over a 12-month period, the Pilot Trial aimed to collect quantitative and qualitative data from a minimum of 50 commercial farms (and a minimum of 70,000-75,000 sheep) operating an EID system, and to compare these data with those collected from three farms maintaining paper records. Specific roles were required from the pool of participating farmers:-

- EID basic level farms - collected data consistent with the proposed minimum requirements of the new legislation;
- EID management farms - collected the minimum requirements plus additional management and performance data;
- EID farms which simulated a 'bureau' - collected data consistent with the minimum requirements, but where data collection was serviced by a third party provider; and
- EID reference farms located on ADAS Research Centres - collected data similar to that collected on the EID management farms.

3.3 Abattoirs and markets

At key points where sheep carrying electronic devices may be brought together, such as markets and abattoirs, it is essential that the EID systems used are compatible, and provide a workable solution. One component of the Pilot Trial therefore undertook market and abattoir evaluations. For the abattoir tests, a range of EID systems were evaluated in abattoirs representing low, medium and high throughput plants. In addition, these systems were positioned to assess reading ability at several points in the slaughtering process. For markets a range of EID systems were evaluated in a single market, but on a non-sale day. The scope of the market and abattoir evaluation was limited to proof of principle, capturing EID information at appropriate points within the market and abattoirs, and was not required to fully integrate with existing management or financial reporting systems.

3.4 EID Equipment and technology

The trial aimed to assess the effectiveness, robustness and ease of use of EID systems when used by a range of participants with differing aptitudes and attitudes to IT technology, and under a range of commercial farming conditions. The trial focused on the issues surrounding the use of EID equipment, rather than comparing manufacturers' products or systems *per se*.

Rather than embark on developments designed specifically to meet the requirements of the project, the trial used a range of existing, commercially available ISO (11784/11785) compliant equipment and software for the on-farm evaluations. This approach had the advantage of assessing the current state of readiness of EID manufacturers to supply and support a rollout of EID to the sheep industry.

At this stage of development, it was recognised that most farmers starting to implement EID would not attempt to integrate a wide range of equipment and technologies from several suppliers. Instead, they would attempt to buy a complete working system from one supplier. The approach taken within the Pilot Trial was to organise the supply of technology through two integrators, Allflex Europe (UK) Ltd (Allflex) and Earlsmere ID Systems Ltd (Earlsmere), supplying fully integrated chips, readers and software, so that commercial, compatibility and connectivity issues would be minimised. A further simplification, at least in principle, to minimise any issues of potential commercial sensitivity, was the sole allocation of farms to one or other of the two system providers.

Although individual pieces of ISO compliant equipment were available, there was no commercially available market EID system for sheep. . Given the importance attached by the Industry Steering Group to evaluating EID in both these environments, and acting on advice provided by its LAA and BMPA representatives, the Project Board agreed that the scope of the study should be amended for markets and abattoirs to include systems which were not commercially available.

3.5 Project database

To demonstrate the principles of electronic data transfer (EDT), electronically captured sheep ID data were down loaded to farm-based computers, before being transferred via the Internet to a central database set up specifically for the trial. The purpose of the trial was not to develop a sophisticated database/livestock register. No attempt was made to transfer data to other existing databases, or to link with any existing market or abattoir computer systems. Therefore the project database only provided a facility which demonstrated that data could be uploaded from farm-based computers, stored and sent back to the participant farmers.

3.6 Roll-out and installation

Ideally, the roll-out of technology and training would have followed a number of distinct phases, in chronological order – identification and recruitment of participants, ordering devices and equipment, delivery and installation of equipment and software, and provision of farmer training. However, for a number of reasons, it was not possible to follow this logical sequence. Rollout therefore was implemented on a farm by farm basis, with the broad range of rollout activities being undertaken simultaneously on different farms.

3.7 Training and ongoing support

Training and support was provided through two models – a cascade approach whereby the supplier trained ADAS Project Officers, in order to train subsequently the farmers, and an approach whereby the supplier trained participants directly.

In addition to ADAS Project Officers who provided the first point of contact, support to farmers was maintained through a dedicated help-line run by ADAS IT staff, which provided a link to technical staff at each of the suppliers.

3.8 Data collection

The trial collected a broad range of quantitative and qualitative data to provide a holistic view of the practical application of sheep EID. This included scientifically robust data from specific tests and evaluations (e.g. market and abattoir tests, ergonomic studies), information provided at farm level through workbooks and Project Officer diaries, structured discussions with participants at all levels, and industry perspectives through wider survey of English sheep farmers. On-farm data collection commenced with a staggered start, between March 2004 and June 2004, and continued for a 12-month period.

3.8.1 Physical performance data

Project Officers collected physical data on system performance during their routine farm visits, through completion of workbooks, and by maintaining trial diaries for each site which captured the more broad-based information not readily collected by other means.

The information collected included:-

- basic farm details (address, farm type, sheep numbers, contact details);
- equipment specification (e.g. tag/bolus, FDX-B/HDX, PC specification);
- the type and amount/duration of training provided;
- times taken to perform various operations (tagging, basic read) and prevailing weather conditions;
- performance of the EID equipment, including malfunctions;
- effectiveness of reading devices and actions taken;
- effectiveness of transferring data to PCs and actions taken;
- effectiveness of transferring data from PCs to the project database and actions taken;
- tag and bolus losses; and
- animal health and welfare details.

3.8.2 Socio-economic data collection

The main purpose of the socio-economic assessments was to assess initial attitudes and opinions to EID, and to determine subsequent changes as the trial progressed. Data in support of this objective were collected by a number of means, and from sources within and outside the participant groups. Sources of data included surveys of the wider sheep industry, structured feedback from study participants, and responses from nominated industry opinion leaders.

Participants' discussion groups

In each cluster, participating farmers met collectively on two occasions. Meetings were held during July 2004 and May 2005 and took the form of a 60-90 minute discussion facilitated by an ADAS Consultant. To ensure a consistent approach across meetings, a discussion guide was developed, in consultation with Defra and the Industry Steering Group. To provide participants with the opportunity to raise farm-specific queries, which may not have been appropriate in the meeting itself, informal discussions were held at the end of each meeting. All individuals directly involved in the trial were encouraged to attend these meetings.

Participants' interim evaluation

A single formalised evaluation of participants' attitudes towards the on-farm implementation of EID/EDT systems was undertaken in February 2005. This took the form of a structured self-completed questionnaire, returned via participants' respective Project Officers.

Opinion leaders' interviews

Structured interviews were held with recognised industry opinion leaders at the start and end of the trial. Participants included leading sheep farmers and other figures within the sheep industry, sheep specialist consultants, the veterinary profession and representatives of the multiple retailers.

Consultation with abattoir and auction market sectors

Consultation meetings were held with members of the LAA and with management staff at each of the participating abattoirs, once the market and abattoir test had been completed.

3.8.3 Ergonomic evaluation

A separate ergonomic study was conducted through a combination of quantitative (a controlled study at a single site) and qualitative (drawing from the pool of participant farmers' experiences) techniques, in order to compare the relative performance and effectiveness of electronic and paper-based systems.

3.9 Project management

Delivery of the project on the ground was the responsibility of ADAS Project Officers, each assigned to a sub-cluster of 5-6 participating farms. Where the training model was a cascade system, Project Officers had a direct role in farmer training and support, in addition to trial and site management duties. Where training was provided directly by the manufacturer, the intention was that ADAS staff would 'shadow' training staff provided by the supplier. One senior Project Officer in each of the three regions took a lead role, co-ordinating activities for that region, reporting monthly through written reports, and through weekly conference calls. Project Officers reported centrally to the ADAS Contract and Programme Manager, who in turn routinely reported to Defra and the Industry Steering Group.

4 FARMER SELECTION AND RECRUITMENT

4.1 Objective

The strategic importance of the Pilot Trial underlined the requirement for a robust design that would allow the findings to be interpreted with confidence and presented credibly to the sheep industry. Initially, approximately 65 sites were sought, to ensure that a minimum of 50 commercial farms representative of the English sheep industry would be retained over the course of the trial.

4.2 Approach taken

Against a background of some 40,000 holdings in England, with a combined breeding flock of approximately 7.5 million ewes, achieving a statistically representative sample was beyond the scope of the Pilot Trial. Drawing from a single sample, without any stratification to take account of additional variables, would have required approximately 600 farms to be involved in the study in order to be 95% confident of the estimates made. Therefore, while not being statistically representative, the sample of participants was selected to be as far as possible a good reflection of the wider English sheep-farming population.

Participants were drawn from lists and contacts provided by NSA, NFU and ADAS. They covered three important sheep producing regions of England – North, Midlands and South West. Selection and recruitment was based on an initial telephone questionnaire, screening farmers on a number of primary selection criteria that were deemed most likely to affect the uptake of EID. These included:-

- attitude towards EID/EDT;
- computer competency; and
- current experience of electronic systems.

The sample was then stratified for secondary parameters related to physical and flock management factors that also had the potential to impact on the successful implementation and uptake of EID. These included:-

- farm type;
- production system;
- flock size;
- labour availability;
- extent of existing flock-recording; and
- farmer’s age and gender.

Based on the initial paper sift, on-farm visits were made by local ADAS Project Officers to short-list participants, confirm eligibility, verify facilities and explain the background and specific requirements of the study. Following this final screening/verification, suitable applicants were recruited to the trial.

The selection of paper-based comparator farms was less formalised than for EID farms. Farmers already known to ADAS staff and who were known to be predisposed to collecting data manually were approached in each of the three study areas and were invited to join the study if they were prepared to tag sheep and collect data manually.

4.3 Results

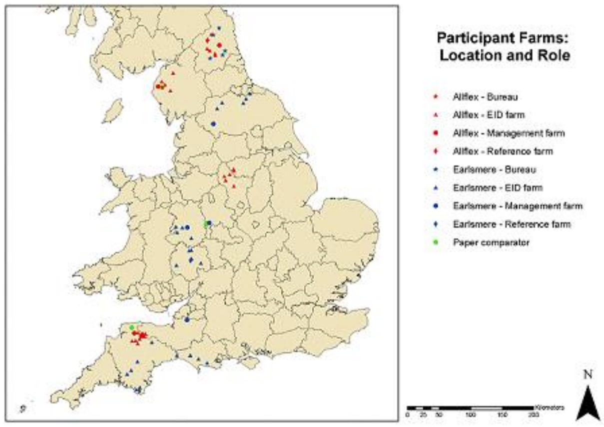
4.3.1 Number of participating sites

From a pool of 278 potential participants, 67 commercial farmers were recruited, fulfilling the various roles within the Pilot Trial. Including two ADAS reference farms brought the total sample size at the start of the trial to 69 farms (Table 1).

Table 1. Number of farms by role

	Allflex	Earlsmere	Total
EID Basic	26	25	51
Management	4	4	8
Bureau	0	5	5
ADAS reference farms	1	1	2
Total EID	31	35	66
Paper comparators	n/a	n/a	3

n/a = not applicable



A proportion of participants were anticipated to fall out over the course of the trial. One farmer resigned from the trial for a short period, but then rejoined and completed the study. Another failed to engage with the trial fully and did not collect all the required information. However, all 67 commercial farms completed the Pilot Trial.

4.3.2 Farm characterisation

Farming system

The breakdown of trial participants by sheep farming system reflected a good cross section of the English sheep industry (Table 2). Although no farm carried less than 100 ewes, this was not considered a serious constraint, on the basis that if EID could be made to work for a large flock it should be equally applicable to a smaller flock. More than three-quarters (77%) of participating flocks lambed at least partly indoors (Table 3). This was higher than expected, given that 51% of farmers were classified as hill and upland.

Table 2. Number of commercial participating farms by sheep farming system*

Sheep farming system	Number	Type of output	Number
Hill only	10	Produce store lambs	15
Hill and Upland	7	Produce breeding sheep (hill)	8
Hill/Upland and Lowland	2	Produce breeding sheep (crossbred)	20
Upland only	15	Finish lambs	66
Upland and lowland	4	Purchase store lambs for finishing	8
Lowland only	29		
Total	67		

* excludes ADAS reference farms.

Table 3. Distribution of commercial flocks by size and lambing system*

Number of breeding ewes	Number	Lambing system	Number
Less than 100	0	Indoors	35
100-500	26	Outdoors	12
Over 500	41	Both indoor and outdoor	17
		Not stated	3
Total	67		67

* excludes ADAS reference farms.

In terms of available labour, two farms (3%) were mainly run single-handedly. Thirty-one flocks (46%) were run by a single full-time person throughout the year, with a wide range of additional full-time and part-time assistance at lambing time. For 23 (35%) of the flocks, two full-time staff ran the flocks year round, six of which did not report any additional labour at lambing time, while the remainder described a range in terms of number of full and part time assistance. Three flocks (4%) were run by three or more full-time staff year round. The remaining eight flocks (12%) described the sheep enterprise as accounting for part-time work throughout the year – becoming full-time only at lambing time.

Although participants represented a range of age groups the overall age profile (Table 4) was slightly skewed towards the higher age groups (57% of participants were 46 years and older) – this breakdown was consistent with the sheep farming industry as a whole. Male participants dominated the study population, but it was recognised that many farming tasks, particularly data collection and record keeping activities, were frequently a shared responsibility, usually between husbands and wives.

Table 4. Age profile and gender of participants*

Age range	No.	Gender	No.
18-30	2	Male	59
31-45	26	Female	8
46-60	35		
61-75	3		
Not stated	1		

* excludes ADAS reference farms.

Twenty-six participants (39%) maintained flock management and performance data, in addition to keeping statutory health and medicine records, and 7 participants (10%) maintained these records using a computer.

Participants' level of computer competency

The majority (90%) of farmers had access to a computer for potential farm-related purposes. Of these, 20 (33%) used a computer to maintain some form of flock records, 40 (66%) for general farm records, 31 (52%) for business/accounts purposes, 52 (87%) for Internet access, 53 (88%) for e-mail and 47 (78%) described general use of the computer.

Within the initial screening questionnaire, farmers were asked to provide a self-assessment of their own level of computer competency. The results showed a population comprising a range of competencies, with 37 (55%) of farmers claiming none or only a basic level of computer competency (Table 5). Fourteen (21%) of farmers considered themselves computer competent, and had received at least some level of computer training.

Table 5. Participants' perceived level of computer competency available on-farm*

Level of computer competency	No.
No degree of competency: use computer as a minimum, if at all (Nil)	14
Basic competency (use of one or two programmes e.g. word processing, e-mail) (Basic)	23
Competent, no formal training: use variety of packages for specific purposes (Competent)	16
Competent, some appropriate training: trained to use 1 or 2 specific packages (Competent + training)	13
Advanced: use a wide range of packages and confident in using new packages (Advanced)	1

* excludes ADAS reference farms.

The initial level of computer competency was reasonably well balanced between farmers using both EID suppliers (Table 6).

Table 6. Computer competency of participants by EID system supplied *

Level of computer competency	Allflex		Earlsmere	
	EID	Man.	EID	Man.
Nil	6	0	5	1
Basic	11	1	9	1
Competent	3	2	6	0
Competent + training	6	1	4	1
Advanced	0	0	1	1

excludes ADAS reference, paper comparator and bureau farms
Man. = EID management farms

Participants' attitude towards EID systems for identification of individual sheep

In response to the question in the screening questionnaire, "would you say that your attitude tended to be positive, negative or neutral towards the use of electronic identification systems for the identification of individual sheep?" a total of:-

- 3 (4%) participants responded to the negative;
- 28 (42%) described their response as neutral; and
- 36 (54%) described their response as positive.

This apparent skew towards more positive responses should be viewed against the background that many participants were negative towards the prospect of individual animal recording. However, if this was mandated, they saw electronic identification to potentially represent their best option.

Table 7. Participants starting attitude to EID by EID system supplied *

Attitude	Allflex		Earlsmere		
	EID	Man.	EID	Man.	Bureau
Negative	4	0	1	0	0
Neutral	12	0	11	0	2
Positive	10	4	13	4	3

* excludes ADAS reference farms

The initial attitude of farmers to the concept of EID tended to be slightly more positive for those using the Earlsmere system, but a range of attitudes was represented for both systems (Table 7). Not surprisingly, all EID-management farm participants had a positive attitude towards using EID.

Participants' starting attitude and computer competency matrix

At the outset, farms supplied by both suppliers had a similar, and varied, mixture of computer competencies and attitudes towards EID (Table 8).

Table 8. Participants' starting attitude and computer competency matrix by EID system supplied

Competency	Attitude to EID		
	Negative	Neutral	Positive
Allflex			
Nil	1	3	2
Basic	2	6	3
Competent	0	2	1
Competent + training	1	1	4
Advanced	0	0	0
Earlsmere			
Nil	0	2	3
Basic	0	6	3
Competent	1	2	3
Competent + training	0	1	3
Advanced	0	0	1

* excludes ADAS reference, bureau and EID-management farms

4.4 Overview and implications for uptake of EID

Although not a statistically significant sample, the farms selected as participants were considered to be sufficiently indicative of the English sheep industry to provide a valid assessment and evaluation of EID in working farm environments.

While participating farms provided a good reflective sample of the industry, because of the scale of the Pilot Trial, inevitably there were sections of the industry (e.g. specialist store lamb finishers, common grazers etc) and individual circumstances which could not be included directly. The specific circumstances relating to these small but important production systems must also be included when considering the implementation of sheep EID in the UK.

The proportion of farm households with access to computers (irrespective of specification) was unexpectedly high, and above that recorded in previous studies. This highlights the importance of other family members, in describing the whole skill set (and by inference training needs) available for a given farm.

The fact that all farmers completed the study, underlines the commitment of participants to the trial, and this in itself further strengthens the data set. The design was unusual in that it deliberately sought out participation from farmers who had little or no IT skills and a negative attitude to the use of EID. At the same time, we are confident that all bar one of the participants did their utmost to meet the requirements of the trial, and that it was a realistic and fair evaluation.

5 FARM-BASED EQUIPMENT AND SOFTWARE

5.1 Objectives

The aim of the Pilot Trial was to evaluate a range of commercially available, ISO compliant/ICAR approved EID equipment, tags and rumen boluses, under commercial farming conditions.

5.2 Approach taken

5.2.1 EID devices

Tags and boluses representing both technology streams (FDX-B and HDX) were used in the trial. Participants had a free choice of using either tags or boluses, and in the main decided at which stage in the trial the devices were inserted. Farmers themselves inserted the devices, after appropriate training in tagging/bolusing and associated disinfectant procedures.

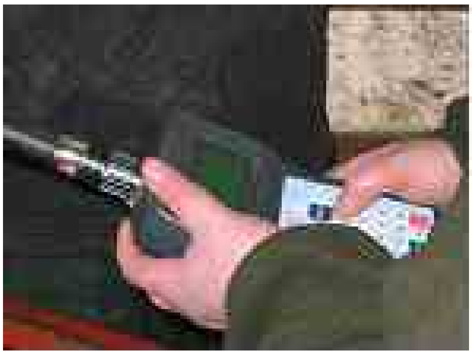
Where a rumen bolus was used it was a requirement of the contract that animals were also identified using a standard visual tag to ensure that bolused and non-bolused animals could be readily distinguished. For welfare reasons a constraint was placed on the use of boluses in lambs. Midi-boluses could only be inserted when the lambs had reached at least 25 kg live weight.

Tags and boluses were ordered from the suppliers by specifying the number required and the run of individual animal numbers needed. In the case of lambs a standardised number was used, typically UK {******(six digit flock no.)******(six digit animal no)}. However for ewes and hoggs, some of which already carried an official number, an additional numbering option was offered specific to the trial, prefixed by ‘EID’ rather than ‘UK’. This avoided the possibility of the same animal carrying two ‘official numbers’, and the time consuming requirement to put in the same visual EID identification number as the number already carried by the sheep.

5.2.2 Reading equipment

For on-farm use, two types of reading system were used; either a hand-held or an electronic weigh crate reader (weigh crate). EID-Basic farms operated using hand-held readers, while an automatic system of identification and recording through a weigh crate was used on EID-Management farms and the two ADAS reference farms (one supplied by Earlsmere – ADAS Rosemaund, and one supplied by Allflex – ADAS Redesdale).

Hand-held readers



The two types of hand-held reader used in the project (Table 9) were portable devices that included an external antenna, display screen, and keypad for data recording. The readers were connected to PCs using either a hard-wired lead or a communications cradle.

Both readers were powered by rechargeable internal batteries and were issued pre-programmed with their specific operating systems. Individual animal data were downloaded to the readers from the PC to enable animals to be scanned and their electronic ID recorded.

Table 9. Features of the portable hand-held readers used in the Pilot Trial

	Allflex supplied	**Earlsmere supplied**
Model	Anilog	Aboca
RFID compatibility	ISO 11784/11785 HDX and FDX-B	ISO 11784/11785 HDX and FDX-B
Moisture resistance	IP65	IP65
Battery recharge	Docking Cradle	Communications Lead
Dimensions	25 x 95 x 35 mm	220 x 116 x 51 mm
Weight	435 g	750 g
Temp range	-10 to +55°C	0 to +40°C
CE certification	UL1950, IEC950	ETS 300 683/I-ETS
Communications	RS 232 Serial Port	RS 232 Serial Port

Electronic weigh crates and readers

The electronic weigh crates comprised a panel antenna linked to a rugged field computer, which together formed the reading and weighing system. Two types of weigh crate were used in the trial (Table 10). Both systems used a single static reader panel incorporated into the structure of the weigh crate, and a field computer to process and record animal numbers, animal weights and other information which might be collected, such as condition score, breed, gender and any management actions.

With both weigh crate systems, data from the PCs' software was downloaded to the reader before data capture in the field. This enabled the reader to link the scanned electronic number to the animals' management number.

Table 10. Features of the weigh crate readers used within the Pilot Trial

Allflex supplied	**Earlsmere supplied**
Static galvanised steel crate	Mild steel painted portable crate
Iconix loadbar weighing mechanism	Suspension weighing mechanism
Iconix FX 15 Weigh Head	Trutest JR3000 single weigh head
Single panel antenna	Single panel antenna
Husky FS2 field computer	Itronix fex [21] field computer
Linear power supply or 12 volt battery	Linear power supply or 12 volt battery ----

All hand-held readers and weigh crate reading systems used in the trial were able to synchronously read both HDX and FDX-B technologies in accordance with ISO11784/11785.

5.2.3 Farm based PCs

The trial required each participant to have a PC capable of storing captured data and then transferring these data via the Internet to a centrally maintained project-specific database. The minimum technical specification required for PC's was:-

- Pentium III (500mhz) or above;
- 128 MB Ram or above;
- minimum 500 MB Hard disk Space;
- operating system - Windows 98 or Windows XP;
- ideally, two serial ports;
- internet service provider (ISP) installed; and
- a 56 Kb modem.

Existing farm PCs were evaluated against the above requirements. Where the minimum operating requirement was not achieved, PCs were where possible upgraded, or the participants were provided with a project-specific PC. Each PC supplied by the project was loaded with commercially available anti-virus software. Participants without an existing ISP account were registered initially with a recognised ISP provider.

5.2.4 Flock management software

The data management software used (Table 11) as provided by the suppliers incorporated the following specific features:-

- application to sheep production systems;
- electronic interface with EID reader systems;
- electronic upload capability to central database; and
- data manipulation and processing to provide individual and group performance output.

Table 11. Features of the flock management software used in the Pilot Trial

Allflex supplied		Earlsmere supplied	
Management farms	**EID farms**	**Management farms**	**EID farms**
Anidata ES	Anidata ES	Pedigree Stockminder	Standard Stockminder (replaced by SP 2004, September 2004)

Both integrators used an approach based on a cross referencing file linking the random electronic number present on the chip to the individual animal management number, i.e. a relational rather than WYSIWYG system (see Glossary).

5.3 Results

5.3.1 EID devices

<u>EID devices supplied</u>

Over 122,000 tags and boluses were placed in sheep on 66 EID farms (64 commercial and two ADAS reference farms). A break down of the spread of devices is shown below (Table 12), and confirms that a representative spread of devices by type and technology was achieved. For the 2005 lamb crop, the range of tags used was broadened to include a proportion of Shearwell and Roxan tags.

Table 12. Tags and boluses supplied to the 66 EID participating farms by type

EID device	Supplier	Type of chip	Quantity supplied
2004			
Standard Bolus	Earlsmere	FDX-B	3,294
Midi Bolus	Earlsmere	FDX-B	1,055
Button Tag – open end	Earlsmere	FDX-B	12,718
Button Tag – closed end	Earlsmere	FDX-B	7,625
Foldover Tag	Earlsmere	FDX-B	16,761
Button Tag	Allflex	HDX	22,021
Button Tag	Allflex	FDX-B	21,632
Standard Bolus	Allflex	HDX	6,960
2005			
Foldover	Earlsmere	FDX-B	5,260
Button Tag	Allflex	HDX	18,610
Foldover	Shearwell	FDX-B	2,450
Foldover	Roxan	FDX-B	3,520
Midi bolus	Earlsmere	FDX-B	800
Total			122,706

Choice of bolus or tag

The project was originally conceived with the intention of inserting an equal number of boluses to that of tags. Where boluses were used the tendency was to bolus ewes, but to tag lambs. A small proportion of farms used boluses in growing lambs during the summer, and a number used both types of device in ewes on the same farm (Table 13). The project-specific requirement for an additional visual tag to indicate that a bolus was present was a factor reducing the use of boluses within the trial.

Table 13. Usage of EID device by class of stock (% of farms)

Type of farm	*Ewes/shearlings*				*Lambs*			
	Tags	**Bolus**	**Both**	**Total**	**Tags**	**Bolus**	**Both**	**Total**
EID (51)	78	18	4	100	98	2	-	100
Management (8)	50	38	12	100	88	12	-	100
Bureau (5)	100	-	-	100	100	-	-	100
Reference (2)	50	50	-	100	100	-	-	100

Stage at which devices were inserted

Ewes tended to be identified *en masse* at a convenient gather. Given the timing of the start of the Pilot Trial relative to lambing, it was not possible to tag many lambs at birth in 2004 (Table 14). The majority of farms tagged lambs before or at weaning, but some of the larger or more extensive farms inserted devices as the lambs left the farm for sale. It is likely that a significant number of farmers would in practice adopt this approach to device insertion so the results obtained in the Pilot Trial are likely to be highly relevant. In the autumn of 2004 replacement stock were also identified using either EID tags or boluses.

Table 14. When devices were administered to lambs – 2004 (% of farms)

Type of farm	At birth	Before weaning	At weaning	As lambs sold	Total
EID (51)		50	15	35	100
Management (8)	12	63	25		100
Bureau (5)		100			100
Reference (2)	50		50		100
Paper comparators (3)	100				100

<u>Performance of devices</u>

Ewe devices

The overall performance of devices inserted into ewes in 2004 is given in Table 15.

Table 15. EID device performance (2004) - ewes

		Tags					Bolus	
		Allflex	Button Earlsmere closed end	Earlsmere open end	Foldover Earlsmere foldover	Ovina Allflex ovina tag*	Standard Allflex	Standard Earlsmere
% lost tags	Av.	2.07	8.89	8.96	3.59	0.54	n/a	n/a
	Max	10.06	32.60	41.57	11.17	1.00	n/a	n/a
	Min	0.00	0.00	0.81	0.00	0.00	n/a	n/a
% about to fall out	Av.	0.58	0.50	1.15	0.32	0.18	n/a	n/a
	Max	5.41	2.61	10.00	1.92	0.53	n/a	n/a
	Min	0.00	0.00	0.00	0.00	0.00	n/a	n/a
% non-reading	Av.	0.49	0.41	0.76	0.15	n/a	0.53	0.18
	Max	3.16	1.08	2.92	0.50	n/a	0.89	0.50
	Min	0.00	0.00	0.00	0.00	n/a	0.00	0.00
% of ears damaged	Av.	1.74	8.19	6.69	5.58	0.74	n/a	n/a
	Max	6.51	35.91	42.33	20.10	1.23	n/a	n/a
	Min	0.00	0.00	0.00	0.15	0.00	n/a	n/a
% ears infected	Av.	1.95	7.52	4.09	1.77	1.87	n/a	n/a
	Max	11.21	20.94	39.92	6.40	2.66	n/a	n/a
	Min	0.00	0.00	0.00	0.0	0.97	n/a	n/a

* visual tag used to accompany bolus insertion; n/a = not applicable

Average tag losses ranged from 2% to almost 9%. In individual cases, this reached nearly 42%. Greatest losses were experienced in some designs of button tag supplied, where it is likely there was a significant interaction of tag design with the time of year the tags were applied. Many of the tag losses were due to ear infection. If those tags recorded, as about to fall out at the end of the trial were included, the range in average loss rates increase from almost 3% to 10%. Comparable data for tag losses on the three paper comparator farms are given in Section 9.

There was a strong correlation between tags lost and the percentage of damaged and infected ears. The percentage of damaged and infected ears varied with tag type, and the results would have been influenced to some extent by the diligence of the farmers in recording individual devices. In some instances the incidence of infection and ear damage was well above acceptable standards. Proposed new standards are to be introduced for sheep tags which should help improve quality. This combined with the optimum time of insertion should also help reduce the number of problems recorded with tag use in the Pilot Trial.

The percentage of non-reading devices generally ranged from 0.15% to 0.76%, with a peak of around 3%. Most devices that failed appeared to do so shortly after insertion.

Lamb devices

Data are given below for lambs born during 2004 in 16 flocks, which were tagged at less than 8 weeks of age (Table 16).

Table 16. Tag performance - lambs

		Button	Foldover
% lost tags	Average	0.34	0.45
	Max	1.25	0.91
	Min	0	0
% devices about to fall out	Average	0.03	3.22
	Max	0.41	9.65
	Min	0	0
% non-reading devices	Average	0.15	0.60
	Max	0.63	0.91
	Min	0	0
% ears damaged	Average	1.46	0.66
	Max	5.71	1.88
	Min	0	0
% ears infected	Average	2.20	28.34
	Max	14.77	80.00
	Min	0	0.06

Tag loss rates were much lower in lambs than in ewes, because they were in for less time before most of the animals were sold, and also because lambs were not exposed to housing and winter feeding arrangements to the same extent as ewes.

Greater ear damage was recorded in button tags compared to foldover tags. The high rate of infection shown for foldover tags was largely the result of one farm, where mild ear infection was recorded in 80% of the lambs.

Poor print quality on some of the foldover tags supplied during 2004 was an issue. The print faded rapidly, and was particularly susceptible where pour-on products were used for fly control. One farmer removed and replaced all the foldover tags used to signify that ewes were carrying a bolus. Where required, the manufacturer provided additional conventional tags free of charge, to ensure livestock were adequately identified at the point of sale. Although a problem in the Pilot Trial, laser printing of tags would do much to reduce this problem and this should not be a major issue for any UK wide roll-out of EID.

5.3.2 Reading equipment

Handheld readers

The reliability of the two hand-held readers used differed markedly (Table 17).

Table 17. Performance of hand-held readers supplied

	Anilog (31 farms)	Aboca (30 farms)
Proportion of farms where reader failure stopped a planned read at least once	29%	87%
Proportion of farms returning hand readers	38%	100%
Proportion of farms experiencing battery or charging problems	23%	23%
Proportion of farms experiencing lead and connector problems	3%	13%
Average number of times returned	1.6	1.4
Mean interval to return (weeks)	1.8	3.4
Range in interval to return (weeks)	(1-4)	(1-18)

It is difficult to fully dissociate hardware and software problems in reading equipment, because they can singly and in combination result in equipment malfunction. Technical problems associated with batteries might be more difficult to resolve, as battery technology has not in the main kept pace with other advance in electronics. Technology such as 'Bluetooth' could reduce the number of lead and connector problems experienced in the Pilot Trial.

The main issues recorded with the Anilog were related to software, batteries/charging, and manufacturing quality. Two instances of physical damage were noted, resulting in the reader being returned – one where the antenna was hit by a sheep while still in the farmers hand, and the other ingress of water when the reader was left outside in heavy rain. These instances are included in Table 17, increasing the return rate from 32% to 38%.

The Aboca reader was beset with a combination of software and manufacturing problems, to the extent that all units were returned to the supplier in September 2004 for repair/service/reprogramming. This improved stability somewhat, but problems (notably with flashcards and software freezing) continued to the end of the trial. The malfunction of hand-held readers caused total data loss in some instances. During cold periods, the poor temperature tolerance of the Aboca was noted. Below zero degrees Celsius the unit frequently failed after only a few minutes use.

At the start of the trial, the volume of sheep being read on some of the larger farms identified a limitation on the capacity of the readers to capture and store data for several thousand individual animals. Adjustments were successfully made to the software to remove this limitation.

Many farmers expressed surprise at the physical size and weight of the readers, preferring something which they would describe as truly 'pocket sized'. In addition there were observations regarding the design of the keypad, and the number of keystrokes required to complete some basic functions.

Reading boluses with a standard hand-held reader and a short antenna was not always easy, particularly in the restricted confines of a handling race. In pens hand held readers were better to use, but still was far from satisfactory. Experience with extended antennae probes provided by one of the suppliers indicated that this was an option that should be available with all hand-held readers. Reading large groups of animals would be simplified by using a run-through race reader, particularly for flocks with boluses.

Weigh crate systems

Two of the five Allflex management sites experienced problems with the weigh crate, one arising from the Husky field computer and one from the electronic weigh head (Table 18).

Problems with the Earlsmere weigh crate system were more widespread and persistent. All sites had issues in relation to either tuning or installation. The structure of one weigh crate was completely redesigned part way through the trial, with minimal metal, to make reading of midi-bolus more achievable on one specific site. The difficulty in reading midi-bolus on this farm was confirmed to be a crate problem (rather than a bolus problem) by testing another make of crate on the same site. The redesigned crate significantly improved reading speed and performance. This result would suggest that installation issues associated with a weigh crate system can be resolved, but the effort required could be site specific.

Table 18. Performance of electronic weigh crate systems

	Allflex	Earlsmere
Proportion of management farms which reported problems with electronic crate weighing system	40%	100%
Date finally operational	June – July	July – December

The trial highlighted several basic design aspects of the crates themselves, which if improved would also assist field operation, e.g. gate opening and fastening mechanisms. The loadbar approach to weighing appeared to be more accurate and easier to calibrate than a suspended weigher system. While this finding has no direct relevance to EID *per se*, if accuracy underpins the basis of using the data collected, adequate calibration is essential.

A specific issue was the placement of the reader panel on the crate. On the reference farm at Redesdale, the position of the panel antenna had a significant impact on the ability to read mixed populations of electronically tagged and bolused animals, in both smaller adult sheep and in lambs. With the original panel, sheep had to be manhandled forwards in the crate to achieve a successful bolus read. Installing a larger panel reader solved this problem. This experience serves as a good example of where relatively simple solutions can be found to practical problems associated with using EID systems.

Farmers had a perception that sheep could literally be run through the EID weigh crate system and that the electronic ID would be captured. This was not within the farm-based equipment specification for the trial, and in practice was not a reliable method for capturing IDs. Different reading equipment and software would be required for this application.

5.3.3 PC performance

Of the 61 farms that required PCs (i.e. excluding the Bureau and Paper Comparators) at the start of the trial 18 participants had PCs that were suitable to run the electronic identification systems. Sixteen met the required specification, while an additional 128Mb of RAM was bought and installed on a further 2 machines. Two of these subsequently failed (hard drive failure) and were replaced by new PCs supplied by the Pilot Trial. Therefore, 45 commercial farms were supplied with new PCs.

The number of requests for data transfers (from old existing machines) was much higher than anticipated. Of the 45 new PCs that were supplied, data were transferred in 10 cases, at the farmers' request. This transfer was carried out by ADAS IT support staff visiting the farm, which was a resource intensive task, and not without inherent risk of data loss. During one of the transfers the hard disk in the existing computer failed. The hard drive was sent to a specialist data recovery company, who recovered the data.

Fifteen participants already had accounts with an ISP. The remaining farms already had modems, so new ISP accounts were set up. Six farms reported persistent difficulties using their ISP. Difficulties varied from obtaining Internet connections, to uploading information. In one case, a farm was unable to connect because their Internet account had been disabled due to lack of use. Five farms reported persistent problems when trying to upload information. The problem was first recognised when one farm had difficulty in uploading information to the BCMS (British Cattle Movement Service) site. The ISP provider could not provide a solution. As the trial progressed, and the frequency of uploads increased, four more similar cases arose. A decision was eventually taken to move these farms to an alternative ISP service. This approach solved some, but not all, of the problems. Given that approximately 10% of participants had difficulties associated with using the Internet to upload data from farm based PC to a central database, this aspect should not be under estimated for any UK wide roll-out of EID.

In one instance an existing PC was found to be heavily infected with viruses. Once the anti-virus software was installed, the machine was successfully cleaned. At the end of 2004 an update of the software was distributed to all farms. Following the update an increase in calls was noted with ten machines found to be virus infected. As a result, machines were cleaned with the assistance of the Project Officers. In addition, a reminder was sent to all farmers and Project Officers on how virus checkers can be managed and monitored against future virus infection. The potential for PC to become quickly infected by viruses with only limited Internet usage has been clearly shown in the Pilot Trial.

5.3.4 Flock management software

Cross reference files

In the absence of a WYSIWYG system (where the electronic number on the chip is the same as the external visual number) integration between readers and the data management software is vitally dependent on the accuracy and robustness of a cross-reference file (or 'tag bucket'). The supplier creates this file during the production of tags or boluses, by matching electronic random chip numbers with the individual animal numbers ordered by the farm. The majority of participating farmers required the production of a standard cross-reference file (Table 19). However, a proportion required cross-referencing of the electronic number to a pre-determined management number either in the farmers' own records, or relating to the National Scrapie Plan (NSP).

Table 19. Type of tag bucket/data file required (% of participating farmers)

Farm type	Standard data file	Data file partly created from existing database of flock numbers supplied by farmer	Data file partly created from pre- databased NSP ID numbers
EID	92	6	6
Management	100	-	-
Bureau	100	-	-
Reference	50	50	-

Experience gained during the trial has shown that this cross-referencing approach is a source of potential errors and an added complication, particularly where cross-reference files produced by one supplier are required to be used in the software supplied by another. Where individual animal numbers can be batched and printed to visual tags using an automatic system, the process ought to be accurate and robust, but nevertheless some spurious errors still occurred.

In terms of how boluses were used in the trial, the provision of data files linking the bolus number to a management number on an external identifier (tag) was even more critical. HDX boluses were supplied in an individual bag, together with the associated visual ID tag, to be inserted in each animal. However, a data file linking management number on the external ear tag to electronic number in the bolus, was not initially provided for the FDX-B boluses. This meant that the data had to be entered manually and as a consequence some farmers took the approach of little and often to databasing bolused sheep, in order to limit potential error rates.

Of the two software solutions used in the trial, participants felt that neither was ideally suited to the range of requirements that exist within the farms participating in this trial, or that may exist when EID is rolled-out in 2008. Whilst both solutions had a suitable level of sophistication to meet the needs of the management farms, the inherent complexity required a disproportionate level of training and familiarity for the majority of farmers who wanted only to meet the minimum statutory requirements of EID for sheep. This result may in part have been influenced by the fact that participants had no prior input to defining user requirements, as these were off-the-shelf systems, without any modification to address specific applications.

Software Stability

Anidata were generally robust in data capture and several updates were issued during the trial to add further features and refinements appropriate to sheep production systems.

During the first few months of use, Standard Stockminder (mainly supplied to basic EID farms) proved to be unstable and inadequate in dealing with sorting and processing a mixture of electronic numbers, standard animal numbers and existing management numbers. The software was also thought to be responsible for corrupting the tag files that it was working with. In order to resolve these deficiencies, the software was revised to simplify procedures and to offer a lower level specification appropriate to the needs of the basic EID farms. The revised software was rolled out in September 2004. The result was a software package that gave considerably more stable performance and greater user friendliness. The disadvantage was that functionality was limited, and once in use farmers quickly queried its value for management purposes. A dam:lamb link function was added from January 2005 to enable this information to be captured at lambing time in 2005.

Pedigree Stockminder continued to be used on management farms for the duration of the Pilot Trial. This software was not problem-free, and significantly high levels of supplier support were required to maintain its function to the end of the trial.

5.3.5 Achieving the target reads

Farmers participating in the trial were asked to read breeding sheep IDs on at least three occasions and lamb IDs at least once or as they left the farm. Given the technical problems this fairly simple requirement proved impossible to achieve in some cases (Table 20).

Table 20. Proportion of farms achieving successful reads (%)

Full reads	EID system	Farm role in Trial			
		EID	Management	Reference	Overall
<u>Breeding flock</u>					
None	Earlsmere	12	0	0	10
	Allflex	4	0	0	3
One	Earlsmere	64	100	100	90
	Allflex	96	100	100	97
Two	Earlsmere	64	75	100	67
	Allflex	96	100	100	97
Three	Earlsmere	24	25	100	27
	Allflex	76	100	100	83
<u>Lambs</u>					
None	Earlsmere	0	25	0	3
	Allflex	0	0	0	0
Some	Earlsmere	100	75	100	97
	Allflex	100	100	100	100
All	Earlsmere	0	50	0	7
	Allflex	61	75	100	65

In terms of successful reading, management and reference farms were better able to meet the objectives set for the trial. The limitation on one Allflex farm which did not achieve a full read in breeding sheep was not technical.

It would be difficult to fully dissociate EID equipment problems, loss of enthusiasm, logistics of location and labour, tag loss and PC problems as reasons why the objectives for full flock reads were not achieved. The proportion of successes on Earlsmere-supplied farms tended to peter out as the number of reads approached three. The main factor here was the performance of the equipment, particularly during the earlier stages of the trial. Although participants were frustrated with the performance of the system, their commitment to the Pilot Trial was admirable, and many went to considerable lengths in conjunction with their Project Officer to try to increase the number of successful full reads of the breeding flock (Table 33). Two of these farmers were highly computer literate, and used their own knowledge to circumvent some of the software issues within the management software issued.

For lambs, early technical problems on some farms had a more significant impact on the trial results (Table 20) in that a high proportion of lambs left the farms as they reached finished condition, and in many cases this was before the EID equipment was fully operational. Therefore many finished lambs were either sold before they could be read, or were about to be read as they left the farm and the equipment failed in the early stages of the trial. Even the reference farm at ADAS Rosemaund, did not manage to read 100% of lambs before they left the farm.

The extent and commitment of participants to achieve the required number of reads is highlighted in Table 21. This shows the total and average number of times participants attempted to read sheep IDs, successfully or otherwise. In addition to the performance of the equipment, the numbers are also affected by many non-EID factors, including sheep group size, accessibility, numbers of times routinely handled, enthusiasm/determination of the individual farmer, etc.

Table 21. Number of attempted whole and partial reads (including successful reads)

Class of stock	EID system	Farm role in Trial			
		EID	Management	Reference	Total
Breeding flock (total reads)	Earlsmere	162	18	12	192
	Allflex	91	23	3	117
Breeding flock (average/farm)	Earlsmere	6.5	4.5	12.0	6.4
	Allflex	3.5	5.8	3.0	3.8
Lambs (total reads)	Earlsmere	150	15	13	178
	Allflex	63	27	4	94
Lambs (average/farm)	Earlsmere	6.0	3.8	13.0	5.9
	Allflex	2.4	6.8	4.0	3.0

5.4 Overview and implications for sheep EID

The equipment used on farms within the Pilot Trial was ISO compliant, off-the-shelf equipment available in 2004.

The Pilot Trial had to be rolled out quickly. This unfortunately created significant supply problems with equipment and devices which, without adequate planning and lead-in time, could be repeated during a national roll-out.

Tags were the option preferred by most farmers in the Pilot Trial, especially given the specific requirement to provide an external identifier for sheep carrying a bolus. The use of boluses might be more widespread at a national roll-out of EID, particularly in breeding sheep. Therefore any requirement for the specific identification of a bolused animal should be carried as an integral part of the official tag, rather than as an additional ear tag. However, for ease of operation, abattoirs and markets prefer tags over bolus, or a single approach rather than mixed devices.

While the magnitude of tags losses have been established within the Pilot Trial, the loss of boluses has not. Tag losses were most likely exacerbated by the time of year they had to be inserted (early summer) to meet the requirements of the trial. Evidence from the Pilot Trial supports the initiative for an approval system for sheep tags in the UK, and indicates that more research is required to understand better those factors affecting the loss of tags and boluses.

In terms of the technology streams used, the Pilot Trial was able to demonstrate that the equipment could read on farm either HDX or FDX-B, as single technology. Although, on-farm the technology was mainly single stream the ability of the equipment to read mixed technologies was shown particularly during the market evaluations and on the ADAS reference farms.

At present the 16-digit electronic number in the chip is cross-referenced to a simpler official or management number, printed on the tag as a visual identified. Although carefully managed within the Pilot Trial these cross-reference files have the potential to be a major problem for any UK wide roll-out of EID. One supplier adopted data files in decimal format; and the other in hexadecimal. This meant that when master data files were required for abattoir or market evaluations, the data had to be transformed to suit each supplier. This transformation was not always 100% consistent. If a WYSIWYG numbering system is not adopted for a national roll-out, it will be essential that a standard data file format is available for cross-reference files, from the range of manufacturers supplying electronic devices, and that their allocation be centrally controlled.

The performance of some of the reading technology was particularly disappointing, with the failure of the Aboca hand-held reader to perform adequately a key element in compromising the overall effectiveness. The reliability of the Anilog was significantly better, but even here 32% of farms returned the unit because of technical problems. High levels of unreliability are not sustainable at farm level. These results clearly show that ISO compliance alone is not a good predictor of field performance. Further development and refinement of readers is required to improve their robustness and ease of use in a farm environment. Recent developments such as the use of ‘Bluetooth’ technology should further help overcome some of lead and cabling concerns identified by participants in the Pilot Trial.

The Stockminder Standard software performed in the main poorly and was not stable. The Anidata programme proved to be stable in use with good connectivity to the project database. Participant feedback was that they did not find the programme particularly easy to use, or to interrogate the data captured. Reporting facilities were therefore underused. If EID is to be used for management purposes the software must meet the requirements of farmers.

The approach taken in the Pilot Trial was to provide a fixed inventory of equipment depending on role within the project – EID farms had a hand-held reader with which to read devices, management farms had an electronic weigh crate. With limitations on the range of equipment and software used within the Pilot Study, there was little opportunity to try and match that supplied to the specific applications required by individual farmers. Based on the experience gained within the Pilot Trial it is possible to identify how different and evolving EID equipment might be optimised for farm specific applications. For example, reading large flocks of bolused sheep with a hand-held reader is slow and difficult. Race reading equipment developed for the market evaluations could be used on farm for rapid reading of groups of sheep, whether carrying tags or bolus. Likely developments in EID equipment have the potential to provide more robust systems better suited to specific on-farm applications. Such development should in the longer-term make any UK wide roll-out of EID more effective.

6 PROJECT DATABASE

6.1 Objective

The objective of the project database was to test the principle of electronic data transfer (EDT) from farm to a secure central repository.

6.2 Approach

Individual farmers were required to export data from their desktop software using specific export routines set-up by the EID suppliers. The export routines placed files in *.csv format onto the local user hard-drive, which was then logged in to the project database to upload the data. Within the Pilot Trial data migration was achieved by following specified export routines; there was no facility for automatic data migration, as this was not a standard feature of the software used.

The architecture used provided a secure and accessible infrastructure for the hosting of the EID database and Extranet. The applications were split between a web tier and a database tier to provide a combination of data security and flexibility for potential future expansion to meet the evolving needs of the project.

Once the core functionality of the database was developed, sample data were requested from the EID suppliers. These data were then uploaded within the test environment and the bugs identified were resolved. Data files uploaded to the server were saved to an area of the server which was not publicly accessible. This process ensured that an electronic paper trail was available to resolve data upload issues and replicate user actions within the test and development areas.

User guides for the export of data from the desktop software and the data upload process were prepared in conjunction with the suppliers, to be used by Project Officers and participant farmers.

Towards the end of the Pilot Trial, additional search facilities were added to aid interrogation of the system.

6.3 Results

In assessing the operation of the database, two areas are considered - connectivity (i.e. the principle that data could be transferred from farm PC to a central database), and an estimate of accuracy (comparing flock inventory data on farm with that on the database).

6.3.1 Connectivity

In terms of the processes involved in EID, the majority of participants considered themselves least confident in the transfer of data from their farm PC to a central database using the Internet (see Section 7 – Training and Support). Nevertheless, all flocks managed to migrate at least some data to the database (Table 22). Fewer lamb data were transferred, mainly because of initial problems with some of the EID software supplied, which meant that many lambs had already left farms before the data could be successfully collected and hence migrated.

Table 22. Proportion of farms successful uploading some data to the project database (%).

	EID system	Farm role in Trial			
		EID	Management	Reference	Overall
Breeding flock					
No	Earlsmere	0	0	0	0
	Allflex	0	0	0	0
Yes	Earlsmere	100	100	100	100
	Allflex	100	100	100	100
Lambs					
No	Earlsmere	24	25	0	23
	Allflex	0	0	0	0
Yes	Earlsmere	76	75	100	77
	Allflex	100	100	100	100

In some instances there were significant problems with the Internet connection, either a poor connection in the first instance, or the system timing out before a full data transfer could be made. The ISP provider was changed on 6 farms in Yorkshire. Two farms were never able to send data directly to the database. In these cases, the data were transferred to a CD and uploaded by ADAS to the central database.

The results clearly identified potential problems likely to be encountered with EDT when EID is rolled-out industry wide, especially on remote farms serviced by poor telecommunication infrastructure and for those not able to convert to broadband to aid the speed of data transfer.

6.3.2 Accuracy of database information

A comparison of sheep numbers on farm at the end of the project, with those shown on the project database is given in Table 23. A total of 56 farms had data available with which to make this comparison - the difference being farms which actually did not know with sufficient accuracy how many sheep they had on the farm when the assessment was made. In addition, the actual numbers moved off the farm during the trial are compared with the recorded movements on the database. These data exclude the bureau farms.

Table 23. Comparison of farm sheep records with project database records for total sheep present at the end of the trial, and total sheep moved during the trial (number of farms in each category)

Deviation (% + or -) between farm record and database record	Total stock numbers		Movement records on and off farm	
	Allflex	Earlsmere	Allflex	Earlsmere
Less than 1	5	11	7	0
1 – 5	3	1	5	2
5 – 10	4	2	5	0
10 – 25	7	7	4	0
25 – 50	5	4	2	3
More than 50	5	2	6	16
Total number of farms	29	29	27	21

Even at this superficial level where only minimum transfer of data were required, the overall level of accuracy was disappointing. These comparisons made above relate to absolute numbers of sheep. It is likely that if sheep were traced on an individual basis, inaccuracy would increase further.

A simple example of a protocol error affecting the accuracy of the database occurred in the transfer of data from Pedigree Stockminder. 'Within farm' movements recorded in the software, were recognised by the database as an 'off-site' movement and the sheep removed from the flock register.

To understand how the integrity of data could have been affected, the flow of information from farm to the database was examined in more detail to identify points at which errors and variations might occur. Errors were categorised under:-.

- **field** - factors affecting the quality and extent of the data collected on-farm (equipment, farming system, management approach, human error, etc);
- **software** - software issues present on the farm PC, in terms of software performance and its ability to capture and transfer data;
- **database** - performance and construction of the project database; and
- **reporting** - asking the right questions, taking account of appropriate factors for the parameter examined, i.e. teasing out and putting the correct interpretation on the outcome obtained.

Actual and potential issues were identified at all levels (Table 24):

Table 24. Potential sources of error in the collection and transfer of data to the project database

Field collection issues	Software issues	Database issues	Reporting issues
Reader performance	Dummy data	Action types	Report options
Reader software	ISP connection	Re-tagging	Number of uploads per farm
Farm PC	Corrupted csv files	Date of reporting	
Proportion of animals read	Action types	Frequency and date of upload	
Completeness of data entry	Password	Software version	
Manual entry	File size		
Lost animals	CSV format invalid		
Rogue animals	Logging dead animals		
Lost tags	Multiple CPH numbers		
Re tagging			
EID device reliability			
Tag bucket format			
Visual ID format			
Legibility of visual tags			

6.4 Overview and implications for the uptake of EID

The project database was constructed as a relatively simple repository to test the principles of electronic data transfer. Operation of the database demonstrated that accuracy and effective operation could be adversely affected at various points during the capture and transfer of data. Inaccuracies may result from human, technological and/or random error.

If the accuracy of the database is to be maintained, it is essential that the data to be transferred are always in a consistent format. The database will only be as accurate as the data uploaded, and the effectiveness of the checks in place to reject files which do not meet the expected format. However, if a file can be manually adjusted to bypass checks prior to upload, some erroneous data may slip through. From a programming point of view there is little that can be done to legislate for such an event. Therefore, if an error is found, files should not be edited by hand, instead, this error should be identified, fixed and re-exported for upload.

For movement and other management actions, a consistent set of actions (together with their meanings) must be defined, so that any database level queries can act upon these correctly. In addition, to improve accuracy and help maintain a clean data set it is advisable that data transfer fits with farm practice and terminology. Simplification of export routines will make this task more user friendly.

The issues with the dialup connection were related to the ISP as opposed to any specific problems with the server. In practice it is likely that because of location a proportion of farms will experience Internet connection problems. Use of broad band where available may assist in the transfer of larger data sets.

7 TRAINING AND SUPPORT

7.1 Objective

The design of the trial required participant farmers to have a range of computer and IT competencies at the outset, including some with no previous computer experience/training. Assessing the quantity and effectiveness of training and support required is a key factor for the successful implementation of EID. The Pilot Trial aimed to establish the extent of training and support required and looked at the effectiveness of two different models for its delivery.

7.2 Approach

All farmers received general background training to encourage participant buy-in, and to provide a clear understanding of what was required within the trial. The trial had a large technology component, which required specific technical training, including the application of tags and boluses, the use of newly installed PCs, and the specific use of the EID equipment and software supplied.

Two models were used for training and support, simulating what might occur on roll-out of EID nationally. Earlsmere's own field staff trained participants directly in the equipment and software they supplied. To collect data on the amount, timing and quality of this training ADAS 'shadow' Project Officers were also assigned to each farm. The role of the ADAS 'shadow' Project Officers initially was mainly passive; to observe the training and support provided by field staff, but not to deliver it. However, from September 2004 (and following the roll-out of the simplified software) until the end of the trial ADAS 'shadow' Project Officers were actively engaged in delivery of training and support. In the second model, Allflex-supplied farms were trained on a cascade approach, whereby Allflex staff initially trained ADAS Project Officers, who in turn provided participants with the technical training required.

7.2.1 Assessing training needs

Training is likely to be most effective when it meets the needs of the individual. Within the Pilot Trial, the training needs of several discrete groups needed to be addressed. These included participant farmers, ADAS Project Officers, EID supplier field staff and ADAS IT staff maintaining a project help-line.

The training needs of participating farmers was assessed initially by means of a screening questionnaire, and by information collected during the Project Officers' first visit to selected farmers. Thereafter, Project Officers continually assessed the training need of individual participants.

7.2.2 Delivery of training

Cascade and direct training models used a range of training materials, and training visits supported by telephone access.

For the cascade training model, technical training was delivered via a series of five, approximately half-day, training modules for the more generic tasks, supported by individual training plans, tailored to each participant's specific training need.

Farmers were given either full or refresher training in tagging and bolusing techniques by ADAS Project Officers, who themselves had been trained and certificated as competent to undertake these procedures, before being allowed to tag and bolus sheep within the trial.

Reference materials (reference manuals, guidance notes, standard operating procedures (SOP), protocols and workbooks) were provided not only to support the one-to-one technical training, but also to help standardise format and ensure the quality of the data collected on-farm.

7.2.3 Ongoing Support

Ongoing support was provided by a number of routes – including one-to-one contact, a dedicated trial help-line, an Extranet facility, ADAS reference farms and participant workshops.

One-to-one

Project Officers made routine visits, at approximately monthly intervals, to the farms for information gathering, training and problem solving purpose. Participant farmers were also provided with contact details for their dedicated Project Officer.

Help-line

Given the diversity of technologies it was considered that the root cause of problems encountered by farmers and Project Officers would not be immediately obvious. Therefore a dedicated help-line was set up to "triage" calls at the outset. ADAS help-line staff were trained to provide technical support for the cascade model, but not the direct training model, and to support all farmers and Project Officers with general IT problems.

Extranet

A trial Extranet was developed to act as a central resource to provide remote access to documentation associated with the Pilot Trial.

ADAS reference farms

ADAS installed examples of the two EID systems being evaluated, one each at its ADAS Redesdale and ADAS Rosemaund sites. These reference sites provided practical support to Project Officers and participant farmers. In addition, a reference flock of sheep was maintained at ADAS Redesdale. These sheep carried a complete matrix of the technologies and devices used in the trial and provided a resource for testing equipment before general release.

Farmer workshops

As part of the socio-economic evaluation participant farmers met twice during the trial for workshop sessions which provided a forum for information exchange and problem solving.

7.3 Results

7.3.1 Participants' training needs

Tagging and bolusing

As expected a high proportion of farmers had previous experience of tagging both ewes and lambs, but only 38% of participants had experience of administering inter-ruminal boluses.

Table 25. Participants' previous experience of tagging and bolusing sheep and of training needs (%)

	Previous experience		Training required	
	Yes	**No**	**Full**	**Refresher**
Tagging – ewes	98	2	0	100
Tagging – lambs	95	5	0	100
Bolusing – any inter-ruminal device	38	62	63	37

Training in bolusing was relatively straightforward and in most cases was achieved in less than an hour of practical instruction and supervision. No participant proved impossible to train in bolusing technique. Furthermore, this training was successful in that only one sheep died, as a direct consequence of bolus insertion. Although there were some welfare concerns expressed with respect to ear infection following tagging, this probably had more to do with the time of year the sheep were tagged and tag design, than the tagging procedure *per se*. Experience from the Pilot Trial would suggest that the need to tag or bolus sheep should not, with only modest levels of training, be an issue for any UK wide roll-out of EID.

IT training requirement

Based on an initial assessment at the recruitment stage, approximately 90% of farmers required IT training (Table 26). Surprisingly 70% of farmers claimed to have at least a working knowledge of PC basic function and of data transfer. This is a much higher proportion than indicated from other available statistics and, if representative of the sheep industry as a whole, should make the task of rolling out EID easier. However, all participants were assessed as needing some training. Sixty percent of farmers claimed some experience of using farm management software but again the majority was assessed as needing training on this topic.

Table 26. Participants' initial computer competence and IT training requirements by topic (%)

Topic	**Full training** (IT illiterate)	**Full training** (IT- moderate literacy)	**Refresher training** (IT- highly literate)
EID equipment for data collection	43	47	10
PC functions, incl. Data transfer	31	58	12
Advanced flock management software applications	40	50	10

7.3.2 Training the trainers

To train farmers effectively required that deliverers (for both cascade and direct models) received sufficient training themselves to be competent in the systems they supported.

Those Project Officers delivering under the cascade model received on average 56 hours formal training from the supplier. Those looking after EID-management farms received approximately 10 hours more training than those looking after basic EID farms.

ADAS ‘shadow’ Project Officers received on average 22 hours formal training on the system they supported. This was less than that received by ADAS Project Officers, supporting the cascade model, as their role initially was one of observation and monitoring rather than training participants. It was only during the last third of the trial that ADAS ‘shadow’ Project Officers provided any training for participants directly.

Earlsmere field staff were trained in-house.

7.3.3 Training resources

The cascade model was set up to service between 5 and 7 farmers depending on the sub-cluster. It was planned that both models would provide a similar training ratio. However, in the direct model only three field staff were deployed initially, and this reduced to two when one was released after an unsuccessful period at the start of the trial. With so few field trainers available it was decided that the supplier’s headquarters staff would also provide training and support functions.

While in theory this should have increased the amounts of training provided, in practice this was not always the case. Headquarters staff were also responsible for installing the EID equipment and for resolving on-going technical issues, often to the detriment of training *per se*.

By late-August 2004 it was apparent that the direct model was not going to provide adequate training and support and ADAS ‘shadow’ Project Officers took a more active role in training from September 2004 onwards.

The cascade approach worked better, with Project Officers being able to focus specifically on training and support, while the supplier was able to concentrate staff effort in solving any technical issues which arose. This allowed trainers to concentrate on providing training appropriate to participants needs, and in a timely manner.

The direct model appeared to work less well, for a number of possible reasons. These included:-

- too few field trainers were available to provide adequate coverage;
- trainers were not full time employees of the company and had other work commitments to contend with. This impacted on the amount and particularly the timeliness of the training provided;
- while the dedication and determination of headquarters staff to make the system work was recognised the fact that they were too few in number and had to contend with other project related demands on their time, meant they were less effective as trainers; and
- the performance of the hand-held Aboca reader and associated software was unreliable and required frequent maintenance. Effective technical training in the context of poorly performing equipment is difficult to achieve.

This view was supported by the participants who when asked whether or not they were satisfied with the training and support they had received 100% of cascade trained farms and 57% of direct trained farms gave a positive response.

7.3.4 Farmer training and support – total given

The training of farmers commenced in earnest at the end May/early June 2004. It was relatively easy to characterise telephone inquiries, as these in the main were short duration and covered a single topic. Farm visits were rarely topic specific and frequently combined site management, training and technical support functions. ADAS Project Officers allocated to the best of their ability their time proportionately to each of these three functions for each visit. Therefore, the overall time spent in delivery of these functions will be accurate but it must be recognised that the apportionment of time to each specific function will be subject to some variation in interpretation.

For ‘shadow’ Project Officers the situation was more complicated, as their role initially was to observe the process rather than delivery. They attempted to apportion their time to the same three functions used by Project Officers, but this proved more difficult and it is acknowledged that the apportionment of time was probably less accurate.

Overall, the average number of visits per farm made by Project Officers and ‘shadow’ Project Officers, in support of cascade and direct training and support models, was 13.3 and 11.4 respectively (Table 27).

Table 27. Frequency and duration of Project Officer contacts for training, site management and on-going support (by category of farm)

Model	**Overall**		**EID basic**		**EID Management**	
	Visits	**‘Phone**	**Visits**	**‘Phone**	**Visits**	**‘Phone**
Cascade						
Total	399	475	328	391	68	84
Average/farm	13.3	15.8	12.6	15.0	17.0	21.0
<u>Time (hr/farm)</u>						
Training	10.5	0.5	10.4	0.4	11.7	0.9
Support	9.0	1.7	8.3	1.4	13.4	3.5
Site management	11.7	2.4	8.3	1.4	13.3	3.4
Total inputs	31.2	4.6	27.0	3.2	38.4	7.8
Direct						
Total	386	801	310	661	56	128
Average/farm	11.4	23.6	10.3	22.0	14.0	32.0
<u>Time (hr/farm)</u>						
Training	7.4	0.1	6.6	0.1	13.6	0
Support	10.2	1.5	9.5	1.6	11.7	1.1
Site management	17.7	3.9	7.8	3.7	17.6	4.9
Total inputs	35.3	5.5	23.9	5.4	42.9	6.0

As might be expected, supporting the EID-management farms was more demanding - on average 35% and 36% more visits were made for cascade and direct support approaches respectively compared with corresponding EID basic farms. This equated to 42% and 79% more time respectively.

Overall, the average time spent by Project Officers and 'shadow' Project Officers during farm visits on training, site management and ongoing support combined was 31.2 hrs/farm and 35.3 hrs/farm for cascade and direct support approaches respectively. On first analysis, the total time inputs would appear similar for both systems. However, in addition to ADAS 'shadow' Project Officer time inputs, supplier headquarters staff also delivered farm visits in support of the direct trainers. Assuming an estimated input for headquarters staff of 50% additional time (to avoid duplication of time recording for 'shadow' Project Officers), the total time spent on delivering training and on-going support was estimated to be 55.5 hrs/farm.

Overall, the average number of telephone inquiries made was 49% higher for the direct model. The greater reliance on telephone calls probably reflected the low number of direct trainers on the ground, and the extent to which the installed system was fully operational. A high proportion of calls in relation to the direct training model were associated with site management issues, such as sorting out equipment problems, and rescheduling visits/appointments with farmers.

The time recorded dealing with training, site management and on-going support through telephone inquires was 4.6 hrs/farm and 5.5 hrs/farm for cascade and direct routes respectively. As with farm visits more time was spent on handling telephone inquires for EID-management farms than for the corresponding EID-basic farms.

Overall, the total time spent supporting the participants on the trial, through visits and telephone calls, was 35.8 hrs/farm and 61.0 hrs/farm for cascade and direct support approaches respectively. This was total time input, representing training, site management and on-going support combined. It is acknowledged that an element of site management time was a consequence of a trial with additional demands being made of participants. Even so these levels of input are unlikely to be sustainable for a UK wide roll-out of sheep EID.

By comparison Project Officers visited the paper-based comparator farms on average 11.3 times during the course of the trial and spent a total of 28 hrs/farm providing site management and on-going support.

7.3.5 Farmer training and support – pattern of delivery

For the Allflex installed system, which in the main functioned well using the cascade training model, a more detailed analysis of time inputs was possible. This showed that ADAS Project Officers training visits and telephone contacts over the duration of the trial peaked in the period June 2004 – August 2004 for EID-basic farms, which coincided with the period immediately following equipment installation (Figure 1). A high input at this time would be expected, as participants received initial modular training and became familiar with the installed systems. The data also showed that a relatively high input of training was required following the initial peak. This reflected the fact that it took participants quite a long time to learn and become competent in specific tasks, as they used the system relatively infrequently and refresher training was often needed. The more advanced features of the system, such as uploading data to the project database, were in the main used only towards the end of the trial.

> *"I found that as I wasn't using the program for sheep every week, I had forgotten the procedure next time I came to use it"*

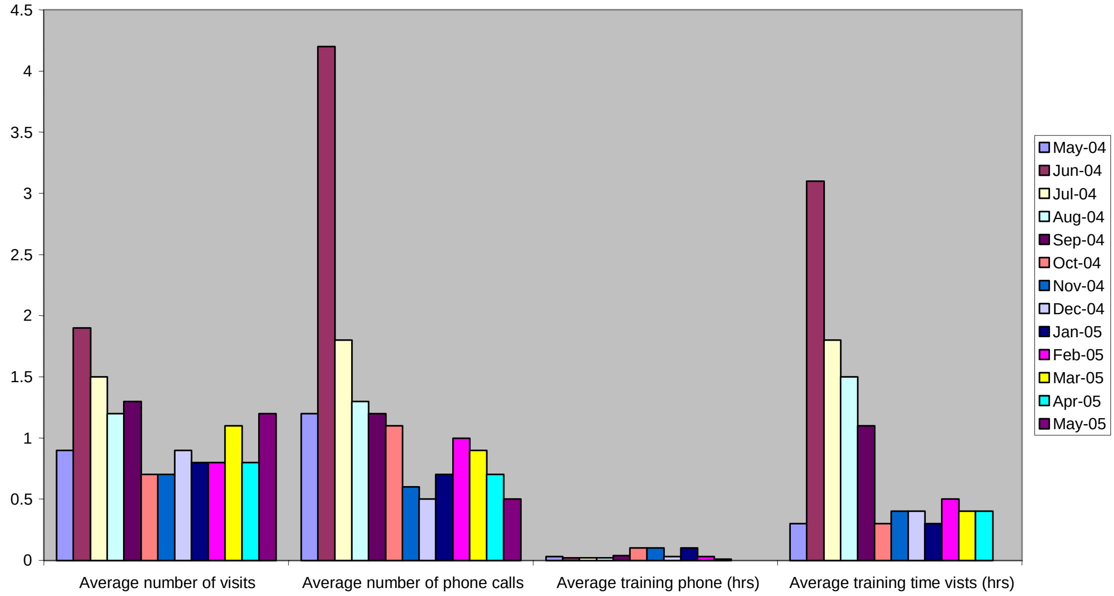


Figure 1. Frequency and duration of training visits and telephone calls

7.3.6 Farmer training and support – variation by farm

It is difficult to dissociate training and support requirements from the delivery model and EID system supplied. The data given below relates only to the cascade training model.

An analysis of individual participants' training and on-going support showed a considerable variation in the amount of training received/needed. The variation in individual training received ranged from 4.5 hrs to 34.7 hrs, and the amount of on-going support ranged from 1.7 hrs to 27.3 hrs (Table 28). There was also considerable variation in the way participants preferred to access training and support. Most preferred one-to-one contact during visits, but some individuals made considerable use of the telephone access provided.

Variation in the amount of training and on-going support provided was probably affected by a combination of the different levels of participants' computer competency at the start of the trial, whether they were EID-basic or EID-Management farms and to some extent the level of problems experienced with the EID equipment.

Table 28. Duration of training and on-going support that was provided to individual participants

Farm ID	On-going support			Training		
	Calls	Visits	Total	Calls	Visits	Total
1	4.2	3.8	8.0	0.7	15.5	16.2
4	0.2	7.2	7.3	0.0	11.8	11.8
7	11.9	5.2	17.1	0.9	12.0	12.9
8	0.0	1.7	1.7	0.0	10.7	10.7
10	2.7	13.1	15.8	0.0	7.5	7.5
15	1.7	20.3	22.0	0.0	8.5	8.5
16	1.2	2.5	3.7	0.0	12.8	12.8
17	1.0	4.5	5.5	0.0	8.8	8.8
28	0.3	13.3	13.6	0.3	9.8	10.2
30	1.0	6.7	7.7	0.0	6.7	6.7
31	0.2	13.3	13.5	0.0	5.6	5.6
45	0.2	3.3	3.5	3.8	30.8	34.7
46	4.5	4.8	9.3	0.6	11.5	12.1
48	3.6	3.8	7.3	0.3	16.3	16.7
49	0.2	7.8	7.9	3.4	5.0	8.4
58	6.0	2.6	8.6	0.5	13.3	13.8
59	0.2	16.3	16.5	0.0	13.4	13.4
60	0.0	14.8	14.8	2.5	16.6	19.1
64	0.0	4.5	4.5	0.0	7.5	7.5
66	0.8	6.8	7.6	0.5	4.0	4.5
85	0.0	5.0	5.0	0.0	5.0	5.0
90	0.0	14.8	14.8	0.0	21.8	21.8
92	7.4	19.8	27.3	1.0	8.0	9.0
99	0.3	7.5	7.8	0.0	6.5	6.5
119	0.5	5.5	6.0	0.0	4.1	4.1
122	0.0	16.7	16.7	0.0	6.0	6.0
123	1.8	9.4	11.3	0.0	11.2	11.2
129	0.0	10.6	10.6	0.0	13.7	13.7
136	0.5	8.0	8.5	0.0	10.8	10.8
188	0.8	15.9	16.8	0.0	8.3	8.3

The analysis showed also a high demand for training by all participants during the early stages of the trial (June 2004 to September 2004). Thereafter, the number of participants needing training diminished and about 25% of participants needed continual training to the end of the trial. This would indicate that the majority of the participants adequately grasped the concepts and became more confident with the operation of the EID system within about four months following installation.

Further evidence to support this view was provided by an assessment made by Project Officers in September 2004 which established the level of farmer competency at that time. An estimated 19% of basic EID farms and 75% of Management EID farms were assessed as being able to go solo in terms of the basic EID functions from that point (Table 29).

Table 29 Competency of cascade trained participants to perform basic EID functions - assessed in September 2004 (%)

	EID Basic	EID Management
Could now go solo	19.2	75.0
Limited further input required	30.8	25.0
Require similar levels of further input	50.0	0.0

However, despite the decline in the number of participants receiving training, all participants continued to receive some level of on-going support to the end of the trial (Figure 2).

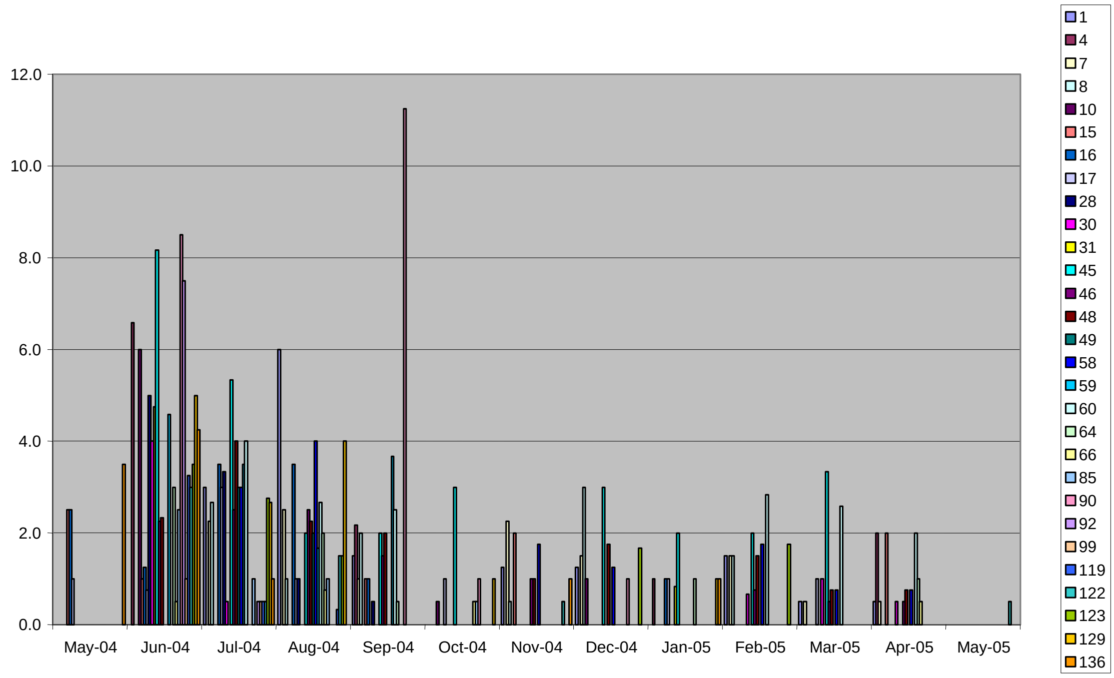


Figure 2. Profile and duration of training provided to individual participants

In terms of on-going support, the amount of time spent in delivery by Project Officers was considerable throughout the trial period (Figure 3). On-going support covered a range of activities which could not be clearly classified as training, and included aspects such as sorting out problems associated with ordering of electronic devices and equipment, PC faults, changing anti-virus software, and sorting out data upload problems to the project data base. The peak in on-going support towards the end of the trial is probably a project specific feature, as it coincided with a lot of farm-based activity transferring and cleaning data in preparation for reporting at the end of the trial. The timing of such a peak in on-going support activity would not necessarily be expected with any UK roll-out of EID.

Although not classed as training *per se,* this type of input would have a significant impact on the rate at which participants adjusted to using an EID system. This type of broad support, although important to the effective operation of an EID system, will be difficult to acquire at roll-out, as it would require a range of skills and experience (e.g. EID systems, general IT, weighing equipment, etc) probably not available from any one provider.

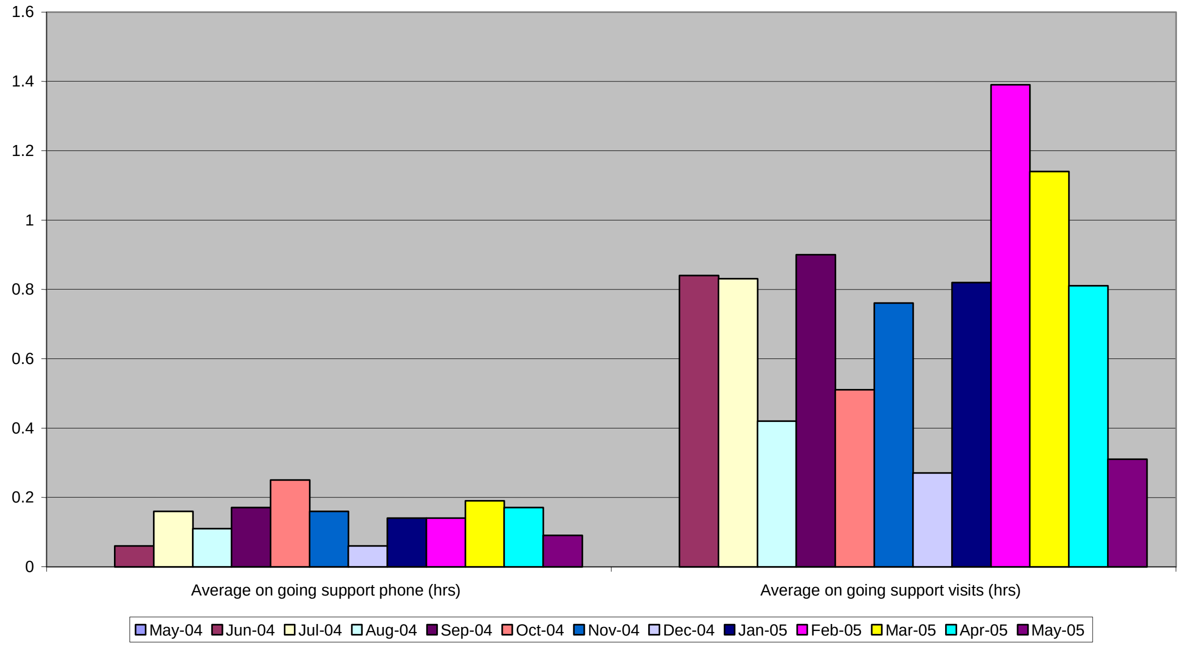


Figure 3. Duration of visits and telephone calls to provide on-going support

There was no real relationship between EID-basic and EID-Management farms in the amount and duration of training and support they needed (correlation of EID system and total hrs r^2 = 0.074). For example, across all farmers trained under the cascade system one Management farmer required close to the maximum amount of training and support given, while another required less than average. There was no relationship between participants' starting attitude to EID and the amount of training and support received (correlation of attitude and total hrs r^2 = -0.070).

There was not a strong relationship between participants' starting computer competency and the amount of training and support they received. Intuitively, it was expected that those with good computer competency at the outset might require less training and support. However, training and support requirements could also be influenced by the amount of user interaction with the equipment and software, irrespective of initial competency level. While there was a trend (Figure 4) which supported this assumption, the relationship was not significant (correlation of computer competency and total hrs r^2 = -0.390).

There was too little spread in the age of participants and the trial population was too male dominated to allow any statistical analysis of the effects of age and gender on the amount of training and support received.

7.3.7 Training Materials

A range of training materials was provided to participants. These included reference manuals provided by the suppliers, which in the main were judged by participants as being overly complicated for the study, and project specific guidance notes and protocols. The latter were written by Project Officers and were considered to be better adapted to farmers needs.

There was little evidence of participants actually using training materials, preferring instead one-to-one contact with the Project Officers.

One participant who had attempted to use one of the Reference Manuals commented -

> *"Instruction manuals seem to be written by people that assume we understand too much, and miss out some of the simple steps which leaves us guessing"*

7.3.8 Usage of the help-line

The call statistics to the help-line are shown in Figure 4. The calls included initial configuration of project-supplied PCs and farm visits by ADAS IT staff. In each case, these are both recorded as a single call.

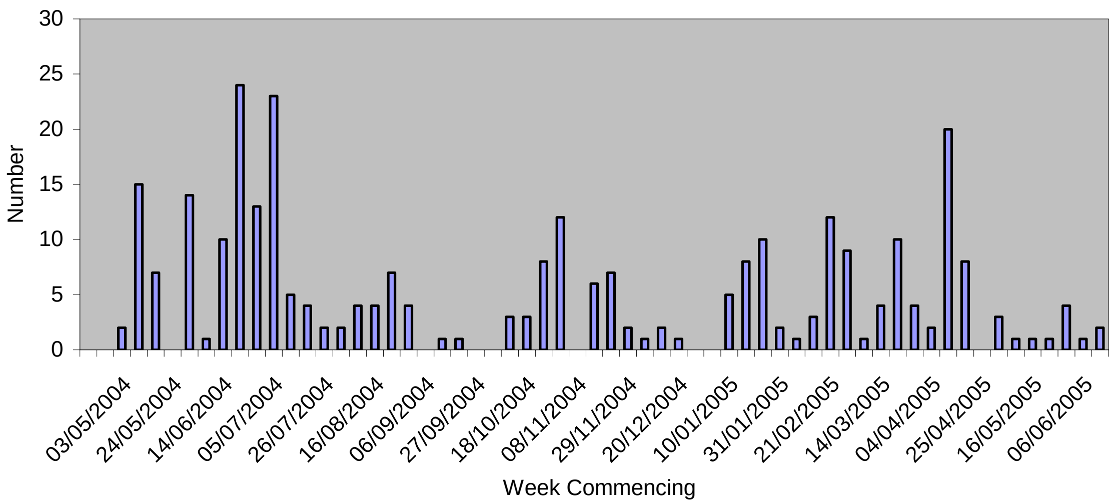


Figure 4. Frequency of calls made to the EID help-line

The number of calls to the help-line was lower than expected. This probably reflected the following:-

- a significant proportion of the project supplied PCs were delivered and installed by help-line staff, who also trained the farmers in the use of the software. This initial input certainly reduced the number of future problems;
- the ADAS Project Officers were adequately trained and dealt with a good deal of the potential queries during their farm visits;
- the distribution of user guides to Project Officers and farmers during key periods, i.e. the virus software updates, uploading information to the project database or checking Internet connections all helped reduce the number of call received by the help-desk; and
- after the initial stages of the trial, participants who were directly supported by the supplier did not route all enquiries through the help-line. Given the level of technical problems encountered and the fact that staff left their contact details for further assistance, a proportion of calls were made direct to the supplier.

The type of call received closely followed the life cycle of the project – initially calls related mainly to assessments of existing PCs and requests for project-supplied PCs to be configured. Most of the ADAS help-desk farm visits were made in the period June 2004 to September 2004, when EID systems were commissioned and farmers received their basic PC training. In the period August 2004 to May 2005 the majority of calls related to the upload of EID information to the project database. Between January 2005 and April 2005 the majority of calls were related to virus software issues, new anti-virus software having been issued in December 2004 to combat a high level of virus infection on project PCs.

Not surprisingly, there were more calls received from ADAS Project Officers and farmers using the cascade training route (193) than from those receiving direct support from the supplier (108). This mainly reflected the fact that farmers, ADAS 'shadow' Project Officers and the supplier's own trainers dealt directly with the supplier regarding specific EID system problems.

The breakdown of calls by call type is given in Table 30. In total, 327 hours were booked against calls. Approximately 40% of time was spent on farm visits during the initial stages of installation and training and 12% of time was spent in setting up trial supplied PCs. Only 33 hours was spent on resolving specific EID system problems and queries. Virus checker issues took 36 hours to resolve. The time input excludes all general activities, training of technical staff and document production.

Table 30. Numbers and types of calls received by the EID trial help-line

Type of call	Number
EID system problem/query	72 (24%)
Farm visit – installation and training	27 (9%)
PC hardware	10 (3%)
Internet access	21 (7%)
PC support type problems	17 (5%)
Hand-held Reader problems	2 (<1%)
Set-up of project PCs	49 (16%)
Suitability of existing PC	7 (2%)
PC training	12 (4%)
Upgrade existing PC	2 (<1%)
Upload EID data to central database	28 (9%)
Virus checker	54 (18%)
Grand total	301

The call statistics detailed above exclude those calls made by ADAS Project Officers which were of a general advice nature and could not be allocated to a specific farm. There were 75 calls of this type, which could be broken down into Anidata software updates and issues (33%), Windows software issues (27%), PC set-up problems (20%), internet access/password changes (11%) and other technical problems (9%).

Of the 45 new PCs that were supplied to participants, in 10 instances data were transferred to the project PC at the farmers' request. This was a higher proportion than expected, and may have implications for any UK wide roll-out involving EDT.

Six farmers (approximately 9% of participants) reported problems when trying to upload information. The problem was isolated to be an ISP issue. The number of calls concerning both problems with the ISP and uploading data to the EID project database, was higher than anticipated.

7.3.9 Usage of the Project Extranet

The Extranet became fully operational in late August 2004. Despite carrying much useful project-related information (user guides, SOPs, manuals etc) the Extranet facility was poorly used by participants.

When asked, less than 1 in 5 participants (18%) had made two or more visits to the project's Extranet site. Approximately one quarter (27%) had made a single visit and by late February 2005, 53% of participants had yet to visit the site. This poor use of the Extranet probably reflected both a lack of confidence in using web-based facility and the fact that it was easier to consult the Project Officers directly.

7.3.10 ADAS reference farms

The ADAS reference farms were established to provide practical help and assistance to ADAS Project Officers, trainers and participant farmers. The reference farms were not widely used to fulfil this function for trainers or farmers. Although not functioning as originally intended the ADAS reference farms proved invaluable, as they were used widely as training sites for Project Officers, and for hands-on experience to validate the performance of the equipment and software being used on commercial farms. Furthermore they were used extensively for proving and dry testing the market equipment and software prior to the market evaluations.

7.3.11 End User Perspective – availability of training and support

Participants were asked to use a four-point scale from 'far too little' to 'far too much' to describe their perception of the availability of backup and support for each of three key activities. These were transferring records between the farm PC and the reader, using the reader in the field and downloading records to the central database.

Responses showed that 82% of respondents felt that the level of support was "about right" in terms of transferring records between the PC and the reader and 87% were content with the level provided for using the reader in field. However, when it came to downloading records from the farm PC to the central project database the proportion describing the level of support as "about right" fell to 67%, with 18% describing it as "too little" and 9% as "far too little".

In terms of evaluating backup and support for transferring records between the farm PC and the reader, significant differences were observed on the basis of supplier and training model. With a mean score of -0.04, users of Allflex equipment and the cascade system, showed a greater level of satisfaction compared to an overall average of -0.22. Users of the Earlsmere equipment and direct training model had a mean score of -0.39. Similarly, we observed that for this aspect those respondents describing their attitude as becoming "more positive" (-0.05) were more likely to describe the availability of support as "about right" than were their "more negative" counterparts (-0.43) with 95% and 99% confidence respectively.

In terms of evaluating the availability of back-up and support when using the reader in the field, farmers trained by the cascade model were unanimous in describing this as "about right" to give a mean score of 0 that was significantly (99%) above average. Although 75% of the direct trained farmers also felt that the level of back-up was about right, there were 25% who described it as either "too little" or "far too little", the mean score of -0.29 was significantly (99%) below the average (-0.15).

When asked to consider the support available for downloading records to the central project database, compared to an overall mean score value of -0.38 – that is, tending towards too little. With a mean score of -0.67, we can be 99% confident that respondents describing themselves as "more negative" were more likely than the average to describe the provision of support as too little. The mean value among farmers trained by the direct route was -0.62 which was significantly lower than average while the mean value among cascade trained users was -0.15 which was significantly above average.

Overall eight out of ten (78%) respondents were satisfied with the way support was delivered. This proportion increased to 100% for the cascade trained and supported farmers but was 57% for those trained directly by the supplier.

Participants were asked whether they had sought assistance with the three defined tasks as above (Table 31).

Table 31 Assistance when undertaking specific tasks

Question - If you have sought assistance when undertaking any of the following tasks, please can you specify where this help came from

		Transferring records	Using the reader in field	Downloading records to the central database
No. Respondents		**55**	**55**	**55**
Any assistant sought		51	45	47
	%	93	82	85
Family member		8	3	2
	%	15	5	4
Project officer		43	38	40
	%	78	69	73
Extranet		-	-	-
	%	-	-	-
Helpline		4	2	4
	%	7	4	7
EID supplier		16	15	-
	%	29	28	-
Other source		-	-	2
	%	-	-	4

Overall almost all respondents had sought assistance at some time when transferring records to and from the farm PC and the hand-held reader. Slightly fewer, but still 82%, had sought assistance in using the reader in the field and 85% when downloading records to the central project database. Project Officers were the most often cited source of support.

A feature of the trial has been the high reliance participants have placed on Project Officers in providing training, on-going support and in sorting problems. Other sources of information and assistance such as the help-line, reference materials and the Extranet have been largely ignored. It is difficult to establish whether or not these other sources of assistance would have been more widely used if Project Officers time had been limited or was not available.

For a UK wide roll-out of EID it is unlikely that the level of one-to-one support provided to participants by Project Officers in this trial will be practicable or achievable, even if finance was available to support such labour intense activity.

7.3.12 End user perspective - effectiveness of training and support

As part of an interim evaluation participants were asked to rate the quantity and quality of training received for undertaking three specific EID related tasks according to a five-point scale.

Responses indicated that for the task of transferring records between the farm PC and the reader almost three-quarters of respondents (73%) thought that the quantity of training provided was “about right” (Table 32). This increased to 91% among those whose attitude was defined as “more positive”. At 93%, the proportion of cascade trained farmers who described the quantity of training received as “about right” was higher than the corresponding 54% of farmers trained by the direct approach, a higher proportion of whom felt they had received too little.

The quantity of training received by farmers trained directly was more likely to be described as “too little” (-0.61) compared to those receiving cascade training who perceived the quantity of training to be have been “about right” (-0.07). Similarly, those respondents that described themselves as “more positive” about EID were more likely to perceive the quantity of training received to transfer records between the farm computer and the reader as “about right” (-0.09) compared to their more negative counterparts (-0.57).

In terms of the quality of training provided to transfer records between the farm PC and the reader, 53% of respondents stated that they were satisfied and 25% were neutral. Against a mean score of 3.51, we can be 99% confident in the observation that farmers receiving the direct approach were slightly less satisfied with the quality of training (3.11) and those receiving cascade training slightly more satisfied (3.93) – no other significant differences were observed.

Table 32. Quantity and quality of training for transferring records to and from the farm PC and the reader

Question - Thinking about the quantity of training that you received/were offered for each of the following tasks, would you say that it was…..

		Score	Total	Attitude		
				More positive	No change	More negative
No. respondents			**55**	**22**	**10**	**23**
Far too little		-2.0	4	-	1	3
	%		7	-	10	13
Too little		-1.0	11	2	2	7
	%		20	9	20	30
About right		0.0	40	20	7	13
	%		73	91	70	57
Too much		1.0	-	-	-	-
	%		-	-	-	-
Far too much		2.0	-	-	-	-
	%		-	-	-	-
Mean score			-0.35	-0.09*	-0.40	-0.57*

Question - And how satisfied were you with the overall quality of training provided for each of these tasks?

		Score	Total	More positive	No change	More negative
Not at all satisfied		1.0	1	-	-	1
	%		2	-	-	4
Not very satisfied		2.0	7	1	1	5
	%		13	5	10	22
Neither satisfied nor dissatisfied		3.0	14	5	3	6
	%		25	23	30	26
Satisfied		4.0	29	15	5	9
	%		53	68	50	39
Extremely satisfied		5.0	4	1	1	2
	%		7	5	10	9
Mean score			3.51	3.73	3.60	3.26

For using the hand-held reader in field, 89% of respondents felt that the quantity of training received to perform this task was "about right" with no significant differences observed between respondents on the basis of their changing attitude towards EID. Cascade trained farmers were unanimous in describing the quantity of training received as “about right” whereas around one fifth (22%) of direct trained farmers felt that they had received “too little” in the way of training for this function. This difference was borne-out by the mean scores that revealed a difference between the direct (-0.25) and cascade (0) training models that can be interpreted as significantly different to the average with 95% confidence.

When describing the perceived quality of training provided on using the reader in-field, almost two-thirds of respondents described themselves as satisfied, 22% were neutral and 9% extremely satisfied. With a mean score value of 4.07, cascade trained farmers tended to have a slightly higher degree of satisfaction than the average value of 3.73. Those trained directly were slightly less satisfied (3.39).

In relation to downloading records from the farm computer to the central project database 58% described the quantity of training received as “about right”, 24% thought it “too little” and 15% felt that it was “far too little”.

With a mean score of –0.82 compared to an average of –0.55 respondents who described their attitude as “more negative” had a greater likelihood of describing their training to transfer records to the central project database as too little.

With a mean score of 3.19, respondents tended to be neither satisfied nor dissatisfied with the quality of training provided to perform this particular function, comprising 40% satisfied, 27% neutral and 18% not very satisfied. No significant differences were observed on the basis of supplier, farm status or changing attitude towards EID.

Participants have received a considerable amount of training. Given the considerable amount of training time they had received the ability of participants to perform a number of EID related tasks were investigated during the Interim Evaluation.

Participants were divided in terms of their confidence to transfer records between the computer and the reader – 13% described themselves as fully confident, 18% were confident, 36% were fairly confident, 27% were not very confident and 5% were not at all confident. No significant differences from the average were observed on the basis of supplier, farm status or respondents’ changing attitude towards EID.

By contrast, respondents tended to feel more confident in their abilities to operate the reader in the field and this was reflected by a mean score value of 3.56, tending towards “confident”. This compared to 3.05 for the task of transferring records between the computer and the reader that reflected a perception of “fairly confident”. Overall, 20% of respondents described themselves as “fully confident”, 35% as “fairly confident”, 31% as “confident” and 15% were not very confident in using the reader in field. The mean confidence score was 3.21 for farmers trained directly compared with 3.93 for cascade trained users.

Confidence levels dropped across the board when respondents were asked to rate their confidence in downloading records to the central project database from the farm computer. Just 10% of respondents described themselves as either “Fully confident” or “Confident” in their ability to download records, 27% were “Fairly confident”, 35% were “Not very confident” and 22% were “Not at all confident”. No statistically significant differences were observed by supplier, farm status or changing attitude towards EID.

Given the considerable amount of training received, after 12 months, not all participants considered themselves fully confident to perform three basic and fundamental EID tasks. While confidence is not a direct measure of training and knowledge acquired, as it reflects also usage and familiarity, the finding of this trial would suggest that training could be a major issue at a UK wide roll-out of EID.

This relatively poor level of confidence probably reflected in part the view of most participants (66%) who felt that existing EID systems were unnecessarily complicated at all levels of operation.

> *"…even setting up the equipment can be complex".*
>
> *"Too many key-strokes associated with reader….unduly complex for my way of thinking"*
>
> *"Software too complex, trying to get your head around it. You can't get to where you want to get to, and get lost".*
>
> *"You should be able to start it up and it tells you what to do, we are not going to have lots of Project Officers across the country to tell us what to do"..*

Adopting more simple EID systems should reduce the need for training and support and also reduce the problem of infrequent use of EID equipment. Where systems are used infrequently needing to know and remember complex initiation and data entry procedures is always going to be problematic.

7.4 Overview and implications for the uptake of EID

The results of this trial indicate that with operator care and a minimum amount of training the welfare of ewes and lambs should not be adversely affected by bolusing sheep. However, depending on the circumstances at the time of insertion and the design of the tag, tagging sheep could compromise animal welfare. More work on tagging, particularly the early tagging of lambs is needed.

The approach taken to training in the Pilot Trial will not be appropriate for a UK roll-out of EID. It is too labour intensive, and hence expensive, and given the skill sets needed to deliver all facets of the training is probably not achievable by any one supplier. The role and need for training and support will require radical revision if a UK wide roll-out is to be effective. Current EID systems are considered by most participants to be overly complicated, and this adds considerably to both the need and amounts of training and support required. Simpler to use EID system would reduce the need for training and support dramatically.

The minimum features required of EID equipment and software and hence the training need will be influenced considerably by the application of the impending legislation. For example legislation that required animals to be identified electronically but with a requirement for minimal data capture and transfer initially would help reduce the training burden at the outset. Appropriately balanced legislation and simpler EID systems could reduce the level of training required to more manageable levels. A phased approach to complying fully with the legislation would benefit any national roll-out of EID from a training and support perspective.

Even with simplified EID systems it must be recognised that there is likely to be a proportion of farmers who cannot be trained to an appropriate level. While the participant group was reflective of the industry, it is certain that a significant proportion of sheep farmers will have even less experience and aptitude for electronic systems than those at the lower end of the range within the Pilot Trial.

The cascade training model worked well with Project Officers being able to focus specifically on training and support, with the suppliers' own staff dealing in the main with solving any technical problems with the EID equipment. Nationally it might be possible to recreate this model or other suitable models using resources and bodies such as the county Colleges of Agriculture and LANTRA.

8 THE BUREAU FARMS

8.1 Objective

The objective of the bureau approach was to determine the feasibility of EID in sheep, if a third-party provider delivered the reading service.

8.2 Approach

Farms were selected for participation in the bureau from those volunteering to participate in the overall Pilot Trial.

A Project Officer was appointed and managed by the supplier to undertake the following:-
- manage the main core of activity and liase with the farming participants;
- screen the existing population of sheep that may be involved in the National Scrapie Plan for the presence of a bolus;
- electronic tag bureau sheep;
- read and record sheep IDs together with associated data collection (such as tag losses) at intervals throughout the trial;
- upload data to a trial-specific central database; and
- maintain a diary of activity.

The primary aim was to capture data in relation to:-
- databasing of sheep IDs;
- sample movements of sheep off farm; and
- record deaths on the farm database.

8.3 Results

8.3.1 Project Officer recruitment

Given the absence of such a bureau service, there was no immediately qualified or experienced labour resource available. A suitable Project Officer was recruited, located some distance from the bureau cluster, in Penrith.

8.3.2 Farm types

Table 33. Description of Bureau farms

Farm type	Ewe breed	Ewe tag type	Lamb sire breed	Lamb tag type	Total no of animals	Distance from project officer	Anticipated journey time
1. Upland	Blackface	Button	Blackface & Texel	Foldover	690	154km	2 hrs
2. Upland	Blackface & Mule	Button	Texel	Foldover	900	223km	2 hrs 50 mins
3. Lowland	Mule & Milksheep	Button	Texel & Suffolk	Foldover	710	146km	1hr 50 mins
4. Lowland	N/A	N/A	Texel & Suffolk	Button	1600	134km	1 hr 40 mins
5. Mixed	Blackface	Button	Texel & Suffolk	Foldover	1230	94km	1hr 10 mins

8.3.3 Screening for NSP boluses

Before insertion of an electronic tag, ewes were screened for the presence of an NSP bolus (Table 34). While relatively, few sheep carried an NSP bolus, in practice even a small number of sheep inadvertently receiving a second bolus could have repercussions for the NSP scheme.

Table 34. Presence of NSP boluses – Bureau farms

Population screened (ewes)	No. of boluses found	Percentage
1271	18	1.42%

8.3.4 Tagging

On four farms, two Project Officers tagged ewes and lambs, and on a fifth farm, only lambs were tagged. All sheep were tagged between 2 June and 30 July 2004, with the exception of 128 sheep, which were tagged on 8 September 2004. The following issues were identified during the tagging process:-

- where a pour-on fly repellent was used this caused the ink on the tags to run, and consequently some tags could not be read visually;
- the tags were not read electronically on insertion. It was taking too long to read and manually enter individual numbers, as data files had not been provided in time;
- initially there was a capacity problem on the Aboca which meant that during tagging the database was full after approximately 200 animals and the data had to be downloaded to clear the reader. Adjustments to the software solved the problem subsequently; and
- the foldover tags were not compatible with the pliers; this caused the tags to jump out of the pliers damaging both tag and in some cases ears. This was a problem in approximately 10% of tags, and resulted in 1%-2% being wasted.

The Pilot Trial required that sheep were tagged within a relatively short period of time, and therefore resident farmer and farm labour were required in addition to the Project Officer. In realty, when electronic tagging becomes mandatory this task is likely to be carried out by the farmer. Due to the starting date of the Pilot Trial, tagging was undertaken later in the season than would be normal commercial practice.

8.3.5 Routine reading of breeding stock

Table 35. Number of reads and missing tags

Farm	Activity	Total Sheep	Total Sheep Read	Unreadable Tags	% non reading	Missing tags	% missing
1.	1st read	302	300	1	0.33	1	0.3 %
	2nd read	254	247	1	0.40	6	2.4%
2.	1st read	265	253	1	0.40	11	4.2%
	2nd read	289	277	1	0.36	11	3.8%
3.	1st read	274	273	0	0.00	1	0.4%
	2nd read	327	321	1	0.31	5	1.5%
5	1st read	384	359	5	1.39	20	5.2%
	2nd read	378	346	5	1.45	27	7.1%

The time taken to tag a group of animals was influenced by the facilities on farm, available staff and skill base, and other variables.

The recording of animal deaths as part of a bureau service was very difficult to implement, particularly given the distances between farms and the location of the Project Officer, and no mortality data were recorded. It was very apparent that to make a specific visit to a farm for the recording of a single death was not feasible. Therefore a system which allows the farmer to record the death himself is required, with the data transferred to the Project Officer at the next earliest opportunity.

There was general agreement that on-farm access to a hand-held reader would have been of value. The availability of a reader would allow farmers to screen for boluses, perform tagging, and record deaths themselves. This process would relieve a huge burden from any bureau-type activity, but would incur additional cost. For reporting deaths and other incidents, an alternative might be for a farmer to record information manually and to forward the data to a bureau provider.

8.3.6 Off-farm movements

Because of the logistics involved with the trial Bureau, no attempt was made to record all 'off farm movements' for a particular farm, but concentrated on the practicalities and success of recording a sample number of movements. This clearly differed from what would be required in practice.

Table 36. Movements off farm

Farm	1st Off Farm Movement	Tags Read	2nd Off Farm Movement	Tags Read	3rd Off Farm Movement	Tags Read	Total Moved	Total Read
1	46	46	41	41	N/A *	N/A *	87	87
2	10	10	19	19	91	88	120	117
3	24	24	24	23	13	13	61	60
4	130	129	120	120	180	180	430	429
5	48	48	31	31	46	43	125	122
						Total moved	823	
						Total tags read		815

* read had to be cancelled due to a family bereavement.

Of the 823 sheep recorded as moved, 5 had missing tags (0.61%) and 2 electronic tags could not be read (0.24%).

8.4 Overview and implications for uptake of EID

Within the bureau farms, the physical parameters of equipment performance, tag retention rates, and proportion of non-reading devices, were very consistent with those of EID farms using the same system.

There was general agreement among non-bureau users that a bureau style option would be a pre-requisite for effective implementation of individual animal identification across the English sheep industry. In particular, this service was thought to be more likely to meet the needs of both the computer-averse producers, who would not have the inclination to adopt the required skills, and the smaller producers for whom the required level of investment in EID/EDT technology may not be justified on economic grounds.

Paradoxically, after 12 months experience the bureau group itself had an entirely opposite view, based on practical limitations.

> *The whole idea of someone coming out to read your tags just isn't practical. The times you want the tags read – at lambing time for management purposes, when you move sheep throughout the year/when sheep die, every Tuesday when you go to market. It wasn't practical to call-out the reader every time.*

The logistical and equipment problems encountered, accentuated the difficulty in achieving the necessary cover and flexibility through third party provision. Even a local provider, possibly even a computer literate farmer, would struggle at times of peak stock movement, given current management practice on sheep farms. If stock were required to be read electronically off farm, it may that farmers would opt to have their own reading equipment, to increase overall flexibility.

Clearly a commercial bureau service would have been capable of capturing all the data required for legislative purposes, for example, sheep movements and deaths on farm.

However, there may still be applications where a bureau approach could work. For example, if the whole sheep flock was to be read electronically at an annual gather, a service could be provided with specialist reading equipment, in a similar way to a pregnancy scanning contractor. Given greater flexibility over dates (in contrast to meeting a specific sale day), the logistics of service provision would be easier. In addition, flock recording services such as Signet, could relatively easily enhance their core activities to include EID. Logistics will always be difficult for the larger and more commercial producers, but a bureau or co-operative approach could be more workable for small and hobby sheep keepers.

9 Paper-based recording

9.1 Objective

Three farms (one per region) were recruited as paper comparators to act as a base-line comparison for electronic identification and data capture.

9.2 Approach

Paper comparators were required to tag ewes (if not done already) and recorded all sheep (ewes and lambs) manually using their own paper-based system of recording.

Each of the paper comparators (Table 37) operated a different production system, had different resources and facilities available to them, and had approached individual identification and paper recording from different perspectives. Therefore, each is reported separately below.

Table 37. Paper comparator farms

	Midlands (Farm 24)	North (Farm 27)	South West (Farm 56)
No of breeding ewes	570	344	410
Ewe breed	North Country Mules	Swaledale	Poll Dorset
Ewe management tag	Ritchey flag tag	Allflex button	Initially Allflex button, then ovina
No of digits on tag	3	6	6
Number of lambs	643	420	836 (over 2 lambings)
Breed of lambs	Suffolk & Texel	Blue Faced Leicester	Dorset, Suff, Charollais, Texel
Lamb management tag	Ritchey Snap tag	Allflex button	Allflex button
No of digits on tag	4	6	6

The farmers mirrored the activities of the EID-Management farms within the Pilot Trial, reading ewe tags on three occasions, and tagging, reading and weighing lambs as appropriate to their system. Several makes of standard sheep tag were used. All three farms tagged lambs at birth.

9.3 Results

9.3.1 Farm 24

Tag insertion

No issues were recorded at tag insertion, but 0.9% of ewe tags were subsequently cut out due to ear infection.

Tag design

The large flag tags (with a maximum of three digits) proved easy to read throughout the trial. Only a few had one or more digits obscured by dirt, which needed to be cleaned off. However the lamb tags (small foldover) were much more difficult to read, as the individual number was often inside the ear, making manhandling of sheep essential to read the tags accurately. The farmer noted the Health and Safety aspect of cleaning dirty tags whilst handling sheep (he tended to lick his fingers to remove the dirt).

By the third weighing, 21 ewes had lost tags and 12 ewes were not read, either missed going through the race or not gathered (Table 38). Two ewes had died. Pregnancy scanning records showed 570 ewes in the flock, but farm records could only account for 553 with 3 sheep unaccounted for (97% accuracy).

Table 38. Tag losses

Farm	Stock	No of animals	Lost by final weighing	Rate of loss (%)
Farm 24	Ewes	570	21	3.7
	Lambs	610	37	5.8

A total of 643 lambs were on the farm in August 2004, 15 were re-tagged and 22 remained without tags (37 lost tags) - a tag loss rate of 5.8 % between birth and weaning. All lambs were recorded, weighed and sexed at weaning, and weighed and recorded again at sale. Twelve lambs were recorded as re-tagged at sale and 10 remained unrecorded. From weaning to sale there were no further tag losses.

System of paper recording used

Most reading was carried out in a covered handling system. Data were recorded on A4 lined paper initially – then the Project Officer transferred these data to an Excel spreadsheet in order to create data sheets for future recording. Paper tended to get dirty, which caused problems when transferring the data. The farmer noted the need for good lighting if recording late in the day. Recording tended to be a two-man operation for the first logging and weighing of sheep. However, when working alone, the farmer preferred to record subsequent data in a small pocketbook, as the sheep came through the handling system and weigh crate. For a large group of sheep, this was faster than searching for individual ID numbers on pre-printed data sheets. However extra time was then required to transfer data from the pocketbook to the data sheets, and then to the computer. Data sheets were given to the Project Officer for transfer to an Excel spreadsheet. It took a period of approximately 4 hours (and 6 staff hours) for the farmer and his niece to input the second lamb weighs (579 lambs) from the pocketbook into the Excel spreadsheet. Effort spent reading tags and transferring data was considered to be time not available to be spent on flock husbandry and sheep welfare.

Time taken

Simply reading and recording three-digit ewe tags could take as little as 16 seconds per sheep. However to weigh, condition score and read tags took from 29 to 69 seconds (Table 39), typically most taking around 43 seconds per sheep for one person working alone. Reading, weighing and sexing lambs tended to take between 60 to 80 seconds on average, due to the difficulties of reading the smaller tags and the additional time of sexing lambs (a slow and labour intensive job on 4 month old lambs). The ewe tags could be read at a distance and had only three digits whereas the lambs had to be caught and restrained in order to read the four-digit tags.

Table 39. Recorded timings for routine recording tasks

Task	No. read	Total time (hrs)	Time /sheep (secs.)	Staff involved	Secs/sheep/ Unit staff
R only	60	0.33	20	1	20.0
R only	94	0.42	16	1	16.0
R, W and CS	88	1.00	41	2	20.5
R, W and CS	76	1.00	47	1	47.0
R, W and CS	76	0.92	43	1	43.0
R, W and CS ewes and R,W and sex lambs	126 ewes 126 lambs	4.80	69	2	34.5
R, W, and CS	126	1.40	41	1	41.0
R,W and CS	126	1.58	45	1	45.0
R, W and CS	107	1.33	44	1	44.0
R, W and CS	102	0.80	29	1	29.0
R, W and sex lambs	37	0.75	73	2	36.5
R, W and sex lambs	11	0.25	82	2	41.0
R, W and sex lambs	97	1.83	68	2	34.0
R, W and sex lambs	40	0.66	60	2	30.0
R, W lambs	114	1.25	39	1	39.0
R, W lambs	94	0.92	35	1	35.0

R, W and CS = Read, weigh and condition score ewes
R, W lambs = Read and weigh lambs

Error rates

At the first ewe read there was only one misread (0.2%). At the second, there were 10 misreads (1.8%) and at the third there were 12 misreads (2.1%). There were no apparent misreads for the lambs, but 31 lambs were sold without being read at all.

It was noted that 28 ewe tags were read twice on the first occasion (tags read while ewes standing in foot bath), and that 13 numbers never appeared again after first logging, suggesting that the tags were misread. On the final read there were five reading errors. Three spurious numbers were recorded (both 551 and 531 were recorded twice – in reconciliation it was assumed that one 551 was 51, but the two 531's could not be placed). Two 97's and two 77's were recorded originally, but neither 98 nor 78. It was assumed that the duplicate numbers were these missing numbers, and had been misread on previous occasions.

9.3.2 Farm 27

Tag insertion

Due to ear infection following tagging, 1.5% of tags were removed from ewes. In addition, 8% 'droopy' ears were reported after young lambs had been tagged. These had not recovered to normal position before sale as Mule gimmers. The farmer started tagging lambs with Allflex button tags at 10-14 days of age (April) but after tagging the first batch of approximately 50 lambs, noted that the tagged ears drooped. By the time he had tagged about 200 lambs, he decided to revert to his old style two-piece tags. There were no problems with these smaller lighter tags. A further 8% of lambs were less affected by 'droopy' ears, but still carried wavy (distorted) ears at sale time.

Tag design

By the third read tags were getting dirty, and the print was becoming fainter, making reading more slow and difficult. The round button tags tended to rotate in the ear making it more difficult to read numbers.

Recording on paper

Reading was carried out in outdoor handling facilities with sheep moved from a large pen into a small pen in batches of 12 to 15. Tags were then read and sheep manhandled into the weigh crate. Data were recorded in a pocketbook which was then photocopied by the Project Officer and transferred to an Excel spreadsheet. In most instances the farmer read the tags, weighed the sheep and shouted the numbers to his wife who recorded the data. Sometimes the farmer read, weighed and recorded animals alone - the pocketbook almost fell into the dip bath twice, which could have been catastrophic. The use of pre-printed recording sheets (i.e. with numbers listed in numerical order) was discounted at an early stage, as the farmer would have needed reading glasses to find the numbers. He considered the risk of losing or breaking the glasses too high when working with horned ewes. The farmer considered that a covered handling area would be desirable to help keep paper records dry. Tag losses were exceptionally low (Table 40).

Table 40. Tag losses

Farm	Stock	No of animals	Lost by final weighing	Rate of loss (%)
Farm 27	Ewes	344	4 (3 removed)	1.2
	Lambs	420	3 (2 removed)	0.7

Time taken

The total time taken for reading and weighing varied from 69 seconds per ewe (Table 41) when two people were working together, to 116 seconds per ewe when there were two people for some of the time (equivalent of 1.5 people). On average, it took about 90 seconds per sheep with two people working together. The difference in time required was marked between one and two-man operation.

Table 41. Recorded timings for routine recording tasks

Task	No. read	Total time (hrs)	Time /sheep (secs.)	Staff involved	Secs. /sheep / staff unit
Read & weigh ewes	124	3.50	101	1	101.0
Read & weigh ewes	177	4.50	92	1	92.0
Read & weigh ewes	100	2.50	90	1	90.0
Read & weigh ewes	60	1.25	75	2	37.5
Read & weigh ewes	66	1.50	82	2	41.0
Read & weigh ewes	75	2.00	96	2	48.0
Read & weigh ewes	67	1.50	81	2	40.5
Read & weigh ewes	54	1.50	100	2	50.0
Read & weigh ewes	203	4.00	71	2	35.5
Read & weigh ewes	209	4.00	69	2	34.5
Read & weigh ewes	78	1.50	69	2	34.5
Read & weigh ewes	132	4.00	109	2	54.5
Read & weigh ewes	155	5.00	116	1.5	77.3

Error rate

At the first weighing, four ewe tags were misread (1.2%) and two sheep were not weighed or recorded (they either 'avoided' being weighed, or were missed in the field since they both appeared at the second weighing). The misreads were fairly obvious – two 87's but no 78; two 109's but no 99; two 171's but no 177; two 264's but no 254.

At the second weighing there were six misreads (1.7%) and two had lost tags. Some misreads were obvious: two 258's but no 158; two 273's but no 275; two 526's but no 520. The other misreads were not so obvious: two 31's, a 218 and a 276, but no 95, 257, 285.

At the third weighing there were 10 misreads (2.9%) - four had lost tags and two sheep were missing altogether. Misreads were all fairly obvious: two 7's but no 70; two 192's but no 190; two 237's but no 273, two 261's but no 267; two 263's but no 268; two 266's but no 26; two 276's but no 274; two 507's but no 505; two 523's but no 525; two 530's but no 550.

9.3.3 Farm 56

Tag insertion

Farmer 56 considered inserting two piece button tags to be two-man job. It was not possible to walk up behind a sheep and simply put the tag in, as it had been possible previously using foldover tags. T he Ovina tags were considered easier and faster to apply than the original button tags. Although the tags were in two parts the individual number was only on one half, which helped to speed up the process. The farmer was surprised how well the lambs coped with the size of the tags, and there were few droopy ears. White spirit was used to wipe the ear before tag insertion, and no problems with flies or infected ears were recorded.

Tag design

For Farm 56 the original Allflex button tags supplied had short stems and were too tight on the ears of Poll Dorset sheep. This caused up to 75% of ewes to rub and flick their ears constantly, making reading very difficult. The tags had to be cut out, and were replaced by the more flexible, Ovina flag tags, which had the individual ID number on the female side which sits inside the ear. This made reading the tags a slow process. The farmer would have preferred to have the individual ID on the outside of the ear. By January, in fully fleeced ewes, most of the tags were greasy and dirty, and needed cleaning (scraping with fingernail) before reading, slowing the process down significantly.

Table 42. Tag losses

Farm	Stock	No of animals	Lost by final weighing	Rate of loss (%)
Farm 56	Ewes	401	18	4.3
	Lambs	836	29	3.5

The majority of missing tags were lost/pulled out during the housing period, towards the end of the trial, due to the weld mesh barriers used to retain young lambs. The farmer also cited hay racks as a cause of tag loss. The ewes did not seem to rip the tags out, but the hole in the ear seemed to get bigger and eventually the tag pulled through.

Paper recording system used

The weighing and recording was done undercover in a race. One person drove the sheep up the race, and the farmer read the tags and recorded all the sheep on pre-printed data sheets. There were no issues about dirty paper and associated loss of data. Weighing was done using an electronic weigh-head which permitted the recording of the tag against the weight of the animal. This can be taken indoors and the information retrieved and logged manually. However, the actual weights were hand written manually against the tags at the pen. The farmer transferred data from sheets to a record book at night (2 or 3 hours for every weighing). The Project Officer collected the books, photocopied and transferred data to a spreadsheet.

Time taken

Farm 56 recorded the fastest time (29 seconds/sheep) for one-person reading ewe tags and recording pregnancy scanning details. The slowest recorded time was 112 seconds per lamb when needing to clean tags before reading and weighing (two people). Typically it was taking around 35 seconds per sheep to read, weigh and record with two people working together (Table 43).

Table 43. Recorded timings for routine recording tasks

Task	No. read	Total time (hrs)	Time /sheep (secs.)	Staff involved	Secs/ Sheep/ Staff unit
Read and weigh	139 ewes 237 lambs	5.25	84	2	42.0
Read and weigh	84 ewes	0.75	32	2	16.0
Read and weigh	77 ewes	0.75	35	2	17.5
Read and weigh	210 lambs	2.15	37	2	18.5
Read and weigh	79 ewes	0.66	30	2	15.0
Read and weigh	91 ewes 103 lambs	2.00	37	2	18.5
Read and weigh	174 ewes	1.5	31	2	15.5
Read and weigh	92 lambs	0.9	35	2	17.5
Read and record scanning	124 ewes	1.00	29	1	29.0
Read and weigh	110 lambs*	1.20	39	2	19.5
Read and weigh	202 ewes*	4.40	78	2	39.0
Read and weigh	32 lambs*	1.00	112	2	56.0

* dirty tags difficult to read.

Error rate

This farmer recorded eight misread ewe tags (2%). These were basically double entries on a particular date for eight different ewes. A process of elimination resolved any transcription errors.

9.4 Overview and implications for uptake of EID

The three paper comparators involved in the Pilot Trial were willing participants in paper-based recording. Therefore it was likely that their attitude to recording and attention to detail, was above the average for the sheep industry as a whole.

Overall, the percentage error in reading tags was less than 5% when reading a combination of four-digit and six-digit management tags. This together with tag loss of about 5% was the major contributor to loss of individual sheep identity.

Work rates varied considerably, depending on the handling system, task being undertaken and number of staff involved. On specific occasions the fallibility of paper recording was evident, for examples, in heavy rain and in poor light conditions. Pre-populated sheets listing ID's were not seen as an advantage to recording, especially for large groups of sheep where several pages were required, each having to be turned over.

It was notable that the paper comparators using non-electronic tags also recorded significant problems of ear damage and ear infection across several tag types.

Although all three farms managed to maintain reasonably accurate records on paper, all were sceptical that very accurate flock records could be maintained long-term. Farmer 24 acknowledged the risk of error from lost tags, misreads and data transfer. His system of sheep farming involved utilising outlying grazing at up to 36 different locations. Lambs were tagged at birth for this reason but keeping accurate paper records of sheep ID's at each location was recognised by the farmer as being very difficult. Evidence from the paper comparators suggests that paper systems could still be workable for some individual farmers depending on the numbers of sheep involved, the number of digits which would need to be recorded and the challenge posed by becoming IT literate.

Farmer 56 attempted to tag lambs at 2 to 3 days old and to keep a record of the dam-lamb link. Maintaining the dam-lamb link was an easy task initially (recording number, date of birth, sex, litter size, weight and dam number) but as time went on the system got more complicated as some tags were lost.

Neither was Farmer 27 confident in a paper-based system, despite having tried hard to make it work. He estimated about 90% accuracy for basic recording, but expected accuracy to fall as the amount of data collected for management purposes increased. At any one time only about 90% of the flock would be within his boundary fence and the flock is subject to numerous movements, with sheep being constantly selected and sub-divided for management purposes. It would be very difficult to be accurate about flock numbers and location of sheep at any one time. He considered that if sheep have to be recorded individually, as an industry, this could only be done electronically.

10 ERGONOMIC TRIALS

10.1 Objective

One element of the Pilot Trial involved a component of ergonomic studies to compare the field performance of paper and EID systems in the trial. This involved a quantitative element (a limited controlled trial) and qualitative component (data and feedback taken from a sub-set of participating farmers).

10.2 Materials and methods

10.2.1 Quantitative information

A quantitative trial was done at ADAS Redesdale. Using a single trial site controlled an important variable, e.g. variations in handling facilities, which may influence both efficiency and effectiveness.

Experiment design

The experiment was designed as a Latin Square, taking account of two tasks (Basic; Advanced), four methods of data collection [**E** (Aboca); **A**(Anilog); **R** (Weigh crate);**P (P**aper)], and four levels of potential operator fatigue (**N**one; **L**ow; **M**edium; **H**igh).

Table 44. Ergonomic study – trial design

Redesdale	Run-in	Basic (Tag Check) a.m.				Advanced (Tag Check & Management Data) p.m.			
Operator Fatigue	Day 0	Day 1 1/2/05	Day 2 2/2/05	Day 3 3/2/05	Day 4 4/2/05	Day 1 1/2/05	Day 2 2/2/05	Day 3 3/2/05	Day 4 4/2/05
None	Project briefing	$P_{(R1)}$	$A_{(R5)}$	$R_{(R9)}$	$E_{(R13)}$	$P_{(R17)}$	$A_{(R21)}$	$R_{(R25)}$	$E_{(R29)}$
Low		$R_{(R2)}$	$P_{(R6)}$	$E_{(R10)}$	$A_{(R14)}$	$R_{(R18)}$	$P_{(R22)}$	$E_{(R26)}$	$A_{(R30)}$
Medium		$A_{(R3)}$	$E_{(R7)}$	$P_{(R11)}$	$R_{(R15)}$	$A_{(R19)}$	$E_{(R23)}$	$P_{(R27)}$	$R_{(R31)}$
High		$E_{(R4)}$	$R_{(R8)}$	$A_{(R12)}$	$P_{(R16)}$	$E_{(R20)}$	$R_{(R24)}$	$A_{(R28)}$	$P_{(R32)}$

The trial was conducted by ADAS staff experienced in the use of the EID equipment. Two staff undertook each operation, with an observer undertaking timing and record-keeping of any factors that may have an effect on the efficiency or effectiveness of the process. To minimise the effects of differential fatigue, the person-system roles were maintained as far as was practicable for the duration of the experiment. Furthermore, activity and rest schedules each day were as consistent as possible.

A total of 200 ewe lambs were used each day over a four-day period for the experiment. These carried a mix of electronic ear tags and boluses, allowing the experiment to be conducted across the range of technologies used in the Pilot Trial. In addition, the sheep carried a secondary three-digit management tag, which was the tag read manually during the experiment. This removed potential variations across the range of electronic tags used due to print size or quality. Furthermore, given the choice farmers might opt to use simpler numbering for every day management recording particularly, for breeding sheep, which will remain within the flock for a number of years. Each day of the trial consistent batches of sheep were used for all assessments. After each day's trial, the sheep were allowed to mix so that different batches were used for the following day's assessment.

Experimental method

All the equipment for the ergonomic study was similar to that used on the wider EID trial. Two tasks were undertaken in rotation over each of the four days (Table 45).

Table 45. Basic and advanced tasks undertaken in the ergonomic studies

Activity	Aboca	Anilog	Weigh crate	Paper
Basic: Tag Check	Scan identifier	Scan identifier	Scan identifier	Read management tag manually and record ID number on paper
Advanced: Tag Check & Record Weight	Scan identifier and read weight manually and key weight band into scanner	Scan identifier and read weight manually and key weight band into scanner	Scan identifier with actual weight automatically recorded	Read tag manually and record ID number and actual weight on paper

The **basic** task was undertaken in the morning and looked at the likely minimum requirement for farmers to record individual sheep ID, e.g. when stock move off the farm to market. For each day of the basic experiment, ID numbers were checked four times. The flock of 200 ewe lambs was run through in random batches of 50 at a time, such that 50 identifiers were checked with no operator fatigue, with low operator fatigue, with medium fatigue and with high fatigue. The order of both methods used was rotated over the four days of the experiment in order to account for fatigue effects.

The **advanced** task (read tag and weight record) followed the same procedure (Table 46) in the afternoon. The **advanced** task was designed to look at the effect of keying, communication and transcription errors. The hand-held scanners were not connected directly to the weigh head and therefore weights were manually entered as one of six pre-defined weight-bands as follows: <30 kg; 30.0-34.9 kg; 35.0-39.9 kg; 40.0-44.9 kg; 45.0-49.9 kg; >50 kg.

Table 46. Procedure for basic and advanced tasks

Individual Record	Basic	Advanced
Aboca	In race hold sheep, scan ID number and release	Scan ID number (using hand-held scanner), load sheep into crate, weight announced and recorded manually into one of six pre-set bands on scanner, sheep then released
Anilog	In race hold sheep, scan ID number and release	Scan ID number (using hand-held scanner), load sheep into crate, weight announced and recorded manually into one of six pre-set bands on scanner, sheep then released
Weigh crate	Load sheep into crate, check scanner reads identifier and release	Load sheep into crate, check scanner reads ID, check weight recorded, and then release
Paper	In race hold sheep, read out ID number for recording onto record sheet – (one person reads number the other keeps record) – and release	Load sheep into crate, read out ID number and record onto record sheet, read out weight and record onto record sheet (one person reads number the other keeps record) and then release

<u>Assessments undertaken</u>

Data were recorded for time (sheep/per second) and percentage error rate (wrong numbers; omissions; duplicates; variance in weight records). Set-up time for recording (organising the flock, setting up equipment etc) was not included in the timing.

Any unforeseen stoppages (e.g. equipment failure) were timed/noted, and excluded from total time taken because the aim of the trial was to provide an estimate for a working system.

Once the last animal in each batch had been recorded the clock was stopped. If any errors were noticed once the clock had stopped (e.g. totals did not tally) a record was made of the errors but the clock was <u>not</u> restarted and the error corrected.

Record sheets were provided for manual recording and electronic data files were used for the export of data into EXCEL for validation.

Other data captured to assist with the interpretation of results included:-

- prevailing weather conditions;
- details of any factors which affected the efficiency/effectiveness of the processes (e.g. sheep jumping out of the crate, manhandling sheep into position to ensure tags were read, equipment malfunction etc); and
- identity of individual operators involved at each stage of the process.

10.2.2 Qualitative information

<u>Time taken to tag and bolus</u>

Data were collected from participants' workbooks to assess the time taken to bolus and tag sheep in commercial practice. Circumstances were expected to vary considerably depending on facilities, work routine and other tasks being undertaken at the same time.

<u>Overall usability of the EID system</u>

To gain further insight into the overall usability of the EID systems, detailed interviews were undertaken with a sub-sample of 12 participants, drawn from :-

- all 3 paper comparator farms;
- 3 Earlsmere Basic EID farms;
- 3 Allflex Basic EID farms;
- 2 Allflex Management farms, and
- 1 Earlsmere Management farm.

The EID participants were specifically selected at the upper end of the scale, i.e. those that appeared to be most confident with the system installed.

The interviews tried to go beyond any practical problems associated with the trial, and the characteristics of the specific equipment used, in order to understand the main issues affecting effectiveness, efficiency and acceptability of the electronic and paper-based systems. One part of the interview was designed around a set of industry standard questions developed to rate IT systems on a System Usability Scale (SUS) of 0-100. For this measurement, usability is defined as appropriateness for a purpose, using a scale which presents a series of ten statements (Table 61). Users of a particular system were then asked to agree or disagree, on a five-point scale. The scores were then weighted, and summed to give an overall usability score that ranged from 0-100. The approach has been shown to correlate well with other more complex usability measures.

10.3 Results

10.3.1 Quantitative studies

<u>Data recording</u>

Time taken

The times taken to complete each of the experimental treatments for each task/equipment combination are given in Tables 47 to 54 below. The Recording Time is shown in seconds, and refers to the total time elapsed from the start to the end of each phase. The Adjusted Time is the time taken, adjusted to ensure the total recording time is based on a similar number of sheep records (49). The Upload Time indicates the number of seconds required to transfer the data from the reader to the computer (for the paper-based comparator this involved keying the data into a spreadsheet). The sum of the Adjusted Time and the Upload Time was calculated to provide the Total Time to complete the task. Any Data Errors were noted in the last column. An average was then calculated over the four runs at varying operator fatigue levels.

Table 47. Anilog - Basic task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R3	579	579	34	613	No
R5	554	554	20	574	no
R12	550	550	28	578	yes
R14	578	590	59	649	no
Average	565	568	35	604	

Table 48. Anilog - Advanced task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R19	972	972	33	1005	no
R21	1002	1002	22	1024	no
R28	954	954	33	987	no
R30	915	934	52	986	yes
Average	961	966	35	1001	

Table 49. Aboca - Basic task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R4	432	432	34	466	no
R7	360	360	84	444	yes
R10	402	410	90	500	yes
R13	413	422	84	506	no
Average	402	406	73	479	

Table 50. Aboca - Advanced task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R20	1020	1020	85	1105	no
R23	608*	1241*	163	1404	yes
R26	480*	1069*	88	1315	yes
R29	1072*	995*	112	1067	yes
Average	795	1081	112	1223	

**: the reader froze on these occasions with only limited sheep scanned, for the purpose of the analysis these timings were computed from the partial data.*

Table 51. Weigh crate - Basic task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R2	392	392	34	426	no
R8	366	366	35	401	yes
R9	347	354	48	402	no
R15	560	560	57	617	no
Average	416	418	44	462	

Table 52. Weigh crate - Advanced task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R18	1020	1020	35	1055	no
R24	744	744	48	792	no
R25	727	742	58	785	no
R31	885	885	62	947	no
Average	844	848	51	895	

Table 53. Paper – Basic task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R1	204	204	105	309	no
R6	219	219	120	339	no
R11	165	165	165	330	no
R16	170	170	120	290	no
Average	190	190	128	317	

Table 54. Paper – Advanced task

Treatment	Recording time (secs.)	Adjusted time (secs.)	Upload time	Total time	Data errors
R18	1020	1020	35	1055	No
R24	744	744	48	792	No
R25	727	742	58	785	No
R31	885	885	62	947	No
Average	672	675	285	957	

Errors recorded

Data verification was undertaken at the end of each day. A number of errors were possible (Table 55).

Table 55. Type of errors checked

Error	Description	How checked
Non-read	The operators thought a sheep's ID had been read but the tally of readings did not match the number of sheep handled.	The operators recorded the number of records made in the field and a physical count was made of sheep before the reading and after the reading
Misread	An ID number was recorded inaccurately.	Morning and afternoon numbers for each paired treatment were compared to see if they matched
Duplicate read	A number was read twice	Electronic records were compared for duplicate numbers in each treatment
Data-loss	A number appeared to be read but did not transfer across to the database	The total number of records in the treatment database were compared against field records of sheep scanned

The results of this verification are shown in Table 56 below.

Table 56. Recorded Errors

Comparators	Method	Number of sheep		Numbers not read		Duplicate numbers		Matched Records	Weight records	Notes
		Basic	Advanced	Basic	Advanced	Basic	Advanced			
R1 & R17	Paper	49	49	0	0	0	0	49	49	
R2 & R18	Weigh crate	49	49	0	0	0	0	49	49	
R3 & R19	Anilog	49	49	0	0	0	0	0	49	Different batches run through in error.
R4 & R20	Aboca	49	49	0	0	0	0	0	49	Different batches run through in error.
R5 & R21	Anilog	49	49	0	0	0	0	49	49	PM one sheep injured by race gate and withdrawn from trial.
R6 & R22	Paper	49	48	0	0	0	0	48	48	One sheep withdrawn from trial due to injury. No recording error.
R7 & R23	Aboca	49	49	2	33	0	1	16	16	System froze for the advanced task. Operators thought they had recorded 24 sheep, but only 16 records were downloaded successfully.
R8 & R24	Weigh crate	49	49	1	0	0	0	48	49	A non-read in the morning
R9 & R25	Weigh crate	48	48	0	0	0	0	48	48	
R10 & R26	Aboca	48	48	3	2	3	5	45	17	Three numbers in basic task were duplicates. 22 sheep were reported as scanned but a total of 51 numbers were recorded for advanced tasks with duplications but only 17 weights were recorded.
R11 & R27	Paper	49	49	0	0	0	0	49	49	
R12 & R28	Anilog	48	49	1	0	0	0	48	49	One non-read in the morning
R13 & R29	Aboca	48	48	0	13	0	11	35	15	A total of 44 numbers were recorded for advanced task with duplications and omissions.
R14 & R30	Anilog	48	48	0	0	0	1	47	48	A duplicate reading in the afternoon
R15 & R31	Weigh crate	49	49	0	0	0	0	49	49	
R16 & R32	Paper	49	49	0	0	0	0	49	49	

Overall performance in data recording

The average time taken (in seconds) for each of the three EID systems used is given in Table 57, together with the overall average for the EID systems compared to the average for the paper-based system. The first figure in the error rate column relates to the number of errors that were made from a possible 196 readings. The figure in brackets is the number of treatments where an error occurred (e.g. 1/4 represents one treatment in four).

Table 57. Summary of total time and error rate in dealing with 49 individual records

Data capture method	Recording		Transferring data		Total Time		Error Rate	
	Basic	Advanced	Basic	Advanced	Basic	Advanced	Basic	Advanced
Anilog	568	966	35	35	604	1001	1/196 (1/4)	1/196 (1/4)
Aboca	406	1146	73	112	479	1230	8/196 (3/4)	65/196 (3/4)
Weigh crate	418	848	44	51	462	899	1/196 (1/4)	0/196 (0/4)
Average time EID Note: total error rate	464	987	51	66	515	1043	10/588 (4/12)	66/588 (4/12)
Paper	190	675	128	285	317	960	0/196 (0/4)	0/196 (0/4)

In interpreting the data two factors have to be taken into consideration. Firstly there were reliability problems with some of the equipment, which impacted on the error rate and overall effectiveness of the EID systems. Secondly, the paper-based system was being operated by research staff who were highly experienced in reading sheep tags and were working under near ideal operating conditions. This therefore gives an indication of the potential performance of a paper-based system that may not be achievable with individuals operating within a more difficult working environment, with a lower level of experience, or with larger groups of sheep being read. Thirdly, simple three-digit management numbers were used as the basis for manual recording.

Figure 5 gives the range, quartiles and median of the time taken to record EID numbers for 49 sheep. It shows that paper recording was achieved in a shorter and more consistent time than was achieved with the electronic systems as tested. On average, it took almost 2.5 times longer to record the sheep's ID number using the EID system than recording tag numbers on paper. Even if the average time to record the ID number using electronic data capture was nearer the lower end of the range, electronic recording would still have taken almost twice as long as the paper-based system (190 seconds vs. 347 seconds) for the small number of sheep handled.

Figure 5. Recording Time for Basic Task

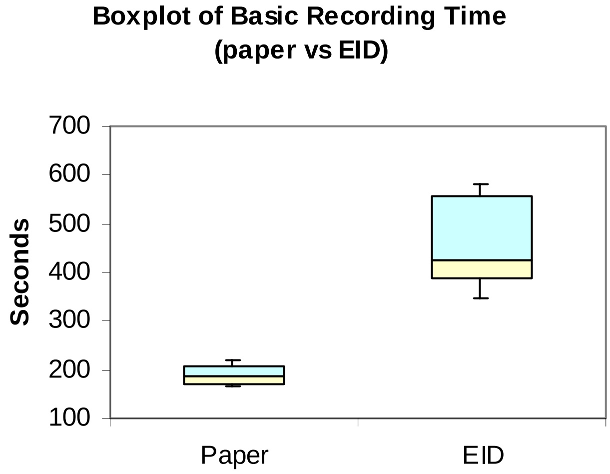
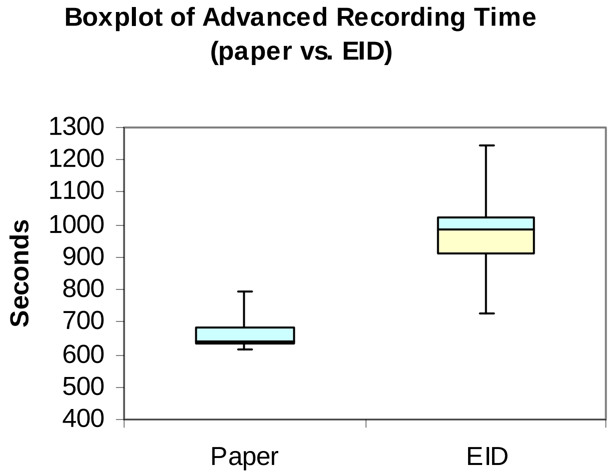


Figure 6 gives a similar picture for the time taken to record the data for the advanced task. The range of time taken to undertake this task on paper was larger than for the simpler task, and the longest time recorded using paper was greater than the time taken for two of the electronic treatments. However, the results showed that the average time to carry out the task on paper was significantly quicker than the average time achieved by the electronic systems.

Figure 6. Recording Time for Advance Task



The experimental design took into account the potential confounding effect of fatigue on operators' performance (speed and error rate). Analysing the data did not show any significant fatigue effect on the speed of performance. However, this would not necessarily be the case in reality, where operators pushed for time might have been collecting this data at the end of a long day's work.

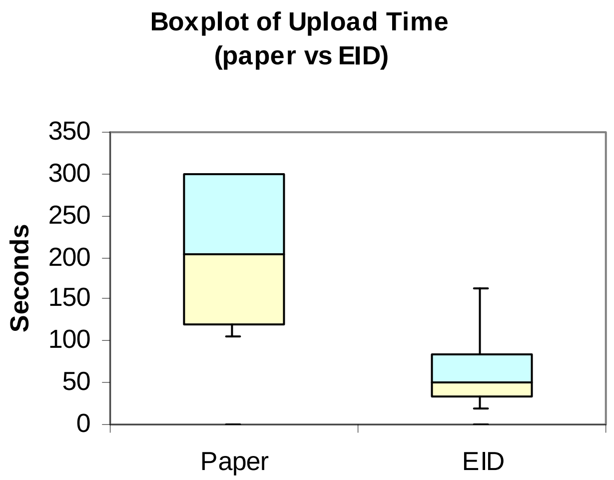
10.3.2 Data Upload

Speed of upload

A paper system requires the manual keying in of data onto the computer, while for the EID system data upload can be done electronically. A key characteristic separating the two systems is that the time taken to upload data on a paper system is directly linked to the number of readings taken, or the amount of data collected. These variables have less of an effect on total upload time with an EID system. This can be seen from the summary data in Table 57 above, where the average time to upload the data for the advanced task using the paper-based system was over twice as long as the basic tasks (285 seconds cf. 128 seconds). This compared to an increase of just under a third (51 seconds cf. 66 seconds) for the electronic systems. These results suggest that as the scale and complexity of the data collection process increases the differences between both systems narrows. The threshold beyond which the electronic systems might be expected to outperform paper-based data collection was not tested within these studies.

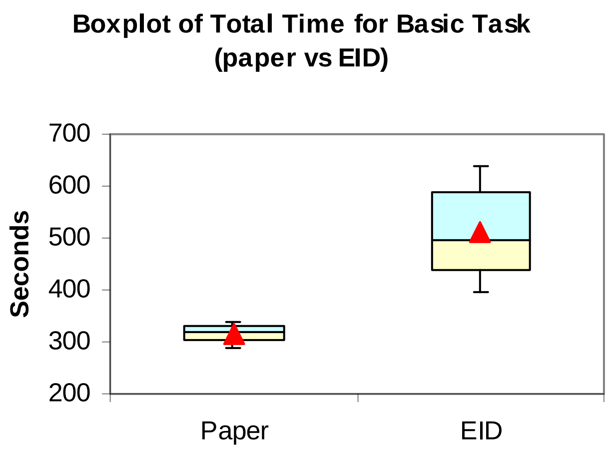
Figure 7 shows the range, quartiles and median of the time taken to upload the data for both the basic and advanced tasks for a group of 49 sheep. The average upload time for the EID system was 58 seconds cf. 206 seconds for the paper system.

Figure 7. Time to Upload Data to Computer



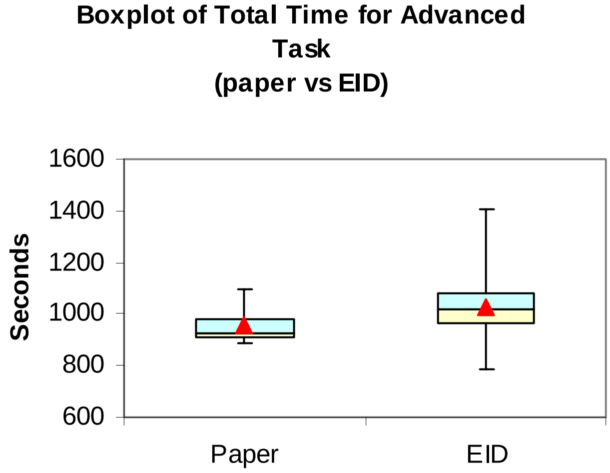
Figures 8 and 9 illustrate data for the combined recording and upload times for the basic and advanced task. The main feature on these charts is the combined average time for reading and uploading the data to the computer (317 seconds cf. 512 seconds). For both tasks, the average total time for the paper system was quicker than the electronic system; 198 seconds quicker for 49 ewes for the basic task and for the advanced task, although the differential was reduced it was still 83 seconds quicker. In other words, under experimental conditions reading groups of 49 sheep, the paper-based method was quicker than the average of the electronic systems.

Figure 8. Combined Recording and Upload Time for Basic Task



Note: '▲' indicate the mean time.

Figure 9. Combined Recording and Upload Time for Advanced Task



Note: '▲' indicate the mean time.

Accuracy of Recording and Data Transfer

The error rates are summarised in Table 58 and the important finding is the 100% accuracy in all eight of the paper-based treatments, compared with two thirds of the electronic treatments.

In four of the electronic treatments there were non-reads, researchers were aware of this due to the scanner freezing, or the number of records reported not matching the number of sheep that had been handled. In the other cases, the non-reads were not identified until the data were uploaded to the computer. These errors were not spotted until data verification was undertaken on the electronic files. For the basic task 80% of total data errors for the electronic systems, and 65 out of 66 for the advanced task were associated with the Aboca (Table 57).

The weigh crate reader had only a single error (non-read), and the Anilog two errors (1 non-read and 1 duplicate). These errors can be linked to sheep handling errors rather than equipment issues, for example, where the scanner picks up the signal from an adjacent tag, or a ewe slips through the handling system without it being read.

Table 58. Number of EID treatments where errors occurred

Error Type	Aboca	Anilog	Weigh crate	Total number of errors
Non-read	5	1	1	55
Misread	0	0	0	0
Duplicate read	4	1	0	21
Data-loss	3	0		61

10.3.3 Qualitative studies

Time taken to insert devices

The times recorded by selected participants for the insertion of tags and boluses varied considerably, even within farms, depending on the handling facilities, the range of other tasks being carried out, the work routine and number of farm staff involved. Examples of typical recorded times for bolusing (and tagging where required) are given in Table 59.

Table 59. Time taken to bolus sheep

Farm No.	Activity	Other tasks	No of sheep	Time (hrs)	Mins/ sheep	No of staff	Mins/ sheep/ staff unit
22	Bolusing & Tagging		161	3.75	1.40	2	2.80
22	Bolusing & Tagging		360	6	1.00	2	2.00
31	Bolusing & Tagging	Drench lambs	113	3	1.59	2	3.19
33	Bolusing & Tagging	Injecting lambs	190	2.5	0.79	3	2.37
28	Bolusing	Castrate, mark and tail lambs	212	3	0.85	3	2.55
28	Bolusing	Castrate, mark, and tail lambs	210	3	0.86	3	2.57
28	Bolusing	Castrate, mark and tail lambs	240	3.5	0.88	3	2.63
						Mean	2.58

Typical recorded times for electronic tagging are given in Table 60.

Table 60. Time taken to electronically tag sheep

Farm No.	Activity	Other tasks	No of sheep	Time (hrs)	Mins/ sheep	No of staff	Mins/ sheep/ staff unit
64	Tagging		67	1.25	1.12	2	2.24
64	Tagging		50	1	1.20	2	2.40
26	Tagging		150	2.5	1.00	3	3.00
16	Tagging		133	3	1.35	2	2.71
30	Tagging		204	4	1.18	3	3.53
30	Tagging		250	3	0.72	4	2.88
30	Tagging		136	2	0.88	4	3.53
119	Tagging		514	3	0.35	4	1.40
119	Tagging	Footbathing	165	2	0.73	2	1.45
58	Tagging	Worming	772	10.25	0.80	3	2.39
						Mean	2.56

Overall usability of the EID system

Usability index

On the basis of the ten statements presented, Table 61 provides the summary scores (1 = strongly disagree to 5 = strongly agree) for the nine individual EID participants interviewed. Each score contributes a different weight to the overall usability, with the maximum possible score being 100.

Table 61 Usability scores summary by individual EID participant

Interviewee	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
I think that I would like to use this system frequently	4	3	5	3	1	1	1	2	1
I found the system unnecessarily complex	4	3	5	4	4	3	5	3	4
I thought the system was easy to use	1	4	1	1	2	3	1	4	2
I think that I would need the support of a technical person to be able to use this system	3	1	5	3	5	1	5	1	1
I found the various functions in this system were well integrated	3	3	1	3	3	4	2	1	1
I thought there was too much inconsistency in this system	3	2	3	3	4	3	4	4	3
I would imagine that most people would learn to use this system very quickly	1	2	1	1	2	3	1	1	4
I found the system very cumbersome to use	2	2	5	4	3	5	5	4	4
I felt very confident using the system	3	4	2	1	2	4	1	3	2
I needed to learn a lot of things before I could get going with this system	5	2	5	5	4	5	5	3	2
Overall Usability Score	22.5	39	10.5	15	15	27	3	24	24

Overall, the data shows wide individual variation (3 to 39) and a very low overall usability score (mean of 20). To put this into perspective, a usability assessment of Windows XP, was undertaken by the American Institute for Research using the SUS technique (American Institutes for Research, November 1, 2001). Questions were asked of 36 users, who were equally divided into novice, beginner and intermediate users (i.e. there were no advanced users). Windows XP achieved a usability score of 74 (range 38-100). Many of the factors contributing to the low usability score obtained in this trial could be linked to design issues with the equipment or software.

End-user feedback

Further insight into factors affecting overall usability was obtained during interviews with the same sub-sample of participants contributing to the usability index described above.

Effectiveness and efficiency of EID equipment

Features required to improve the effectiveness of EID include:-

- Elimination of programme bugs undermining reader performance;
- Improved tolerance to variations in weather conditions (cold temperature tolerance and water proofing) and the working environment on farm

- improved functionality of the reader – clear easy to use controls in all types of working environment;
- simple software structure with a minimum number of instructions to operate (ideally a single button to read a tag);
- ability to design functionality to meet specific needs of individual flockmasters;
- faster reaction time in the reader to minimise the interval between giving an instruction and the reader responding;
- fast, clear feedback so that the operator knows that action has been completed;
- reduced reliance on the need for a PC by increasing the stand alone functionality of the reader
- small and simple enough so that shepherds can manage and record flock movements on their own;
- long-battery life – so that it is always available to use when and where it is needed; and
- multi-purpose – ideally a hand-held reader should be able to be attached to a race to become a race reader, with the ability to plug in a weigh crate direct to the reader.

Effectiveness and efficiency of data management software

The low usability scores and the comments from participants indicated that the software design did not meet the expectations of its users. Some farmers were computer novices, and found the software overly complex. Many reported that the system was not intuitive, a particular problem when the software is used intermittently, as users reported the need to start from first principles every time they went back after a period away from the computer.

Lack of transparency and data security were issues that were raised by both computer novices and experts. One particular concern was the possibility of commercial software providers 'locking up' the data to tie people in to their software products. As data collection would be a legal requirement, participants had strong views that the data files should be open so that they can then be exported into any package, or backed up as standard spreadsheet files. A strong argument was made that there should be a basic software package that would enable a farmer to undertake the legal minimum, and that this software pack should be freely available. One participant, who was one of the more elderly computer novices on the trial, found the software so complicated that it created unnecessarily high levels of stress. Yet he cited the online BCMS system as an example of how things should be done, software he started to use as a result of being on the trial.

A frequent comment from participants, as part of the ergonomic interviews and the wider socio-economic consultation, was that the software did not appear to have been designed by a software engineer who understood the specific requirements of the sheep industry. For example, the inability of a system to cope with animal losses, which users were not able to remove from their database. However, once the detailed requirements of the Regulation are finalised, software developers will have a greater understanding of the functionality required of the software.

A key element of the data management software was the ability of the software to produce useful and actionable reports. Because of data collection problems, particularly with the Aboca, and the lack of confidence in the subsequent information provided, many of the participants did not use this aspect of the software. However, in the wider socio-economic consultation a number of participants complained that they were unable to generate consistently useful reports.

Effectiveness and efficiency of tags and boluses

The insertion of a device (tag or bolus) is the first stage of the EID process. There were few complaints about the design of the bolus. However, perceived welfare concerns regarding boluses did arise and may, in part, have contributed to the low take-up of this option by participants. Uncertainty over whether a bolus has been lost, or has failed, can lead to a prolonged search, contrasting with the obvious presence or absence of an ear tag. As well as the inconvenience, there is the potential for sheep to be bolused twice or to have a separate EID ear tag attached, which could cause operational difficulties.

Tag losses were seen as too high by many participants. Two piece tags had a number printed on each half of the tag so the matched pairs had to be applied to each animal. The original packaging for some button tags was so difficult to open that it slowed down the application process. When the packaging was redesigned, the tags came out too easily, the halves got mixed and time was spent matching the halves before insertion.

In many cases the printing was too small to be easily read without getting close and having to wear glasses. As one shepherd said, "you don't want to wear glasses around sheep!" Depending on the breed, the tag sometimes became covered with oils from the sheep's coat, leaving an opaque crust on the tag. This had to be scraped off in order to read the tag, a time-consuming process (especially as this happened on one of the paper-comparator farms).

Ease of application was a concern raised by some participants. The design of the applicator for some button tags resulted in a more complicated action to insert the tag. After insertion the applicator had to be fully opened before it could be removed, and if the animal moved its head during this process there was a risk of tearing the ear. Comments were received that with foldover tags application could be achieved with one action, and the tag applied almost before the animal realised.

Many of the potential benefits of EID are linked with the ability to link lambs to their mother. Participants indicated that the best way to establish this link was to tag a lamb within the first 24 hours of life. Many raised concerns about the design of the tags used for young lambs, in particular weight and ease of application.

Other ergonomic issues

Asking people to undertake new tasks, which require a degree of new expertise, without adequate training and support can lead to workplace stress. There was evidence that many of the participants in the trial felt that they went through a degree of stress. The stress would have been worse if they had been under a legal obligation to keep accurate records, if they had not volunteered to take part in the trial and had not had the support of their Project Officer. There is no doubt that the introduction of EID legislation has the potential to create high levels of stress amongst farmers, especially amongst those farmers with little or no computer experience. Well-designed and intuitive hardware and software together with good training and support will be pre-requisites to minimise the potential problems.

There was agreement amongst all the participants that use of EID for undertaking individual animal identification related tasks – at least with the current equipment – will significantly increase both the workload and the labour requirement. Where this additional labour is not readily available, farmers will be forced into trying to cope alone, adding to their long working days. One farmer, during the wider socio-economic evaluation, made the connection with the EU pressure for the UK to reduce the length of the working week and this type of regulation, which has the potential to create additional work!

Similarly, there are drives to reduce excessive manual handling in the workplace. Using hand-held readers to read boluses can involve considerable effort on the part of the operator, particularly with large breeds of sheep. Some participants did comment that the task was hard and tiring, but none mentioned this as a specific health and safety risk.

10.4 Overview and implications for sheep EID

Although not intended to be a comprehensive evaluation, the ergonomic studies conducted within the Pilot Trial provided useful comparative data on the field performance of electronic and paper-based approaches to data capture. The results were consistent with findings given elsewhere in the report.

The relative performance of the electronic system depends not only on its own performance and reliability, but also on what is being asked of a paper-based system. In the replicated ergonomic trial, paper recording was undertaken by experienced staff, reading a three-digit management number and in batches of only 50 sheep. In practice, this could be a six-digit individual number, and if animals have been sourced from several flocks, a six-digit flock number may also need to be recorded. Therefore, the potential contrast in time and accuracy between electronic and paper-based systems will be significantly affected by the requirements of the legislation. If the requirements are onerous, then a paper-based system could be expected to fail sooner, or at a lower threshold, in terms of the number of animals handled.

With more time and development EID equipment ought to become better suited to the range of field conditions experienced by sheep farmers in the UK. Several areas have been highlighted for improvement by end-users participating in this Pilot Trial, and suppliers need to be aware and incorporate this feedback into future products. Some of the problems identified are not directly associated with EID, but highlight very practical considerations that will also impact on a successful roll-out of EID. Feedback from the Pilot Trial should be taken into account when developing a UK manufacturing standard for sheep tags.

Livestock farming is a strenuous activity. A risk assessment/risk reduction philosophy for health and safety should be considered when assessing the impact of EID Regulations on livestock farmers.

11 AUCTION MARKET TESTS

11.1 Objectives

The overall objective was to develop approaches which would allow effective use of EID within the auction market sector. The LAA membership were particularly concerned about the potential impact of implementing EID on the operation of their businesses, potentially replacing tried and tested processes and procedures. Against this background, exacting targets were set for the performance of EID equipment:-

- reading capability of up to 4000 sheep per hour, to reflect maximum intake rates to large auction market sites;
- the ability to read the full range of technologies likely to be encountered when EID was implemented; and
- an effective facility to identify, segregate and deal with non-reading EID devices, or animals that were not carrying EID devices

11.2 Approach

The auction market evaluation was evolved in conjunction with the Project Industry Steering Group, and the LAA in particular. The LAA engaged positively in the trial so as to increase the probability of workable legislation being drawn up and implemented.

> *"Support for livestock markets is growing year on year. We want traceability to work, we believe it's a good thing, but it has to be a workable system." (Livestock Auctioneer)*

The Pilot Trial was originally conceived with the aspiration, if possible, to take the market evaluation to the point of a live demonstration on a sale day. However, given previous lack of development in EID equipment for use at sheep auction markets, and the demanding technical challenges set, the LAA strongly recommended a "closed doors" approach to validate the performance of the equipment, before any move to extend the demonstration into a live sale. Therefore, a phased approach was adopted;-

- Phase 1: Demonstration of 'proof-of-principle' in rapid reading of mixed technology devices (HDX/FDX-B; tag/bolus);
- Phase 2: Siting and testing equipment in a market environment, including EID and non-EID animals; and
- Phase 3: Further development and refinement, based on results and feedback from Phase 2.

As there was no fully integrated off-the-shelf ISO compliant systems available for market installation, prototype systems were produced for sheep, and used at several stages of the project.

Tests addressed the combined technical performance of the equipment and devices, i.e. the EID system.

During the tests, there was no attempt to prescribe the best locations to site equipment or to handle sheep, as these aspects would be expected to vary, depending on the legislation adopted, and on the requirements of each auction market.

11.3 Phase 1: Proof of Principle

The first step was to demonstrate, in principle that HDX and FDX-B technologies could be read in a mixed group of animals close to the throughput speeds required. The demonstration was held at ADAS Redesdale, on 13 August 2004, with several LAA members present as observers.

11.3.1 Materials and Methods

Test animals

Two groups of sheep were used. For a volume read, 200 lambs were taken from a commercial flock of 240 Swaledale ewes, making up the reference flock at ADAS Redesdale. This flock carried a mixture of HDX and FDX-B button tags.

A further group of 35 Mule hoggs carrying a range of devices (tags/bolus; HDX and FDX-B) were also put through the race, to demonstrate rapid and continuous reading of mixed identifiers.

Equipment and software

A twin-race, consisting of two parallel synchronised reading races, was set up in the sheep handling pens. Each of the two races had two panel antennae. Data were captured and displayed on a laptop, with basic software capable of identifying each individual animal from a string of electronic numbers. The supplier had access to the data file for both flocks as a whole, but could not tell before the test which animals were to be presented.

11.3.2 Results

The demonstration provided sufficient evidence to recommend further development of a prototype, to be tested within a real auction market environment.

11.4 Phase 2: Auction market testing

Following the demonstration at Redesdale, a large auction market in the north of England was approached and agreed to provide the location for market testing. This would test the performance of EID equipment, in a 'metal-rich' auction market environment, and from a broader base of test animals.

The demonstration was intended to be an unbiased evaluation of the principles and efficiencies involved in capturing individual identities of sheep entering the auction market. The specific objectives were, to:-

- demonstrate a prototype twin race reader system in the physical environment of a modern commercial market;
- test the ability of the reading system to identify and display individual animal numbers at a speed representative of commercial transport unloading rates (4000/hour);
- assess the ability of the software to identify non-reading or missing tags/boluses; and
- demonstrate the availability and practicality of a back-up system using a hand-held stick reader.

11.4.1 Materials and Methods

Animals and devices

The test included:-

- the range of ISO compliant EID devices (tags/boluses; HDX /FDX-B);
- mixing of sheep to ensure random presentation of devices to the reading equipment; and
- inclusion of a proportion of animals which did not carry an electronic device.

A total of 330 lambs were used (Table 62).

Table 62. Lambs used for Phase 2 market evaluation

Device		EID animals	Non-EID animals	Total
Allflex-supplied	HDX – bolus	60		
	HDX – tag	100		
Earlsmere - supplied	FDX – B bolus	50		
	FDX - B tag	100	20	
Total		310	20	330

The supplier had no prior knowledge of:-

- the exact number of total sheep involved ;
- the proportions of the various devices and technologies involved in the mix; and
- the number of animals deliberately presented which did not carry an electronic device.

Equipment and software

The installation was a dual, multiple antennae race. 'Intellieye' sensors were positioned in each race to sense for an animal present, connected to serial ports and sensor termination boxes with DIO capability, illuminating a red light to show a non-read (or 'exception').

In order for the software to check-off the electronic 16-digit number contained in the chip against its external management or official number, the software carried a pre-loaded database that contained the identities of all EID test animals as an unknown (to the supplier) sub-set. This database was formed either from the original flock data file (tag bucket) or by Project Officers going to the farm and specifically reading the devices of animals (which included the test animals, again as a sub-set). This was to ensure that for the test run data from both suppliers were incorporated n accurately and in a consistent form into one overall database.

For each sheep, a successful read was denoted by a change of colour on the line appropriate to that sheep within the database visible on the PC. At the end of the run, the number of reads indicated on the computer was recorded, and the file saved for further interrogation.

Unsuccessful reads ('exceptions') were indicated by a red light, signalling, either:-

- no device present, or device not reading; and
- an exception, where a device is present but had not been picked out by the system, e.g. two devices simultaneously presented to the antennae, as a result of the way the sheep have come through the race.

Test runs

For this phase, an automatic shedding facility was not incorporated, on the basis that if an electronic signal could be generated to accurately identify non-reading animals, this could subsequently be used to control a shedding gate. The intention was to set up the equipment on the morning of the test. However, due to frozen pipes and blocked drains, the test run was delayed by approximately 2 hours, and the setting up time for the complete system was reduced to 45 minutes. The animals were put through the reading equipment twice by market staff - once to calculate the rate of throughput and the proportion of non-reads, and the other at slower pace to enable non-reading animals to be pulled out for investigation/verification. In the second and slower throughput, unsuccessful reads (identified by a red light) were shed off, and checked by Project Officers for the presence of a device using a hand-held reader.

11.4.2 Results

Rate of throughput (Run 1)

The total time taken to run 330 sheep through the system was 7 minutes and 3 seconds. This equated to a throughput rate of 2809 sheep per hour.

Of the 310 lambs carrying an electronic device, 288 animals were logged on the database. This included 10 lambs, which were read by the antennae, but were not recognised on the database.

The number of exceptions which occurred, indicated by the number of red lights, was 47 (23 and 24 respectively for each of the twin races). Combining the number of animals read by the software (288) with the number of exceptions (47) resulted in 235 (5 more than the number of lambs presented).

Identifying exceptions (Run 2)

The purpose in putting the sheep through the second time was to try and relate any pattern in devices present to the occurrence of an exception. Without the installation of a shedding gate, controlled electronically by software linked to the reader, the segregation of animals had to be done manually. This process was liable to significant human error, particularly in identifying which sheep had triggered a red light.

On the second run, 285 animals were identified by the software as having been read.

A total of 51 animals were pulled out as having triggered a red light. Of these:-
- 46% were bolused (29% HDX; 17% FDX-B)
- 20% were tagged (5 % HDX; 15% FDX-B)
- 5% were HDX-bolused animals (which could not be read using a stick reader)
- 31% were animals known not to carry a device

These figures should not be taken as definitive for the reasons given above. However, they were in the same order of magnitude as the number of exceptions identified in the first run. A lower rate of exception might be expected when the animals were put through singly (as in Run 2). However, only one race was used to enable sheep to be diverted off. The animals appeared to run at greater individual speed when they were put through the race singly rather than as a continuous flow.

The test demonstrated that it was possible to put sheep through a race reader system rapidly and still read both FDX-B and HDX technology. However, the accuracy with which exceptions were identified clearly needed improvement. It was concluded that the red light exception logic was not 100% correct, as approximately twice as many animals (47 and 51 in each run, respectively) were flagged up as exceptions, compared to the number not picked up in the software (22 and 25 respectively). Subsequent analysis of the data strings captured by the software, showed instances where data collisions occurred, and approximately 8% of genuine reads may have been 'discarded' as a result.

11.5 Phase 3: Auction market testing

Following Phase 2, attention focussed on minimising the proportion of animals that might be shed off as exceptions through a race reader, and the speed with which they could rejoin the sale batch. In addition, it was felt that the potential of a manually operated stick reading system should be more fully explored.

Phase 3 incorporated improvements to the software logic controlling the operation of the race reader. Shedding gates, driven by compressed air, were added to facilitate automatic segregation of non-EID animals and other exceptions. The range of approaches was widened, to give greater flexibility to auction market sites, notably the balance of speed and accuracy through two differing race reader systems. A stick reading system was demonstrated, as a potential solution for smaller markets (where sheep are sold in their pens), or as a back-up/contingency to handle exceptions identified by a race reading system.

The specific objectives were to:-

- compare the relative merits of a fast flow race system, identifying exceptions to be shed off, with a slower stop/start system;
- address the ergonomics of how exceptions and non-reads could best be handled and returned to the flow of sheep; and
- demonstrate the capability of a stick reading system.

11.5.1 Materials and Methods

<u>Animals and devices</u>

A total of 284 ewe hoggs were used. These included 184 from a mixed-device reference flock at ADAS Redesdale. This flock had been through the race system during pre-testing at Redesdale. The remaining animals were from a participating farm within the Cumbria sub-cluster and carried Allflex HDX button tags. These animals had never been through the system until the actual test itself.

As a comparison of reading performance using mixed and single technologies, sheep from each source were put through each system separately.

<u>Equipment and software</u>

The equipment was set up during the early afternoon on the day of the test. Once set up, the supplier was allowed to put a group of six randomly chosen animals through the races to check that shedding gates were functioning. No other animals were put through the races until the test itself.

The software was designed to identify animals present, as a sub-set of a pre-loaded database. While the supplier had access to the Redesdale flock for testing purposes, as before, they did not know the exact number or make-up of the animals presented on the day. For the other participating farm, a sub-set of over 700 animals on the farm database were presented from which the animals present had to be identified. For each of the three auction market systems tested, output from the software was taken by project team staff on the day, for analysis and independent verification.

Stick reading system

Three pens of sheep (64 in total) were made up randomly by project staff. Pen 1 contained 26 sheep from ADAS Redesdale, carrying a range of technologies (Table 63) and including 4 non-EID animals. Pens 2 and 3 contained sheep carrying electronic tags only.

Before the test, the ability of the remote reading system was checked within the pen area. In one of the pens, a 'blind' area was found adjacent to one of the metal stanchions. This corner of the pen was separated off using a sheep hurdle.

Each pen was read by supplier staff working in pairs, using a Bluetooth reader. Data were captured and transferred to a base station, situated 3 – 6 metres away.

The software used on the laptop was a pen-based system that allocated EID tagged animals to a specific pen. At the start, the pen EID identifier (fixed to the front of the pen) was read by the stick reader, which allocated the pen. Animals in that pen were then read. A safety factor was included which allowed the stick reader to store the data, should connectivity be lost for any reason. This stored data could then be downloaded to the database, when connectivity was resumed.

Stop:Start reading system

A stop:start prototype race was configured to handle each sheep separately. As an animal entered the race, a gate closed behind it. If a read was obtained within 7 seconds, the animal was allowed through; if not, it was shed off. Exceptions were then checked using a stick reader, and where an electronic device was found, it was read. If a read was not obtained, the visual tag was read manually.

Continuous flow race system

This system was configured to stop and shed only those animals identified as exceptions, i.e. animals not carrying an EID device or where a device might have been present but could not be read. The principle was that flow would not be stopped until an exception was identified. The mechanism to stop sheep could be configured so that sheep were held either by a moving race wall, or by closing gates at either end of the race.

11.5.2 Results

Stick reading system

The reading performance of the stick reading system for mixed and single technologies is given in Table 63.

Table 63. Reading performance – Stick reading system

Device	Type	Technology	No. submitted	No. successful reads	% successful reads
Pen 1: Mixed technologies					
Tag	Allflex	HDX	4	4	100
	Earlsmere button	FDX-B	6	6	100
	Earlsmere foldover	FDX-B	1	1	100
		Total tag	**11**	**11**	**100**
Bolus	Allflex	HDX	2	2	100
	Earlsmere standard	FDX-B	3	3	100
	Earlsmere midi	FDX-B	4	4	100
	NSP	HDX	2	2	100
		Total bolus	**11**	**11**	**100**
		EID total	**22**	**22**	**100**
		Non – EID	**4**	**4**	**100**
Pen 2: Single technology					
Tag	Allflex button	HDX	22	22	**100**
Pen 3: Single technology					
Tag	Allflex button	HDX	16	16	**100**

Although the numbers of sheep involved were small, across the three pens, and range of technologies tested, the stick reading system was 100% accurate. Speed of reading for each pen is given in Table 64.

Table 64. Speed of read – Stick reading system

Pen	No of EID Sheep	No. non-EID sheep	Total Sheep	Total time to read	Time /sheep (secs.)
1 (mixed technology)	22	4	26	156	*6.0
3 (single technology)	16	0	16	65	**4.1
4 (single technology)	22	0	22	65	***3.0

* Equivalent to 600 sheep per hour
** Equivalent to 878 sheep per hour
*** Equivalent to 1200 sheep per hour

Speed of read varied from 3.0 to 6.0 seconds per sheep. The time taken by the operator to check and read sheep with mixed technologies (including some non-EID animals) took approximately twice as long, compared with reading sheep carrying only electronic ear tags.

Stop:Start system

Reading performance

Reading performance for both single and mixed technologies is given in Table 65.

Table 65. Reading performance – Stop:Start race

Device	Type	Technology	No. submitted	No. successful reads (within 7 sec)	% successful reads
Run 1: Mixed technologies					
Bolus	Allflex	HDX	13	13	100
	Earlsmere midi	FDX-B	19	17	89
	Earlsmere standard	FDX-B	20	19	95
	NSP	HDX	45	45	100
		Total bolus	97	94	97
Tag	Allflex button	HDX	30	29	97
	Allflex button	FDX-B	4	4	100
	Earlsmere button	FDX-B	26	26	100
	Earlsmere foldover	FDX-B	19	18	95
		Total tag	79	77	97
		Overall	176	171	97
Non – EID	N/A	N/A	8	7	88
Run 2: Single technology					
Tag	Allflex button	HDX	100	98	98

Within the parameters set for the test, and a seven-second reading interval, the range of mixed technology devices present were handled (read and sorted) with an efficiency of 97%.

For the group wholly identified by a single technology (HDX button tag), the overall efficiency was 98%.

Of the 184 sheep presented for the first run (Redesdale flock, mixed technologies), 173 animals were recorded by the software. However, 12 sheep were shed off:-

- 7 carried no EID device;
- 1 read, but was released into the shedding pen by human intervention, when the sheep tried to force its way through the shedding gate;
- 2 were read but potentially after the 7 second delay which triggered the shedding gates to open (also see paragraph below); and
- 2 devices (1 FDX-B midi bolus; 1 FDX-B foldover tag) failed to read even when put through the race for a second time.

Of the eight animals submitted without devices, seven (88%) were shed off. This was not expected, in that non-EID animals were consistently shed during pre-testing. Based on video evidence of the test, the theory put forward by the supplier to explain this observation was that an animal bearing an EID device had backed up in the race, its tag was read after the seven second period, and it was shed off. However, the tag was held in the reader buffer and was released to the system when the next sheep (non-EID) passed the first sensor. It was concluded that further refinement was required in the logic of the controlling software.

Of the 100 sheep presented as a single technology (HDX button tag), two animals were shed off:-
- 1 device did not read; and
- 1 device read, but not before the shedding gates had been triggered to open.

It was observed that one animal was handled by the race, in a different manner to the others. It was diverted to the left (not to the right, and into the shedding pen), and rejoined the main group of read animals. This individual carried an electronic device, but was discovered by ADAS on arrival at the market (and unknown to the supplier) not to be contained in the supplier tag data file. The system read the electronic device, but the number could not be picked from the pre-loaded database specific to the trial, because it was not present.

Overall, in terms of animals carrying devices which read in the race, i.e. including those which read after the 7 second cut-off for shedding, the proportions of devices read were 98.9 % and 99% for mixed and single technology groups respectively.

Speed of reading

Speed of reading for the stop:start race is given in Table 66.

Table 66. Speed of read – Stop:Start reading race

Group	No of EID Sheep	No. non-EID sheep	Total Sheep	Total time to read	Time/sheep (secs.)
Run 1: Mixed technologies	176	8	184	11 min, 17 secs.	*3.7
Run 2: Single technology	100	0	100	5 min, 19 secs.	**3.2

* Equivalent to 973 sheep per hour
** Equivalent to 1125 sheep per hour

Speed of reading is affected by how the sheep run through the system, which in turn is affected by the design of the entry area, experience of the sheep themselves, and the skill of the handlers in moving the stock forward. On the day, the single technology system was recorded to be 15% faster than the mixed system.

<u>Continuous flow system</u>

During pre-testing, this race appeared to have the potential for a faster rate of throughput than the stop:start race. However, this could not be verified during the test. On the day, a control box from the stop:start reader had inadvertently been attached to the continuous flow race, so the logic was incorrect for the operation of the race. As this system was the last to be demonstrated at approximately 6 p.m., and the auction needed to begin washing down, there was insufficient time to reconnect the controlling electronics, and put the sheep through for a second time.

<u>Racewell system</u>

Twenty Scottish Blackface hoggs carrying NSP boluses, and which had never been through the system before, were put through as a demonstration.

The observers present expressed some concern about the potential for carcass bruising, as a result of the restraining mechanism, in slaughter lambs.

11.6 Overview and implications for sheep EID

From a position of considerable technical challenge, and underdeveloped systems for sheep EID at auction market sites, considerable progress was made during the Pilot Trial. An evolutionary approach, in collaboration with the LAA, contributed greatly to the outcome. The assessments were designed only to test proof of principle. As such, further technical development and validation of performance and reliability is required, under a wider range of practical conditions. However, by the end of the study, prototype race and stick reading systems were presented, with the potential for a high degree of accuracy in reading mixed technology identifiers, as well as segregating animals carrying no electronic device. The range of options tested would also allow markets of differing throughput, layout and operating systems, to consider options for what might be the best approach for their circumstances.

Following the final run at the auction market, the LAA commented that they now believe systems of EID could be developed for practical application in the auction market sector. The progress achieved was acknowledged to have made the prospect of a workable system appear much more realistic than was previously the case, although it was emphasised that further progress was required.

> *"It does now look as if there could be systems out there that we could work with."*

The balance between speed and accuracy of reading is important. Adequate, or ideally very high levels of performance, appropriate to the situation are required for both. The priority to maintain throughput to the sale ring is not just concerned with coping with the volume of stock presented, but also maintaining sales momentum, which is an important, intangible aspect of the auction market.

> *"As an auctioneer you cannot afford to stop the flow of livestock through the sale ring."*

Throughput capacity of 4000 sheep per hour, as stipulated by the LAA, was not achieved using a single race. Further thought is required to achieve sufficiently high throughputs, so as not to slow the sale ring, or create a bottleneck at the unloading bays. Theoretically, a number of races could be linked to provide simultaneous reading capacity at several positions in the market. Combining three races, reading sheep at 1200 per hour, into an integrated system could give the throughput capability specified. Further consideration of the siting of a race reader, avoiding a potential bottleneck at the unloading bays, is also an option, as selling capacity through the ring is likely to be only 1500-2000 an hour. With more time and consideration, improvements could be made to the ergonomic design of how sheep are presented to the race, which might increase throughput capacity, by perhaps a further 10%-15%.

The LAA view was that tags were easier and quicker to read than mixed groups of tagged, bolused and non-EID animals. Also noted was the likely mix of devices (tags and bolus), and potential mix of technologies. Reassurance was sought regarding the reliability and compatibility of the various systems and their ability to interface with one another. A key question that remained was how to cope with sheep that either appear as misreads or non-reads, the aim being to route them back to their colleagues prior to sale.

> *"It's not the ones it reads that's the problem, but the ones it misses – how do you get them back to their batch and how long does it take? These are questions we need answers to from Defra. If you have an animal in the market that's a non-read, what do we do with it?"*

To the LAA, the stick reader was a system that appeared to offer a more affordable and practical solution to the markets' requirements. There were also perceived to be advantages in terms of the flexibility of the system and its ability to adapt to various selling situations (sales ring and pens) together with its inherent portability, for example between market sites. In contrast to the stick reader, the race reader was perceived to be a more complex proposition.

> *"The Stop/Start system was a great system but there's so much to go wrong with it and we can't afford anything to go wrong on a sale day."*

A key concern of using a stick reader to read sheep in pens was the risk of misread. While it was acknowledged that this problem had not been encountered in the second market trial (Phase 3) it was recognised that the risk had been minimised by the presence of two operators, one holding the sheep and the other completing the read. This approach was ruled-out in the commercial environment on the basis of labour cost and potential carcass damage that might result from manhandling sheep close to slaughter.

Further development work is required to refine each of these systems, reduce labour inputs, and validate longer term performance, reliability and robustness. Despite current progress, none of the systems has yet been tested in a live auction or at a scale which incorporated the whole auction site. The Pilot Trial made no concession for a permanent or semi-permanent installation, which might reasonably be expected to improve performance and reliability. The occurrence of a blind area in one of the test pens indicates the importance of good site survey and installation.

The animals used in the current tests were of a consistent type (finishing lambs or ewe hoggs). No consideration was made of how to handle the full range of stock classes passing through the market, for example, ewes with lambs at foot.

No projections of the likely costs of implementation at auction sites were attempted. The assumed costs of implementing EID, both in terms of technology and additional labour required to operate the system, were major concerns to a sector which is under increasing financial pressure.

Ultimately, much will depend on the legislation as implemented. A requirement to read twice at the auction market (on entry and exit) would add further cost and complexity. Decisions regarding how the data collected is to be handled, the provision of a central database holding individual electronic identifications, and exemptions for certain classes of stock, will aid or impede the process of EID at the auction market.

12 ABATTOIR TESTS

12.1 Objectives

The main objectives of the abattoir tests conducted within the Pilot Trial were to:-

- assess technical performance and practical implications of using EID within the abattoir environment;
- individually record sheep, carrying a range of electronic devices, in a format usable by the abattoir for traceability and feedback of carcass information to the farmer; and
- assess the likely impact and potential benefits to the abattoir sector of automated individual identification and data processing

12.2 Approach

Three abattoirs collaborated in the Pilot Trial. These were selected in consultation with the British Meat Processors Association (BMPA), to reflect some of the differences in plant design, scale and operation likely to be encountered during the wider roll-out of EID. These were located in each of the three regional cluster areas, and were involved in assessing three different approaches:-

- South West Cluster - a large single species abattoir, testing in line pre-stunning reading;
- Midlands Cluster - a multi species abattoir slaughtering lambs and pigs, testing an in-line panel antenna, situated post-stunning and post bleed; and
- Northern Cluster - a small multi species abattoir slaughtering lambs, pigs and cattle, testing a lairage entry race reader, supported by a hand-held reader system.

Two test runs were scheduled at each site. The aim was to demonstrate ‘proof of principle’ in capturing EID data. There was no attempt to integrate directly with existing abattoir financial, information or carcass feedback systems.

12.3 Pre-stunning reading – in lairage

If the objective at the abattoir was simply to comply with the legislation, then theoretically, reading of EID devices could take place on entry to the lairage. A potential advantage of pre-slaughter reading is that non-EID animals could be segregated while still alive and dealt with according to the prevailing legislation.

Three tests were undertaken for lairage reading, two in the North East abattoir and one in the South West.

12.3.1 Materials and Methods

Equipment and software

A prototype mobile race reading system was used with double panel antennae and entry and exit gates controlled by compressed air. Using sensors fitted to the top of the race, linked to the controlling software, each animal was handled separately. If an EID number was captured, the exit gate opened to release the sheep. If no EID was read the animal was retained, where ultimately they could be dealt with as appropriate to meet future legislative requirements. For each sheep, a successful read was denoted by a change of colour on the line appropriate to that sheep within a database located in a laptop computer. Where no EID was read, the visual number was taken manually and entered into the software.

As in the auction market tests, the software was pre-loaded with a database which contained the identities of all EID test animals as an unknown (to the supplier) sub-set.

Test animals

At the North East abattoir thirty finished lambs were used for each test run. The majority were identified electronically, either by tag (Allflex, HDX) or midi bolus (Earlsmere, FDX-B). Due to the relatively low level of lamb slaughtering through the plant, the test was more concerned with how the options tested related to the plant infrastructure and operation, rather than performance of a full range of EID devices. Before each run, all lambs were checked for the presence of an EID device by Project staff.

The South West abattoir test was undertaken with 152 lambs, sourced from four participating farms, carrying a range of devices (Allflex HDX tag; Earlsmere FDX-B foldover tag; Shearwell FDX-B foldover tag and Earlsmere FDX-B midi bolus), and including a proportion of animals which did not carry electronic devices.

12.3.2 Results

Run 1 (North East)

Lambs were put through the race twice. On each occasion, all devices were read with 100% accuracy (Table 67).

Table 67. Reading performance (lairage race reader)

Device type	HDX / FDX-B	Total presented	Total read by the race reader	% accuracy
Allflex button tag	HDX-B	15	15	100
Earlsmere midi bolus	FDX-B	14	14	100
No device	N/A	1	0	100

One particular bolus, which could not be detected using a hand reader in the live animal, was read by the race.

The independent observers voiced concerns about the potential of the entry and exit gates to bruise some of the carcasses. On carcass inspection, the abattoir reported that no bruising was evident.

Based on the first run, the control of entry and exit gates in the race needed further adjustment. On one occasion, two lambs ended up in the reading field. This was due to a small lamb moving its head into and out of the field, causing the exit gate to close and the entry gate to open, but without allowing exit of the first lamb. Subsequently, adjustments were made to the software logic, positioning of the controlling sensors along the race better suited to slaughter size lambs, and the action of entry and exit gates.

Run 2 (South West)

Having carried out the modifications above, the mobile race was taken to the South West abattoir and positioned to read sheep before the entry to the elevator race.

However, communication problems became evident as the first group of 65 animals went through the race. Initially, the database on the laptop did not appear to recognise the incoming ID data, and an increasing number of sheep had to be read and entered manually on the software. This appeared to compound (‘loop’) the more sheep that went through the system. Throughput slowed well below the 6 seconds per sheep required to maintain throughput on the slaughter line. After 75 animals, the test was terminated, and the remaining animals allowed up the elevator line as normal.

Run 3 (North East)

The modifications made to the race reader between the first and second runs had not been tested with live animals. Following further testing and adjustment, the race was taken back to the North East abattoir for a third and final test run.

Reading was 100% accurate (Table 68), at a throughput rate of 5.3 seconds per lamb.

Table 68. Reading performance (lairage race reader)

Device type	HDX / FDX-B	Total presented	Total read by the race reader	% accuracy
Allflex button tag	HDX-B	14	14	100
Earlsmere midi bolus	FDX-B	12	12	100
No device	N/A	2	2	100

Two further issues were noted during the third test run. One lamb jumped as it approached the end of the race, collided with the top bar over the exit gate and went down. On recovery, this animal and another lamb, were removed from the race test, but subsequently rejoined the group for slaughter. Although not overtly dangerous, the incident suggested that further design input was required to the prototype race to minimise the risk of injury or carcass damage.

The importance of database management was also highlighted. Initially the database on the laptop (expecting two alpha numeric characters – UK), could not process the three alpha numeric characters (EID) specific to the test tags. A brief adjustment to the field, by removing one alpha numeric character, restored functionality, and allowed the test to proceed successfully.

12.4 Pre-stunning reading – kill line

In order to use EID to collect and feed back carcass information, sheep must be read once they have entered onto the slaughter line, and the integrity of the kill order retained as the lambs are processed.

The first test at the South West plant involved a pre-stunning read of lambs moving up the elevator line to the point of stunning.

12.4.1 Materials and Methods

Equipment and software

The reading system, comprising two panel antennae, was installed on the elevator leading to the stunning point by removing two side panels on the race. Data were fed back via cables to controlling units and a laptop. Data files containing the transponder electronic number, animal ID and kill number were created for each batch of sheep for each supplying farm.

Test animals

Finished lambs were obtained from four participant farms, two from each supplier. The elevator speed was within the normal operating range (approximately 300 per hour) as determined by the abattoir. Each farm was put through separately.

12.4.2 Results

Overall, 96% of all EID animals were read through the race. The non-read rate was exclusively in FDX-B technology (Table 69).

Table 69. Reading performance and integrity of kill order (in line panel reading)

Device	HDX / FDX-B	Total Presented	Total read	% read	Reversals (as % of tags read)
Earlsmere foldover tag	FDX-B	56	53	95	6
Destron midi bolus	FDX-B	50	48	96	6
Allflex button	FDX-B	118	112	95	11
Allflex standard bolus	HDX	31	31	100	0
	Total EID	255	244	96	9
No EID device	N/A	14	N/A	N/A	

When compared with the kill order, as recorded by abattoir staff, the order in which the EID devices were read was reversed in approximately 9% of cases (11%, if HDX standard bolus are excluded). This could be because of the interaction of the reading field, with the strength of signal coming from devices, and the behaviour of sheep climbing the elevator race. Adjustments to the software logic would be required to eliminate the possibility of this occurring.

Two animals, which should have carried midi boluses, were not read in the elevator race. The same two animals failed to read ex-farm, when tested using a handheld reader. One of the non-read boluses was recovered in the gut room, and its read distance to a handheld reader subsequently shown to be much reduced. It is reasonable to assume the other bolus was also present in the animal, but did not read, because of complete or intermittent failure.

A key feature of siting the reading equipment on the elevator race is that there is no opportunity to shed off an animal that does not read. It has to be dealt with in the race, or let go through the system, and catered for post slaughter. Dealing with it in the race would be far from ideal, given the likelihood of slowing the slaughter line and increasing labour costs.

12.5 Post slaughter reading – fixed antenna

The advantage of post slaughter reading is a position already fixed in kill order. Two fixed panel tests were carried out post slaughter at the Midlands abattoir.

12.5.1 Run 1

Materials and methods

Equipment and software

The system was installed the day before the run. The antenna was mounted at the end of the dripping bath, just beyond where the carcasses turned 90^{o} after stunning and bleeding, at the point where the teeth were checked and the head removed. The antenna was mounted approximately 500 mm off the wall, to account for the distance between the wall and the track from which the carcasses were suspended.

The major hardware components of the system comprised of an automation controller, providing communication and timing of an ISO 11784/85 reader, proximity detection, indicator lights and a data link to a laptop computer. The laptop software gave a front-end interface that provided start/stop signals to the automation controller, vendor selection, reports and counters including kill number.

As the lambs were processed, the system provided a degree of line control by detecting the presence of a carcass using a photocell. This in turn activated the read cycle of the antenna to read the device as it entered the radio frequency field. The read cycle was maintained until a device was read or a timer elapsed.

The transfer of the 16-digit number to the laptop signalled a device read. When the read cycle timed out (after eight seconds) a ‘no-read’ condition was transferred to the laptop. On receipt of either of these signals, the software incremented the kill number. A ‘no-read’ counter was also displayed which gave indication of a carcass detected by the sensor, but where a device was not read within time frame allowed. These conditions were also visually displayed to line operators by a green light for a successful read, and a flashing orange light for ‘no-read’.

Two output files were created, one listing successful reads by electronic and management number, and the other a list in kill order of animals present but not read. Software on the laptop recorded individual kill order number, and then incremented separately for total and unsuccessful reads.

The software was also programmed to account for the possibility that an animal entering the field might not be recognised on the database. In this instance, the animals identity would still be recorded and the result flagged up separately.

Animals and EID devices

A total of 140 lambs were used for the run, carrying the full matrix of technologies (Table 70).

Table 70. Source and type of devices tested

Device	Technology	No. of animals presented	Interval (hrs) to last verified read (handheld)
Earlsmere foldover tag	FDX-B	30	60
Destron midi bolus	FDX-B	30	36
Allflex button	FDX-B	30	60
Allflex button	HDX	20	84
Allflex standard bolus	HDX	20	84
No device	N/A	10	N/A
	Total	140	

To ensure they were carrying electronic devices, all test animals were individually read on farm by project staff, using a hand-held reader, 1-3 days before slaughter. Individual identities of all the test animals were taken before the test run. As the animals were processed, the ear tag numbers of lambs which triggered an orange 'non-read' light were taken in sequential order by project team staff. Carcass data and abattoir kill order numbers were obtained from the abattoir as a further cross-reference.

<u>Results</u>

Overall read performance

One lamb was put through the slaughter line, before the software was set up to capture the data. The number of this animal was known, and has been removed from the data set. On this basis, effectively 29 lambs were put through in the first batch and 139 for the test run in total.

Summary output from the software recorded 137 carcasses detected, 74 successful reads and 63 unsuccessful attempts to read an animal, of which 10 animals carried no device.

The results of examining the software output on an individual animal basis are given in Table 71. The number, by farm, of individual lamb IDs successfully captured by the software are given in column B. The result (137) of combining the total number of successful reads (74) with unsuccessful reads as determined by the software (63) may be compared with the total effective number of animals presented (139).

A total of 60 lambs were recorded manually has not having read, on the basis of an orange rather than a green light on the indicator.

Table 71. Number and proportion of successful and unsuccessful reads

Device	Technology	Total (A)	No. of reads - software (B)	No. of non reads – deducting (B) from (A)	No. of non reads – by light indicator
Earlsmere foldover tag	FDX-B	29	24 (83%)	5 (17%)	5
Destron midi bolus	FDX-B	30	14 (47%)	16 (53%)	14
Allflex button	FDX-B	28	0 (0%)	28 (100%)	27
Allflex button	HDX	20	16 (80%)	4 (20%)	4
Allflex standard bolus	HDX	20	20 (100%)	0 (0%)	0
No device	N/A	10	0 (0%)	10 (100%)	10
	Total	137			
Less 10 with no device		127	74(58%)	53 (42%)	

Read performance by slaughter group

Group 1(FDX-B tag, Earlsmere foldover)

For this group there was a very good match between the visual indicator light and the data captured by the software. The software did not read five of the 29 lambs, and these same lambs were also recorded manually as non-reads.

Group 2 (FDX-B midi bolus)

Less than 50% of the midi boluses (FDX-B) were read by the software. However, two further lambs were manually recorded as having been read on the basis of the indicator light. This could be a genuine result, or potential operator error.

Group 3 (FDX-B tag)

The software captured none of the Allflex FDX-B button tags. However, three of the animals were manually recorded as successful reads (i.e. a green light). While this result could again be due to operator error, a different team was recording at the time.

Group 4 (mixed HDX tag, HDX standard bolus, and non EID lambs)

All HDX boluses were read, but only 80% of HDX tags. The software was 100% successful in identifying animals known not to carry an electronic device. There was an exact match between the animals identified by the software as non-readers, and those manually recorded as such.

Overview (Run 1)

The whole batch of 140 lambs took 1 hour and 46 minutes to slaughter (approx. 80 per hour). The test run was estimated by abattoir staff to have taken approximately 15 minutes longer than normal. This was mainly due to limiting the bunching up that might normally occur over the drip bath, in order to avoid carcasses coming too close and breaking the beam on the sensor. However, it could also be expected that the presence of observers and data recording staff during the test run might also have reduced the operating speed of the line, compared to normal operation.

The overall success rate of 58% was well below expectations. Only those animals carrying HDX bolus or known to carry no device were read with 100% accuracy. The best reads in ear tags (approx. 80%) were obtained from Earlsmere foldover (FDX-B) and Allflex button (HDX) tags. Although all the boluses were not recovered *post mortem*, it is reasonable to assume (i.e. some were recovered which were not read) that the poor read percentage in the midi bolus was down to the system (device/technology/reader) or orientation, rather than bolus loss.

It may have been entirely co-incidental, but the best reading was obtained from the first and last batches of animals processed. Various pieces of electrical equipment e.g. blood pumps, were cutting in and out during the intervening period. Virtually none of the Allflex FDX-B tags were read, and a sample was taken for performance testing. It may be that some interactions occurred depending on the device and type of technology, which could be further affected by the overall level of (or fluctuations in) the electromagnetic ‘cleanliness’ of the abattoir background environment.

The absolute success rate observed may not have reflected exactly the total number of devices read by the antenna, due to the design and operation of the system. The system was dependent on the manual input of a vendor name prior to processing the relevant batch of animals. To select the vendor, and allow for any work to be carried out on the line, the system was designed to stop. This disabled the sensor, so that any carcass that passes would not have triggered the read cycle. This occurred on at least one occasion. Furthermore, the height at which the antenna was mounted in relation to the variation in carcass length was not optimal (to suit tag and bolus) particularly for the batch of FDX-B button tags.

12.5.2 Run 2

Materials and methods

The second run improved the ergonomic design of the system, which included entry and exit triggers, and a three light system to indicate read status. A sub-sample of ten lambs were killed the day before (to test the position and operation of the panel antenna), so the test run was made up of 154 lambs. These represented a range of tags/bolus FDX-B and HDX technologies, plus a number of animals known not to carry an electronic device.

Results

The test added approximately 10 minutes to normal expected kill time - 154 animals were killed in just under two hours. The proportion of reads obtained, by category of device, is given in Table 72 below.

Table 72 Number and proportion of successful and unsuccessful reads

Device	Total presented	Total non-reads	% Non reads
Allflex FDX-B button	26	5	19.2
Allflex HDX button	39	0	0.0
Allflex standard bolus	17	2	11.8
Earlsmere button	15	0	0.0
Earlsmere foldover	12	1	8.3
Earlsmere midi bolus	15	5	33.3
Earlsmere standard bolus	15	4	26.7
Grand Total	139	17	12.2
No EID device	15	15	100.0

All Allflex HDX, Earlsmere FDX-B button, and all but 1 Earlsmere foldover tag were read. The highest rates of non-read were in FDX bolus (both midi and standard). In total, 12% of all animals carrying an EID device failed to read.

Significant electromagnetic interference was noted during the operation. Over 50% of carcasses had to be manually orientated towards the antennae by the operator before being read. The antennae appeared to work better when running off an independent battery supply. Unfortunately, the battery was not matched to the voltage on the indicator lights, and the equipment had to revert to mains supply for the test run. The quality of the earth was considered critical to reading performance.

12.6 Post slaughter reading – stick reading system

A stick reading system was used during two test runs at the North East abattoir, to demonstrate the potential for carcasses to be read over the drip bath, before the heads were removed.

12.6.1 Materials and methods

Two, differing stick readers (Class 1 Bluetooth and Radio Frequency) were used. Each stick reader was capable of holding up to 1600 identities, which could be downloaded to a file on a laptop situated approximately 3 m away from the drip bath.

In a preliminary demonstration, a robust link to a laptop (i.e. base station) was not available. For the second test, only the Bluetooth reader was used, reading back to software on the laptop.

12.6.2 Results

Preliminary demonstration

In effect, the first demonstration was a test of principle in reading devices. Both types (Bluetooth and RFDC) of stick reader performed similarly (Table 73).

Boluses were more difficult to detect than tags, which were clearly visible to the operator. One midi bolus which was present pre-kill, could not be detected in the carcass suspended over the drip bath. This was a different bolus to the one which could not be detected with a Destron hand reader prior to the test.

Table 73. Reading performance (stick reading system)

Device type	HDX / FDX-B	Total presented	Total read by stick reader	% accuracy
Allflex button tag	HDX-B	15	15	100
Earlsmere midi bolus	FDX-B	14	13	93
No device	N/A	1	0	100

Test 2)

In contrast to the first run, all boluses were successfully read by the stick reader, and one tag was missed (Table 74).

Table 74. Reading performance (stick reading system)

Device type	HDX / FDX-B	Total presented	Total read by stick reader	% accuracy
Allflex button tag	HDX	14	13	93
Earlsmere midi bolus	FDX-B	14	14	100
No device	N/A	2	0	100

Comparing the kill order taken manually, with the output from the stick reader, there was an exact match for the first half of the slaughter group. Thereafter, the kill order on the stick was disrupted. This occurred at a point when reading on the stick 'timed-out', and had to be reset to a longer time out interval.

The test indicated the need for further development in the operation of the stick reader, to improve its usability and reliability in the abattoir environment. Although a read triggered an audible beep, the noise in the plant made it impossible to hear. Therefore, the operator was reliant on a green light showing, or reading the number on the screen as it incremented. Boluses were more difficult for the stick operator to detect. To be certain whether a bolus is present or not, a clearer signal needs to be in-built to the reading system, to confirm to the user that a successful read has taken place.

12.7 Bolus recovery

In order to determine whether any non-read might have been due to bolus loss or bolus failure, the Pilot Trial aimed to recover as many boluses as possible during the abattoir tests. The attempt by abattoir staff to recover boluses post slaughter was rigorous at all sites. Abattoir staff were made aware of those batches which were expected to contain boluses - but this could have been complete or part batches, depending on whether single or mixed technologies were used for that test group.

The best rate of recovery was in the North East plant (Table 58), possibly because a slower rate of throughput left more time in the gut room for a comprehensive search. A hand reader was only used once (first run in the North East), to assist in location of boluses.

Overall, 92% of standard boluses were recovered, compared with 76% recovery for the smaller midi-bolus; 19% of all boluses got through the check (Table 75).

Table 75. Bolus recovery rates (all test runs)

Site	Run	Device type	Total presented	Total recovered	% recovery
South West	7 Dec 04	Standard (HDX)	31	31	100
		Midi bolus (FDX-B)	50	43	86
	24 May 05	Midi bolus (FDX-B	63	47	75
Midlands	28 Jan 05	Standard (HDX)	20	17	85
		Midi bolus (FDX-B)	30	17	57
	11 March 05	Standard (HDX)	17	14	82
		Standard (FDX-B)	15	14	93
		Midi bolus (FDX-B)	15	8	53
North East	19 May 05	Midi bolus (FDX-B)	14	13	93
	14 June 05	Midi bolus (FDX-B)	14	14	100
		Total	269	218	81

At the North East abattoir, it was noted that a relatively high proportion of boluses were recovered from the reticulum, rather than the rumen. In that instance, location in the reticulum may be due to the short interval between bolusing and slaughter. However, in term of bolus recovery it is important to note that the reticulum is often discarded, whereas the rumen is usually sent for further rendering.

Abattoir preference is for tags, because they are so visible, particularly given the difficulties of bolus recovery. Evaluating approaches to bolus recovery was not within the scope of the Pilot Trial. Recovery rates were reasonably good. However, the abattoir staff knew they were present, and had been asked specifically to recover them. Neither will boluses be well received by the renderers, who it is feared may take the opportunity to reduce the price of offal. As with the auctioneers, gearing up to one system (and, for them, ideally tags) would be preferred. Stomach contents, presumably including a proportion of boluses, if they are present in the live animal, are usually spread onto land. The Environment Agency has expressed some concern regarding boluses spread onto land. Where a bolus ends up depends to a degree on where it lies in the digestive tract, which can vary. In the past, anthelmintic boluses in cattle have created mechanical problems at the abattoir, depending on how the paunch contents were handled (i.e. pumped or blown). If a future need for bolus recovery is highlighted, it is likely that automated systems will have to be developed.

12.8 Overview and implications for sheep EID

The three approaches tested provide options for consideration by the abattoir sector in meeting the requirements of the Regulation on EID in sheep.

If the requirement was simply to read animals onto the abattoir premises, a lairage reading system was demonstrated with a high degree of accuracy. Some refinements may be required to design and operation in order to minimise the risk of injury or carcass damage. The potential advantage is the ability to deal with non-EID animals before they are slaughtered. The disadvantage is that unless positioned on the kill line, at a point where animals can not change their order in the race, identities will not collected on the basis of kill order. Depending on the work routine, use of a separate race reader is also likely to increase labour inputs. Also cited by the abattoir, as a potential disadvantage of the race reader, was increased stress on the animals prior to slaughter, arising from being pushed through yet another race. Given appropriate legislation to deal with non-reading animals, there is probably little application for a race reader system into lairage (or at the foot of the elevator race), for a plant which wishes to have the option of going beyond the minimum required by the Regulation.

Occasionally animals can jump out of order on the elevator race. However, providing suitable software is developed to account for potential electronic reversal of kill order, positioning EID reading equipment on the elevator race is feasible and less likely to increase labour requirements compared to a separate race reader. A stick reading system might also be workable, as a person is required to be present to oversee lambs entering the race. T he potential for human error is a factor, which theoretically could be reduced by appropriate software, indicator lights, etc.

In terms of minimising the impact on the operations of the plant, post-kill reading in effect means dealing with a captive audience. Maintaining the integrity of the kill order is fundamental to accurate carcass feedback. The relationship between where the EID is taken (before head and stomach are removed), and how carcasses are moved during the dressing process to the weigh point is critically important. Although carcasses do occasionally fall off the line, with care in handling and to avoid bunching, reading in kill order will be maintained. Once the kill sequence has been established, protocols will be required to handle any deviation. Adjustment to the slaughter and dressing line may be required in some plants.

Abattoir staff themselves felt the optimum reading position post slaughter was at the drip bath, just before the point where the head comes off. If kill order was not required, a panel antennae system in the elevator line could be sufficient to meet legislation simply to read animals. Positioned in the race there would be no break of flow. If kill order could be affected by carcasses being diverted on several lines, the best place to site the reading equipment would be at the weighing and grading point. However, by that time the head and stomach has been removed. Retaining plant internal batch and kill order numbers was preferable to any system based on externally provided individual random numbers, which would not be workable in practice.

Within this Pilot Trial, an inline panel reader situated at the end of the drip bath was the least successful method tested. However, it is worth emphasising that none of this equipment was set up as a permanent installation. Commissioning, and subsequently adjusting and refining, a permanent installation could be expected to result in a significant improvement. The electromagnetic characteristics (‘cleanliness’) of the site will also have a significant impact on the performance of EID equipment. The abattoir work carried out in this Pilot Trial suggests that differences between HDX and FDX-B technologies may become more apparent in challenging environments.

The principle of a Bluetooth stick reading system was demonstrated. For a small multi species plant, a stick reading system post stunning, post bleeding could suffice, particularly if stunning and bleeding is done on a batch basis. Ergonomic refinements more suited to an abattoir environment are required. Within the NE plant participating in this Pilot Trial, lambs are usually slaughtered and bled in batches of 10-12. A suitably positioned stick reading system (possibly operated by the slaughterman bleeding the animals) would have little effect on the overall rate of throughput. Abattoir labour is often transient, a mixture of skilled and unskilled staff, and implementing systems of EID tended to be seen by the abattoirs as tasks orientated towards foreman or supervisor personnel.

The overall view of the participating plants was that there is technology available which with adequate installation and refinement could do the job. Comment was made as to the robustness of the equipment, for example resistance to water during washing down, etc. One breakdown a month would be far too much. Nevertheless, teething problems with installation and reliability at the abattoir could be ironed out. In the future (perhaps as early as 3 years time) image grading for sheep carcasses may be possible, and cost effective in the larger plants, providing more objectivity and a perception of greater transparency in carcass assessment. This would assume greater importance if more meat were sold in boneless form, where carcass yield is important.

All three participating abattoirs felt that the biggest practical problems with EID were likely to occur at farm level. Another concern was the potential for adverse effects on flock profitability, in addition to CAP reform, which could affect the supply base for the abattoirs.

13 COST:BENEFIT

13.1 Objectives

One of the key objectives of the Pilot Trial was to identify any cost:benefit to be gained through use of EID/EDT.

13.2 Approach

At various stages through the Pilot Trial, perspectives on the likelihood of cost:benefit were collected from farmer, auctioneer, abattoir and opinion leader participants. Feedback was also taken from the sheep industry surveys conducted in June 2004 and May 2005.

13.3 Results and discussion

13.3.1 Farmer cost:benefit

Cost:benefit data

Given the duration of the Pilot Trial and the experience of participants to date, quantifiable data has not been produced demonstrating additional benefits of EID at farm level. The cost side of the EID system is relatively straightforward to calculate. Table 76 is based on the costs of EID devices and equipment used within the Pilot Trial

Table 76. Establishment and running costs of farm-based EID at current prices

Flock size	Tag system - ewes and lambs		Bolus system – ewes (lambs tagged)	
	Allflex	Earlsmere	Allflex	Earlsmere
Establishment				
250	10.95	8.95	11.95	10.92
500	8.35	6.10	9.35	8.07
750	7.48	5.15	8.48	7.12
Running				
250	3.75	1.85	4.02	2.53
500	3.65	1.75	3.92	2.43
750	3.61	1.72	3.89	2.40

The establishment costs of inserting devices in every animal, and to purchase a hand reader, software, PC and printer could vary from £5.15 to £11.95, depending on the size of flock. It is assumed that the price of hand readers will remain similar to today's prices, although functionality might be expected to improve. No direct or indirect training costs are included in these figures.

Given that the Regulation requires EID for animals born after 1 January 2008, in practice there would be no statutory requirement to insert electronic devices separately in the breeding flock.

The costs of maintaining EID in the flock once established would be significantly less (£2.12 to £4.55 per ewe), assuming that all replacement sheep (home bred or purchased will carry an EID device). In the bolus option, only those lambs intended as flock replacements have incurred the increased marginal cost of a bolus compared with a tag.

If volume production of devices drove down prices, for example to £1.50 for a ewe bolus, £1 for a ewe tag and £0.50 for a lamb tag, EID costs would fall proportionately (Table 77).

Table 77. Costs of implementing EID on an assumed future scenario

Flock size	**Tag system - ewes and lambs**		**Bolus system – ewes (lambs tagged)**	
	Allflex	Earlsmere	Allflex	Earlsmere
Establishment				
250	7.03	7.53	7.53	8.03
500	4.43	4.68	4.93	5.18
750	3.56	3.73	4.06	4.23
Running				
250	1.03	1.03	1.29	1.29
500	0.93	0.93	1.19	1.19
750	0.89	0.89	1.16	1.16

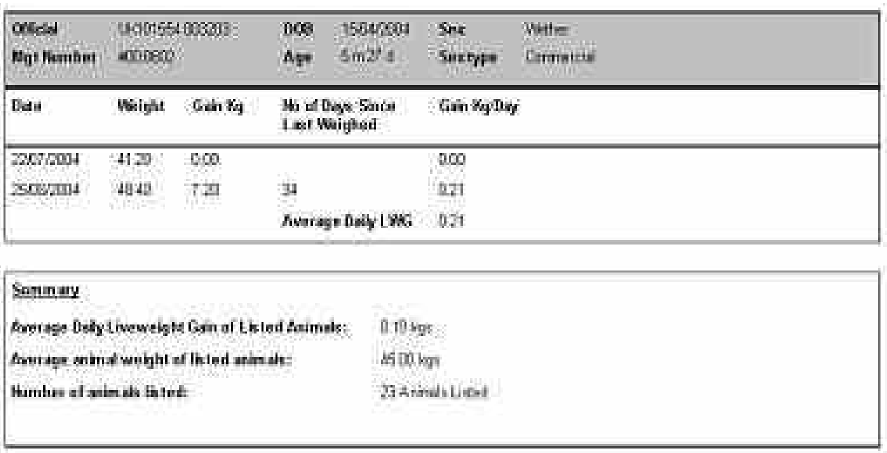
However, this is not to suggest that participants did not perceive potential benefits.

Views of trial participants

During the pre-trial participant discussion groups, farmers were asked to consider potential cost:benefits from the on-farm implementation of EID/EDT. While not readily identified at that early stage, participants tended to focus on the provision of individual carcass feedback from the abattoir sector. This information could then be used to make management decisions in some, but by no means all, flocks. At that early stage, participants remained unconvinced of the ability of EID systems to deliver benefits and looked to the trial to provide them with the opportunity to explore how they might be realised.

As part of the interim evaluation, participants were asked to set aside any systems issues that they may have encountered and to identify what, if any, benefits they envisaged from the successful use of EID/EDT for flock management purposes. Responses fell into four distinct categories – those that did not see any potential benefits, those that saw benefits for pedigree breeders but not in purely commercial flocks, those that perceived benefits to have been derived already from their involvement in the Pilot Trial, and those that anticipated potential benefits.

Six of the 49 respondents saw no potential benefits - four of whom stated potential benefits as *“none”*, with two describing *“no benefits over the existing paper system.”*



Six of the 49 respondents cited potential advantages for the pedigree sector.

A single respondent stated that their involvement had yielded valuable flock information.

> *"I am learning some interesting management information which will be useful in future planning, such as how different ages of ewes are performing. Now that I have the equipment, I shall probably continue to use EID in the future. However, I don't think that a normal sheep farmer would find this information so useful. I have always kept a lot of records, and on computer, before."*

The remaining 36 respondents described a range of potential benefit, including:-

- Improved flock health
    - better health/medicine records (10)
    - Targeted culling (5)
    - Targeted feeding (1)
- Improved flock performance
    - Individual carcass feedback (6)
    - More accurate flock physical and financial information (3)
    - Increased lamb growth rates (1)
- Improved breeding
    - Selection of breeding stock (8)
    - Follow-through of breeding/mating data (3)
    - Improved ewe performance data (2)
- Improved flock records
    - Improved flock management – unspecified (8)
    - Movements and traceability (6)
    - Compliance with assurance schemes (3)
    - More efficient recording of flock management data (2)
    - Flock security represented by bolus (2)
    - More efficient animal identification (1)
    - Less paperwork (1)

A summary of these potential benefits was then presented to the post-trial discussion groups to stimulate discussion regarding the extent to which these potential benefits had been realised, or at least appeared to be achievable, in the light of twelve months' experience. There was a consensus that these benefits might not be attainable using the systems trialled over the preceding twelve months. Some doubted that they could ever be effectively achieved. A minority felt that they had gone some way to achieving benefit – in one case using their own computer knowledge, and in the other using a paper-recording system.

Time and labour were identified as key constraints to achieving the desired benefits. There was general agreement that individual carcass feedback represented a key benefit, but it was acknowledged that even this would not represent a universal benefit across the industry. At the start of the project, participants needed to be convinced of the potential benefits of EID/EDT systems in their flocks. Twelve months later they remained to be convinced.

> *Benefits are what we want, we're all after all those – we need a system that works first.*

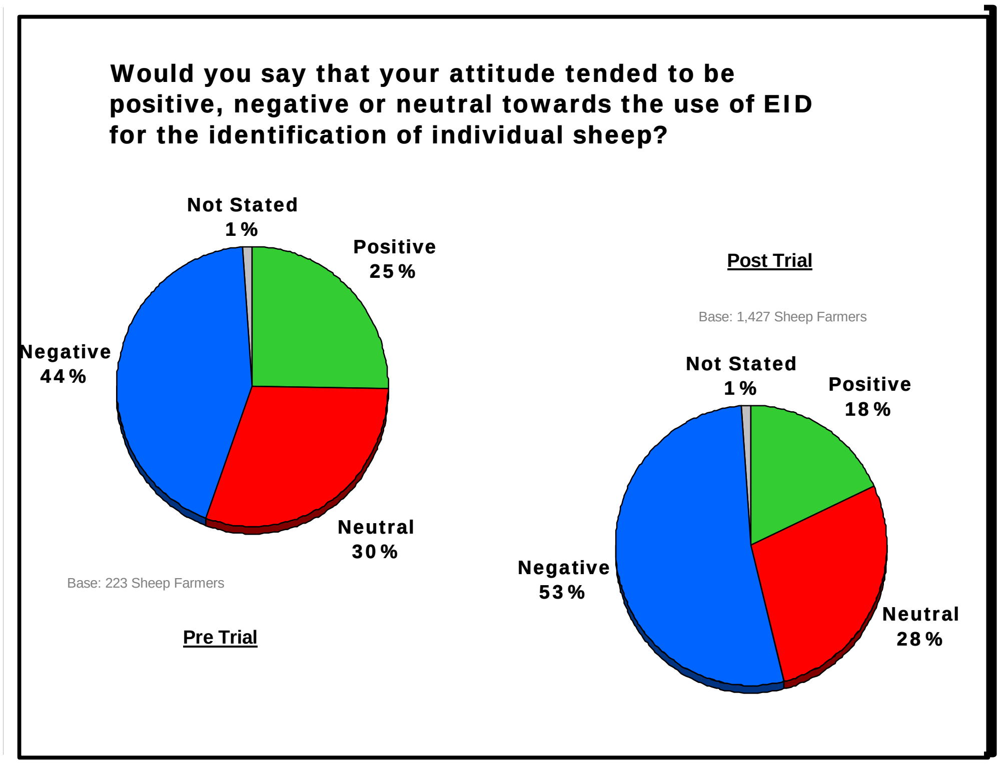
In terms of application, feedback from participants indicates that the majority of farmers currently have information systems for managing their flocks that meet their particular information requirements. These information systems have been developed over time and use a range of approaches. A characteristic of most is that the information is stored on the animal in the form of coloured tags, spray markings on the fleece, notches in the ear, location of animal, characteristics of the animal (size, condition) and even recognition (and naming) of individual animals.

As well as the information on the animal, most of the participants mentioned their own record books/diaries, which may contain a substantial amount of information, and these are typically carried around in a pocket or stored in the lambing shed, so they can interrogate the information in the field. Many mentioned the ability to look in a field or pen of sheep, and being able to immediately identify, for example, those ewes that they intend to cull. They then related this to the electronic systems, where interrogation of the flock data had to be undertaken in the office, away from the animals. A number of participants commented that a system which reflected their own field notebooks might be useful, but on further consideration felt that the cost would be high, and wondered about its value when they had a paper-based management system which already worked adequately.

Views of the broader sheep industry

Respondents to the sheep industry surveys conducted as part of the Pilot Trial, were asked which of three options – positive, neutral or negative - best reflected their attitude towards the use of EID to identify individual sheep. In the pre-trial survey, 25% described their attitude as positive (Fig 10). In the second survey, this proportion had slipped back to 18%. The proportion of respondents who described their attitude as negative increased from 44% to 53%. Attitudes were more likely to be positive among lowland producers (20%), relative to upland (14%) and hill producers (12%). At 64%, almost two-thirds of upland producers described their attitude as negative, as did 56% of hill producers and 50% of lowland producers.

Figure 10. Attitudes towards the use of EID for identification of individual sheep



Consistent responses were obtained from both industry surveys, when sheep farmers were asked to describe their perceived positives and negatives in relation to the application of EID on farm. In the second survey, those 255 respondents whose attitude towards EID was described as positive, prioritised:-

- accurate traceability/fast identification (66);
- good records/animal history (44); and
- help with flock development/breeding schemes (34).

Of those 97 respondents that cited a negative attitude towards EID in the pre-trial survey, over half cited concerns about cost (53), ahead of time concerns (21), little or no benefit (20), too much additional work (20) and potential loss of electronic identifiers (18). From 753 respondents who described their attitude towards EID as negative in the second survey, for the majority (416) cost and expense was the primary concern. This was rated higher than time concerns (152), too much additional work (150), reliability and robustness of electronic equipment (124), and potential loss of electronic identifiers (120).

Moreover, almost half of those 255 respondents' who described themselves as positive towards EID expressed concern about potential costs (107). These also expressed reservations with regard to the reliability of equipment (41) and loss of electronic identifiers (38).

In the second survey, 55% of all respondents perceived negative consequences for the English sheep industry (c.f. 51% pre-trial), and 56% expected negative consequences for their own business (c.f. 48% pre-trial). A lower proportion (12%) identified positive benefits for the industry rather than for their farms (16%). Some two-thirds (69%) of respondents felt that the Regulation posed a moderate to high risk to the continued viability of their sheep enterprise.

Assuming that EID was implemented, 31% of respondents indicated that they would be likely to use electronic identification to increase flock recording, with the aim of improving performance and offsetting the additional costs. At the other end of the scale, a total of 51% (c.f. 40% pre-trial) stated that this was unlikely.

13.3.2 Livestock Auctioneers

At the end of the market tests a consultation meeting was held with the LAA. From their perspective, the implementation of EID was viewed against a background that auction markets must continue to sell lambs, create competition, set prices and provide a service to customers. In the eyes of the auctioneers, the Pilot Trial served to highlight potential costs, not only in equipment, but also in terms of manpower. Under existing trading conditions, market profitability was described as very tight, and likely to be squeezed further by CAP reform, and the prospect of falling lamb prices.

> *"At the end of the day we have to remember we're all handling stock, be it ourselves, be it slaughtering – it's a business not a tag-reading service that we run. Ultimately, it's here to make our job easier, not more difficult and pile on costs."*

No immediate prospect of cost:benefit was held as a result of introducing EID, apart from removing the need to read tags manually. Based on experience of reading individual animal numbers for the export trade, it was estimated that the equivalent of almost 1 man day was required to read and record the tag numbers of a single lorry-load (c.400 head) of sheep. Electronic systems were unanimously perceived to represent the only practical means of implementing individual animal identification and recording, in the commercial livestock market environment.

> *"That's the option – electronic tagging OR a (manual) system like that – and there's absolutely no question which we have to have."*

Against a background of reducing margins there was major concern as to who will carry the cost. With little prospect of costs being absorbed downstream from the markets, they were likely to fall on either the primary producer or the auction markets. The consensus was that commission rates would not bear an increase to cover the additional costs associated with EID.

Many auctioneering firms operate at more than one site, which has implications for the likely scale of investment that might be required, and demand for flexibility/portability of systems capable of covering more than one site.

The potential knock-on effects of the implementation of individual animal identification on hauliers were also noted. These included potential delays caused by reading sheep that could have ramifications on operators' costs, working time directive and potentially animal welfare. Particularly so, given that many of the larger auctions in the North supply abattoirs located in the South.

In contrast, the auctioneers believed that benefits were more likely in the abattoir sector, where the provision of individual animal kill data may represent a value to the producer.

> *'For our industry, I'm struggling to find any advantage to electronic tagging compared to what we have now. We are not going to gain any brownie points from the farmer, as we're not selling by classification – all that we'll be doing is putting in another layer of service in order to assist traceability and Defra."*

Were implementation of EID to cut down on the volume of paperwork required in the auction office, this could represent a potential benefit. However, this will not be clear until a number of outstanding issues are resolved e.g. whether information is required to go onto the accounts at the auction market; whether the electronic transfer of livestock movement into and out of the market is to be to the equivalent of BCMS; does the abattoir or farmer receiving the stock notify receipt; do customer bills have to specify each individual ear-tag number; do the numbers need to be on the license rather than the invoice; how the movement document is to be administered if the consignment arrives at the abattoir outside office hours, etc.

13.3.3 The abattoir perspective

The abattoir view is that if the Regulation demands it, equipment will have to be installed. For a big plant processing 400,000 lambs a year the cost per head for a reading system is low – initial installation costs and an annual software charge. There would be little impact on labour costs. Once sheep are on the line, and the information captured, thereafter the system is software driven, with little extra cost. If all tags had to be read manually the cost would be one staff salary (approx. £15,000/year).

Although the Pilot Trial gave no real impression of the costs likely to be involved, in terms of hardware, a factory-based system ought to be smaller and cheaper than farm or auction market equipment. However, any slowing down of the line would be not be well received by abattoir staff who are normally paid on piece work. Adjustments to the kill line or computer systems in the plant to accommodate EID, or the legislative protocols involved, could add significant additional cost.

Several comments were received regarding utilising existing Inspectorate agency staff to read and record tags in sheep, thereby reducing the cost to the abattoir.

The traceability that EID could potentially offer could have significant benefits in terms of automated data capture and feed back to help producers do a better job. Data could also be taken forward and used for better marketing by retail customers. However, retail price sensitivity and number of farmer suppliers limits the value of traceability on an individual animal basis for the large multiples. However, for small butchery outlets or selected export markets, traceability to individual farm would be workable and could have an added value.

There could be significant production and disease control benefits of automatic data capture. The information fed back to producers could improve the relative performance of individual producers.

Abattoirs cannot see any particular benefit to them of individual identification in sheep. The financial benefits of improved carcasses, e.g. increased meat yield, generally end up with the consumer. In a price sensitive volume market, efficiency gains along the supply chain are generally given away in competition. Benefits can be returned down the production chain in terms of feedback to the farmer, but it is generally thought that few benefits can be exploited at the retail end of the chain.

13.4 Overview and implications for the uptake of EID

Given the start date (mid-way through a production cycle) and duration of data collection (15 months) it is not surprising that within the Pilot Trial cost:benefit has been difficult to quantify. In addition, it was never intended that the Pilot Trial would integrate directly with existing abattoir systems for the feedback of carcass data, a key area of potential benefit. However, from the point of view of future implementation, it is disappointing that many participants have still to be convinced that any cost:benefit will accrue. If anything, negative attitudes hardened over the course of the trial.

Without hard data, feedback on potential costs and benefits is limited to the opinion recorded from farmer, market and abattoir sectors. Perceptions were influenced by comparing the costs and benefits of EID with current legislative requirements, which require only batch recording of movements. As indicated by the market sector, from their experience of the export trade, the requirement to accurately read large numbers of tags manually would involve considerable expense. This is particularly so where stock have come from several flocks, carrying various types of tags, with different print sizes and quality of print. In such circumstances, the effective use of EID could be a cost saved rather than a benefit gained. In addition, future cost:benefit relationships will be affected by the prevailing economic conditions, as well as the relative costs of EID equipment, which are also likely to change. The way that the legislation is applied will have a significant bearing on the relative costs and effectiveness of electronic and manual systems.

A high proportion of respondents perceived negative impacts from the introduction of EID, either on the industry generally or on their business in particular. The Pilot Trial recruited from a cross section of the industry, and did not ‘cherry pick’ from those who might be favourably disposed towards EID or the use of intensive flock recording for management benefit. Therefore the perceptions recorded are representative of the industry, and indicate the scale of effort remaining to identify, quantify and promote applications where tangible cost:benefit can be found.

EID in itself is only a method to identify an animal and capture information associated with it (weight, sex, litter size, etc). Some participants felt that current systems of EID limited the opportunity to quantify benefits. However, the technology and labour costs involved in data capture are only the first part of the investment required. In order to exploit the opportunity for management benefits, the management software used alongside EID is fundamental to analysis and interpretation of the aggregated data. This in itself results in a further input cost, in terms of farmer time and effort required to sit down, generate and analyse the management data needed to drive management decisions.

When assessing the potential management benefits of EID/EDT, it is important to recognise the existence, flexibility and value of existing flock identification systems. This is the minimum benchmark against which systems of EID will be judged. User feedback within the Pilot Trial suggested that the speed and efficiency of EID systems were below the expectations of sheep farmers, who had no previous experience of the technology. To benefit sheep farmers, an EID system must be as efficient and user friendly as the flock management system, be it manual or computerised, currently in place on most sheep farms. These are often very simple visual systems, based on recognising particular actions, or information related to particular groups of sheep. Even for flocks of similar types, personal preferences and business objectives will result in different information needs.

Evidence collected from the auction market and abattoir sectors, points to costs having to be absorbed, or passed back to the primary producer.

14 ANIMAL WELFARE

14.1 Objective

The Pilot Trial was set up to evaluate the effectiveness and practical application of EID in the field. It was not designed as a controlled experiment, with control groups, to investigate the occurrence of specific diseases, or to measure secondary or tertiary effects on animal welfare. Nevertheless, welfare was an important consideration. At the outset, there was considerable awareness of the potential welfare impact, particularly of bolusing sheep.

14.2 Approach

Protocols were produced by ADAS, for tagging and for bolusing, with appropriate veterinary input. Participants were trained, or 'refreshed', in the application of tags or boluses as dictated by their choice of electronic device. Health and welfare data were collected through the workbooks, overseen by Project Officers, who in specific circumstances recorded intervention by the farmer or by the farm veterinary surgeon. The cost of any losses was covered in a Compensation Plan for the project, which required confirmation of cause of death through *post mortem* examination.

14.3 Results

14.3.1 Effect of bolus

In over 11,000 sheep bolused, the loss of only one ewe was recorded. This was a Mule ewe which developed an infection in its oesophagus, was subsequently put down, and subjected to *post mortem* examination by the farm vet.

A total of 1600 lambs, above a threshold weight of 25kg, were identified using midi-bolus. No particular problems during administration, or lambs losses due to bolusing, were recorded.

14.3.2 Effect of tagging

Of the two approaches to identification, the greater welfare problems were associated with tagging. Within the Pilot Trial, identification with a bolus automatically meant that a visual tag was also inserted as an external identifier.

The timing of the study was not optimum to minimise the risk of ear infection in breeding stock, in that most breeding stock were tagged in the April – June period. Time of tag insertion was therefore a confounding factor. Ideally most farmers would elect to insert tags from the autumn through to the spring, when temperatures were cooler.

Rate of infection

Earlier in the report data were presented for the proportion of infected ears after tagging. Incidence and severity varied, from a lesser number of more severe cases recorded, to more general occurrence (up to 80%) of mild infection. There were several flocks where widespread and severe infection was recorded. In ewes, there was specific veterinary involvement on three farms.

In lambs, overall rates of infection were low, mainly because the majority were tagged close to when they left the farm.

Greater problems with ear infection (and tag loss) were recorded with button tags compared with foldovers, and Earlsmere button tags compared with Allflex. Foldover tags tend to be lighter and allowed better air circulation, particularly where air movement is further restricted by the length of the male pin relative to ear thickness. There appeared to be little difference in infection rates between closed and open end Earlsmere button tags. However, one observation is that where the button tags do not have a good mechanism to stop the depth of penetration achieved by the male pin, the two parts of the tag may be too tight from the time of insertion. A significant proportion of losses with button tags were due to the ear rotting through between male and female parts of the tag.

Ear damage

A small proportion of ears were damaged at tag insertion, when the sheep pulled back at the wrong moment, before the applicator was fully disengaged. The incidence tended to be higher with two piece tags, and particularly where applicator design slowed the speed of release. It was observed that, in principle, the design of the single piece foldover tag made for easier and quicker application. However, the foldovers supplied had too soft a plastic, which softened in warm weather, to the extent that in 1%-2% of cases the male pins bent and could not be inserted.

A manufacturing fault in the design of the foldover tags supplied was that the two opposing walls of the tag lay together, so the tag tended to form a loop. This loop tended to rotate in the ear, and slow the rate of healing.

The size and weight of the Allflex button tag supplied, was thought by many farmers to be too large for insertion in day old lambs.

The design of the Earlsmere open end tags meant that the male pin often protruded beyond the female, such that the sharp point caused irritation and infection on the sheep's head.

Problems of tag design were not restricted to electronic tags. One of the paper comparator farms had to remove all the button tags because it was found the pin supplied was too short to accommodate the thicker ears of Dorset sheep. The tags were replaced by a design with a longer pin, without further problems.

A second paper comparator, experienced ear damage (droopy or 'crinkly ears) in approximately 15% of Mule gimmers tagged at birth. The effect of tissue damage and changes to the appearance of sheep, is clearly more important in stock intended for breeding.

Other design issues, e.g. jagged finishes on tags, were noted which might also have had an effect on welfare and infection rates.

14.3.3 Other conditions

Joint–ill is not uncommon in sheep flocks, but in most cases occurs at a relatively low level in most years. Nationally the incidence of joint-ill appeared to be significantly higher than normal during 2005 and two severe cases of joint-ill were reported on participating farms in the South West. Both resulted in approximately 20% of lambs being treated for joint-ill, some receiving multiple injections of antibiotic. While a level of joint-ill might be expected on both farms, the incidence experienced this year was out of proportion to that experienced in the past.

Both cases were viewed as typical joint-ill. Lambs at 4-5 days presenting with lameness, with a further indeterminate proportion of stiff lambs. Extensive laboratory analysis at one farm pointed towards the involvement of *S. dysgalactiae*, an organism well known to cause joint-ill. In 11 lambs taken for *post mortem* examination, and clearly suffering from joint-ill, *S. dysgalactiae* was recovered from three animals. Lack of detection of *S. dysgalactiae* in a larger number of lambs may reflect the fact that lambs had previously been treated with antibiotics. Two of the 11 lambs presented had not been tagged, but *S. dysgalactiae* had been cultured from one of these.

Swabs were also taken from both ears in 31 lambs, at the stage they would normally have been tagged. No *S. dysgalactiae* was recovered in any of the 62 samples cultured. Vaginal swabs were also taken from ewes – and *S. dysgalactiae* recovered from one sample in eight. *Aerococcus viridans*, also associated with arthritic conditions, was found in 3 animals examined *post mortem*.

Despite the above, circumstantial evidence from both sites indicated that joint –ill was not present, or was dramatically reduced, in groups which had not been tagged. Both participants felt very strongly that there was an association between tagging and the high rate of joint-ill.

In terms of any predisposing factors, overall husbandry and hygiene had been exemplary on both farms. At one farm, lambs were also scratched for orf, and the significance of this as an entry point could not be ruled out. It was difficult to determine whether the lack of antiseptic used at tag insertion (as set out in the protocol) had any material effect. Examination by a veterinary surgeon did not indicate a purulent infection.

On the basis of the evidence presented, a direct causative link between the incidence of joint ill and tagging could not be proven. It was also difficult to ascertain whether there was any effect of the type of tags used. If there was an effect of tagging, the main impact was expected to be the creation of a wound rather than tag type/design *per se*. The tag being bigger and heavier than might be ideally used in lambs was an unknown factor, worthy of further investigation. The same tags had been used over two years on the reference farm at Redesdale, inserted into smaller lambs (Swaledales), without joint-ill. However, a big tag might be expected to be more stressful.

14.3.4 Overview and implications for the uptake of EID

In terms of potential effects on animal welfare, tags were a more serious problem than boluses. Notwithstanding the time of year the tags were put into breeding stock, in a number of instances at least, the effect on animal welfare was not acceptable.

Tag design *per se* will have as big an impact on the effectiveness of EID (through tag retention rate, and impacts on animal welfare) as the technical performance of the device used. Tag design has a significant impact on ear damage and infection rates, as well as retention rate. The optimum arrangement may also be affected by breed factors such as ear thickness. Tag design for insertion in young lambs needs particular careful consideration. Further data are needed to develop more scientifically based recommendations on tagging technique.

The evidence suggests that further work is required to understand better whether or not tagging lambs under four weeks of age poses an additional health risk, from joint-ill or any other disease or condition affecting peri-natal lambs.

15 WIDER PERSPECTIVES ON THE IMPLEMENTATION OF EID

15.1 Objective

The objective was to get a broader industry perspective on sheep EID, and to verify the extent to which perceptions of the participating farmers reflected those of their peers. This was intended to provide a more robust data set than that which could be achieved from a relatively small sample of 67 trial participants.

15.2 Approach

The views of participants were captured during the structured discussion group meetings and in the interim evaluation questionnaire. In addition, feedback was obtained from surveys of the wider industry in England, the three collaborating abattoirs, and the Livestock Auctioneers Association.

Pre- and post-trial industry opinion surveys were conducted in July 2004 and May 2005 respectively, targeting NSA members in England. Approximately 220 responses were obtained from the first survey. The second produced 1,427 respondents, from a mailing list of approximately 6000 farmers, and as such can be considered a definitive sounding of the English sheep industry. Repeating the survey allowed any shifts in underlying attitudes to be identified.

Opinion Leader interviews were held at the beginning of the Pilot Trial (July 2004), and again at the end (August 2005).

Following the second test-run at the auction market, a meeting was convened with the LAA to document their reactions to the test results and prevailing views on the implementation of EID in sheep. Participating in the discussion were the LAA Chairman, Executive Secretary, Chairman - Sheep Sub-Committee, and a representative from the auction market.

Following the abattoir test runs, a structured interview was also held with management at each of the three collaborating plants.

15.3 Results

15.3.1 Trial Participants

<u>Traceability</u>

In the pre-trial discussion groups, perceived advantages of individually recording sheep were primarily associated with pedigree flocks, and it was expected that electronic systems would make this task more efficient and more accurate. For most commercial flocks, participants anticipated that the disadvantages of individual animal recording – in particular time, labour and cost impacts - would outweigh potential advantages. Exceptions were acknowledged in circumstances where flock-masters had a particular interest in exploiting more detailed flock recording. For the majority, the experience of taking part in the trial had, at best, confirmed these concerns and at worst convinced them that accurate traceability at an individual level could not be achieved.

While there was general satisfaction with the electronic reliability of tags, there was widespread concern at tag retention, and the probable impact of tag losses on maintaining the integrity of any associated records. The chief concerns regarding the use of boluses were lost or intermittent readers.

> *Once you lose a tag, where does the traceability go? We've only lost about 4% but as far as I'm concerned traceability has gone out of the window.*

> *The best flock mark of the whole lot is the nip in the ear – that's fool-proof. They won't lose it, each farm has its own marker.*

Unreliable performance of electronic readers could leave data at risk – for example, where off-farm movements were recorded, any subsequent failure of the reader, before this data could be downloaded, left the records at risk of loss or corruption.

<u>The alternative to EID</u>

Despite the above concerns, there was consensus among participants that to achieve individual animal identification and tracing required the effective implementation of electronic systems. This was not from the perspective of proven EID technology, but more in recognition that paper-systems could not cope with the volume of transactions required. Feedback from the paper comparators highlighted the potential difficulties of managing paper records in the outdoor environment, and the possibility of duplication, where bought-in animals might carry the same management number. If the unique flock number was also to be recorded manually in every case, the task was seen as unworkable.

<u>Interpretation and implementation of the legislation</u>

During the second round of participant discussions, farmers were presented with five key points from the legislation as of May 2005. Initial reactions tended to be ones of despair and disbelief, as they were informed of the potential requirements of the Regulation set against the background of their own practical experience within the trial. A widespread reaction was that implementation of the Regulation could force many producers out of sheep farming and this gave rise to knock-on concerns regarding the potential impacts on the wider natural environment.

> *The key word here is draft – what has to be said loud & clear is that if it's anything like that, it won't work.*

Specific concerns were raised regarding potential impacts on older members of the industry.

> *How do you expect the older farmers to cope with all of this, it will force the older generation out.*

The impacts on time and costs of production were widely quoted.

> *The sad thing is that I think there is good potential for the sheep industry, but this will wipe it out, that's the end of it.*

The prospect of an increased focus on animal recording led some to question whether animal welfare would suffer as a result, given that there are only so many hours in the working day.

> *We won't have time to notice the disease in our animals as we will be too busy recording…time would be better spent eliminating foot-rot.*

Within the stratified nature of English sheep farming, pressures being brought to bear on the producers of breeding stock were acknowledged, and the viability of the store lamb trade was brought into question.

> *For us (hill farmers) what do we do with our store lambs and our breeding females? It will end up adding costs because we will have*

to finish them ourselves. If we can't sell our gimmer lambs, the job's going to grind to a halt and we will all go out (of business).

A potential derogation for lambs less than 12 months of age was seen as a threat to the continued viability of the livestock markets.

My first impression is that it will decimate the markets, if you have to buy tags to send a lamb to market, with the hassle of the reader, everyone is going to send them dead weight and save themselves some money.

The potential derogation also gave rise to confusion since it exempted the vast majority of sheep movements, and ironically those very movements going into the food-chain.

So why are we doing this if there is a derogation for the biggest part of moving sheep. What are the EU trying to achieve through individual IDs? Is it disease control – if there's a derogation for fat lambs, it makes a nonsense of the whole thing.

How can it be traceability if it allows a derogation for those under 12 months of age? Those are the very animals that are going into the food-chain.

It tells me that the EU don't know why they need it – is it Animal Health or Public Health? If it's the latter, this scuppers it straight away that's the very one that should be in. If it's not in, it's bureaucracy gone mad.

Furthermore, a derogation for lambs under 12 months of age going direct to slaughter risked undermining the one key benefit that individual identification could, namely individual carcass feedback from the abattoirs.

A derogation for lambs to slaughter is interesting … that's probably the most important one of the lot. That's where we see the benefit.

These comments were all made against the backdrop of established flock identification systems that had stood the test of time and were tried and trusted. For the majority of participants, the EID technology had fallen short of existing systems in terms of its application and reliability. While some respondents indicated that they would do the minimum possible to comply with the terms of the legislation, others sought answers to questions regarding "missing" sheep, e.g. those in the hill and upland areas that might not be rounded-up from one year to the next. Clarification regarding the proposed tolerance levels of the system was required. At the same time, others expressed concern that anything less than 100% accuracy would risk undermining the credibility of the system and leave it open to abuse. Possible links between sheep identification and cross-compliance led some to suggest that they could not allow the former to compromise the latter, and would rather exit sheep farming than jeopardise their single farm payment entitlements.

We have got to do a risk assessment. If this is one of the pillars of the single farm payment, if we get it wrong, we put all that at risk.

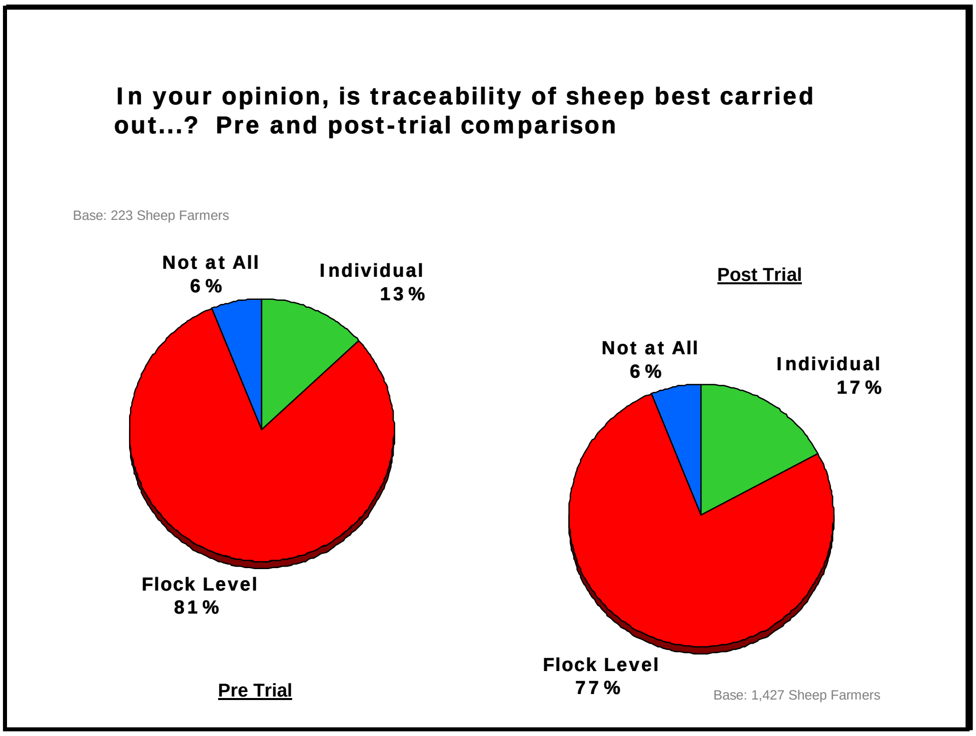
15.3.2 Wider English sheep industry

<u>Traceability</u>

The majority of respondents to the industry opinion survey indicated a preference for traceability at flock level. This may be due to perceived inability to establish and maintain reliable records throughout the supply-chain. Concerns about individual identification of sheep tended to reflect experiences of BCMS. Existing flock-based recording systems – tried and trusted in the farming environment - are the measure against which implementation of EID/EDT will be judged by farmers.

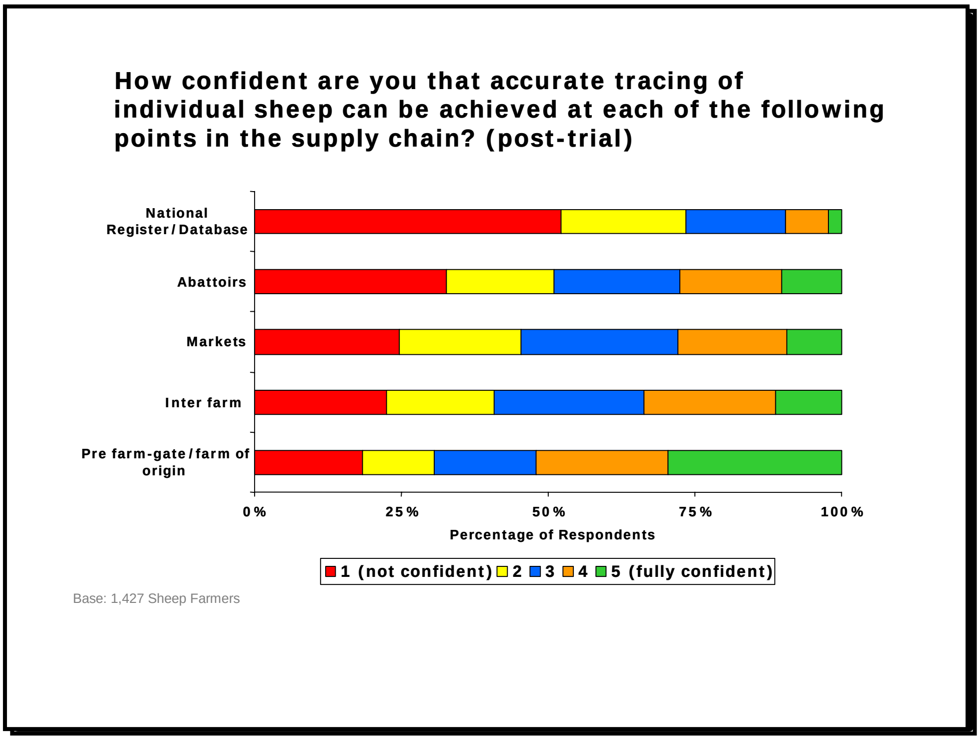
While recognising the need for animal identification and recording, 77% of respondents were of the opinion that traceability in sheep was best carried out at flock level (Figure 11). Compared to the pre-trial survey, the proportion favouring flock recording showed a decrease of 4 percentage points (from 81% pre-trial), while the proportion opting for individual recording increased correspondingly.

Figure 11. Level at which traceability of sheep best carried out



Confidence in the accuracy with which tracing of individual sheep could be achieved through the supply chain declined post-farm gate (Figure 12). This perception was consistent for both pre- and post trial surveys.

Figure 12. Confidence in tracing of individual sheep throughout the supply chain

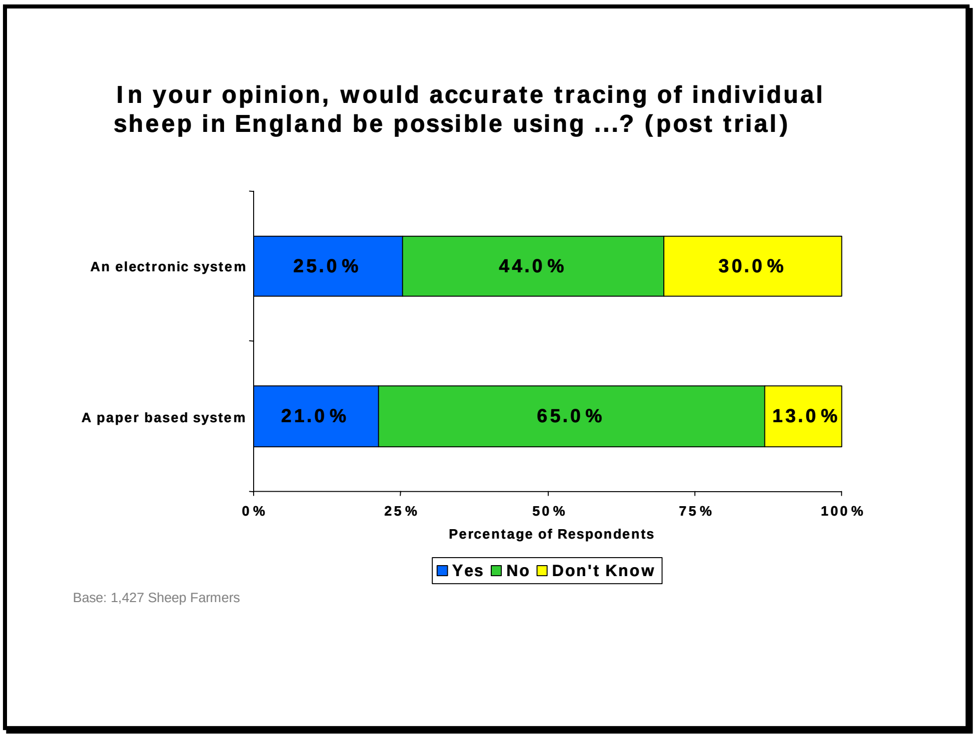


Whereas 18% (c.f. 19% pre-trial) of respondents were not confident that accurate tracing of individual sheep could be achieved pre-farm gate, this increased to 22% (c.f. 25%) for inter-farm transfers, and to 24% (c.f. 26%) at market level. A total of 32% (c.f. 41%) of respondents expressed no confidence that accurate tracing of individual sheep could be achieved at the abattoir. Using the same scale, 49% of all respondents indicated no confidence in the ability of a national register/database to maintain accurate records of individual sheep movements.

The alternative to EID

Approximately 65% of respondents to the wider industry survey did not believe that accurate tracing of individual sheep was possible using paper-based systems, down from 75% in the pre-trial work. However, only one quarter believed that an electronic system provided a viable alternative (Figure 13).

Figure 13. Perceived potential to achieve accurate tracing of individual sheep



Interpretation and implementation of the legislation

At 46%, awareness that the Regulation would require electronic identification and traceability of individual sheep from 1st January 2008, remained unchanged between the pre-trial and post-trial surveys.

Prompted to indicate their preferred option for the identification and tracing of individual sheep, almost half (49%) opted for a fully electronic system with management and transfer of data operated on-farm by existing staff. Slightly fewer (45%) indicated a preference for a manual, paper-based system. The remainder, 6%, preferred the option of a bureau service, with management and transfer of data handled by an external service provider. Pre trial, the proportion selecting each of the three options was 59%, 27% and 5% respectively, indicating a decreasing preference for electronic systems.

Table 78 Preferred approach to implementation – by existing computer use – comparing responses pre and post-trial.

If your business was required to implement identification and tracing of individual sheep within the flock, would your preferred approach be for...

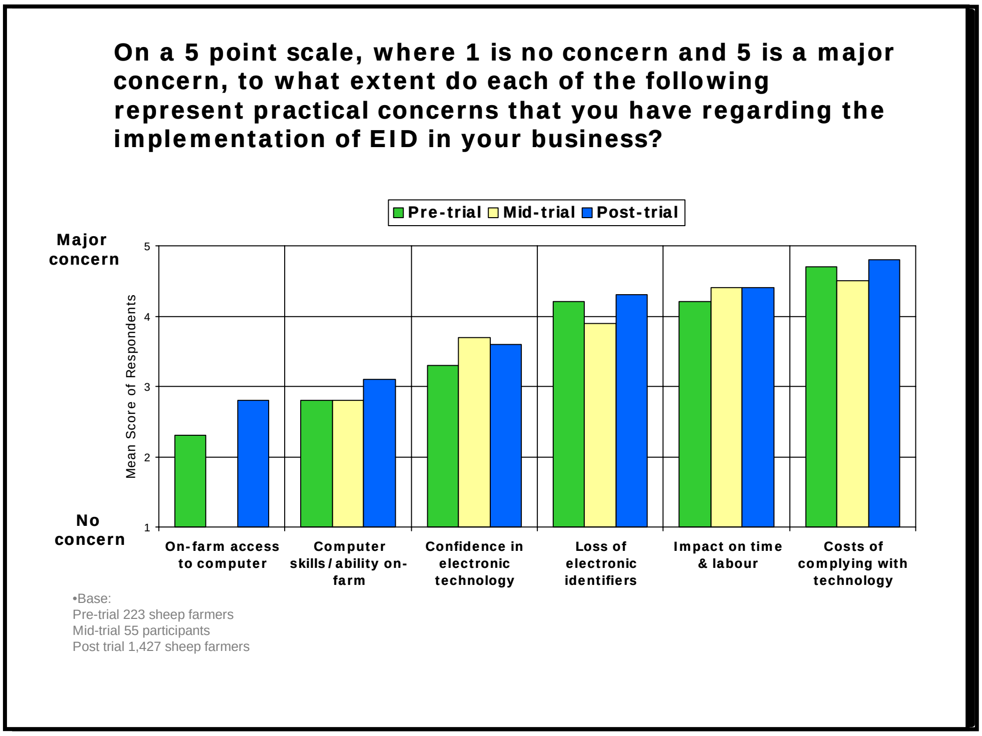
	Total	Computer access and application			
		Yes, for flock records	Yes, for no flock records	No	Not stated
Pre-trial – total number of respondents	223	78	94	49	2
A fully electronic system with management and transfer of data operated on-farm by you/existing farm staff (%)	59	72	64	31	50
A fully electronic system with management and transfer of data operated by an external, off-farm, service provider (%)	5	1	6	10	-
A manual, paper-based system maintained on-farm by you/existing farm staff (%)	27	21	22	49	-
Not stated (%)	8	6	7	10	50
Post-trial – total number of respondents	1,320	400	556	354	10
A fully electronic system with management and transfer of data operated on-farm by you/existing farm staff (%)	49	65	55	21	30
A fully electronic system with management and transfer of data operated by an external, off-farm, service provider (%)	6	7	5	7	-
A manual, paper-based system maintained on-farm by you/existing farm staff (%)	45	28	40	73	70
Not stated (%)	-	-	-	-	-

Base: All respondents selecting one response only

Around 30-40% of all respondents, pre and post-trial, felt they required more information before being able to express a preference for tags or bolus, as an EID device. Where a preference was stated for identifying ewes, this was split between bolus (22% post-trial c.f. 29% pre-trial) and ear tags (31% post-trial c.f. 27% pre-trial). For lambs, tags (38% pre and post trial) were preferred to bolus (12% post-trial c.f. 18% pre-trial). The majority of respondents (58%) would prefer to apply identifiers to lambs as they depart from the farm.

Based on a five-point scale from 1 (no concern) to 5 (major concern), the main concern regarding on-farm implementation of EID were the costs of complying, with a mean score of 4.8 (c.f. 4.7 pre-trial). The loss of electronic identifiers (mean 4.3) and the impacts on time and labour (mean 4.4) also represented major considerations (Figure 14). There was less concern about the technology (mean 3.6), or on-farm computer skills and ability (mean 3.1). At 2.8, on-farm access to a computer was of least concern.

Figure 14. Practical concerns regarding on-farm implementation of EID



15.3.3 Livestock auctioneers

The LAA stated that the auction market sector was willing to change existing working practice in order to facilitate effective implementation of EID. Considerable advancement was perceived over the course of the market tests, particularly in terms of improved accuracy. Although further technological development was required to reach the desired performance levels, for throughput as well as accuracy, the key requirement now was to move on to consider wider issues, e.g. farming costs, and especially the structure of the livestock register database.

<u>Traceability</u>

Existing market systems were deemed by the auctioneers to provide satisfactory levels of traceability. However, it was unanimously recognised that the legislation would be implemented.

> *"(EID is) not a lot of benefit to us, as the traceability is there anyway. Just putting in electronic tags isn't really going to make traceability an awful lot more accurate out of markets."*

The auctioneers felt a live, real-time database was a prerequisite for the introduction of EID, and would at least allow an opportunity to gain maximum advantage from the data collected.

> *"The structure of the database will be critical – what they want, how they need it. This database needs to be up and running before anything is ever electronically tagged."*

A paper supported or retrospective system was seen as being of very limited use. An additional concern focused on the challenge of reconciling market records with farm records.

It was noted that the market trial had run against the background of an established database, e.g. during tests the equipment was recognising individual numbers in a larger, but pre-populated database. In the absence of a live database, auction markets may effectively be required to establish their own sale-day database, and concerns were expressed that this may impact on the speed and accuracy of EID systems at market. Clarification was sought as to how the option of a WYSIWYG numbering system might act as a safeguard in the event of equipment or database failure.

> *"What we've seen so far is a read of tags or bolus that are already pre-entered into a computer system – they are effectively cross-checking against an existing entry. What we will be doing – unless there is a live database – is creating our own sale-day database. This is a massive difference and my understanding is that it will be an awful lot harder to build a database for each sale rather than reference existing records."*

Attitudes towards a potential EID database for sheep were framed against the participants' experience of BCMS. While this BCMS was perceived to have fallen short of expectations, encouragement was taken from systems seen in operation in Belgium and Spain.

> *"On a recent visit to Spain we saw passports scanned live, straight into the equivalent of BCMS – real-time – absolutely unbelievable. You knew at once whether there was a problem, if that animal shouldn't be in the market. You immediately had access to the database that you needed."*

<u>The alternative to EID</u>

The auctioneers highlighted a key difference in the application of current legislation and the Regulation - the requirement for markets to read and record individual animal identifiers.

> *"Legally, it's not our responsibility to read the tags at present and that's where all this talk about electronic tags is very different. Although we have to note and report the movement, at present we don't actually have to read the tags."*

One circumstance where full individual recording is currently required is when animals are being exported. Under existing legislation, a manual read of all individual animal numbers must be carried out, with a 10% random back-check completed by a veterinary surgeon.

> *"At the moment if we send live exports to Ireland we have to read all the ear tags every time – so that's given us a taste of what's involved…it's not good!*
>
> *"The case that I quote is that there were some in three weeks ago in a pen of 20 with 17 different flock numbers, coming through a big dealer."*

Interpretation and implementation of the legislation

The scale of the challenge required to implement individual electronic animal identification across the sheep farming industry was described as requiring a massive shake up. Until the exact requirements of the legislation are defined, a spirit of denial was felt to be pervading the wider sheep industry.

> *"It's too easy just now to say 'It'll never happen'."*

Achieving satisfactory uptake and compliance among producers will be critical to achieving a successful roll-out.

> *"Requirements will have to be clarified to avoid a lot of confusion…and it will happen if people turn up with animals they didn't realise they had to tag."*

Industry is looking to Defra to provide the necessary interpretation of the legislation that, once defined, will trigger the auction sector to act. Early definition is required to allow the industry to begin making preparations. It was also suggested that justification as to why the legislation was required, and the potential benefits that it represents to the industry, should accompany the definition of the legislation.

Given pressure on margins at both producer and market level, the need to ensure a level playing field in auction market practices was highlighted, in order to prevent custom from drifting to the lowest common denominator to the detriment of the industry overall. Furthermore, consistency between regions of the United Kingdom was sought, in recognition that trade straddles internal borders – in England, Wales and Scotland.

With livestock markets handling a mix of store and finished lambs, cull ewes, breeding sheep, and ewes with lambs at foot, clear guidance was sought for all classes of stock. Clarification was also sought as to how the potential derogation for lambs going direct to slaughter under 12 months of age (see below), related to the requirements for detailed on-farm records and movement records of stock on and off-farm.

There was unanimous agreement that a potential derogation for lambs going direct to slaughter would work to the disadvantage of the livestock market, relative to the dead-weight sector.

> *"We definitely don't want an exemption of slaughter animals - for our trade that would ruin the livestock markets.*

Implementation of dedicated slaughter markets was described as having caused considerable difficulty. This could arise due to the combined logistics of incomplete loads, oversubscribed loads and abattoir slaughtering capacity, when stock had to be moved and slaughtered within the prescribed 48 hour period.

Although fatstock and 6-day rule markets are held, stock cannot be guaranteed to be slaughtered within 48 hours. It is not until the fall of the hammer that the auctioneer knows the likely destination of animals going through the sale, and this negates the potential benefits of any derogation for slaughter animals. Electronic identification would represent an additional cost to producers opting to sell their finished animal's live-weight through the livestock markets compared to dead-weight.

> *"If we're not very careful it's going to be the death-knell for prime sheep sales."*

Slaughter-only sales were now estimated to cover only 5% of auction sales of prime stock. Although the 6-day sale was widely regarded by the industry as a slaughter sale, it allowed the vendor the right to return stock to the farm of origin and the purchaser the right to move stock on for further finishing. It was reported that the LAA have been in dialogue with Defra regarding legislation for markets, expressing a desire to see implementation of EID debated alongside any future consideration of animal health regulations in this sector. It was stated that small changes to existing legislation could have disproportionately large benefits.

Any transition or changeover period was thought to represent a particularly high risk, emphasising the requirement for effective dissemination of information. Concerns were expressed at the prospect of dealing with a mix of EID and non-EID bearing stock, where this had potential to impact on time and labour requirements in the market. In the absence of a batching system for prime lambs, and lambs under one year old coming into markets, the only alternative was seen as complete EID of all sheep leaving the farm.

> *"If we can't have a batching system right from the start we might as well go for electronic tagging of every sheep."*

> *"This comes back to recording and checking every animal's movements – if that's the case we might as well go straight to full EID for all sheep because we can't have a mixed system, it's not workable."*

With some sheep sold in varying sized batches the volumes can be very large, adding to the challenge of individually reading stock. There was consensus that the preferred option was to read animals once they have been taken onto site, and made up into lots prior to sale within the confines of the market's holding pens.

> *"We can cope with the sheep as they're moving around the market, once we've got them into the market."*

Once in lots these are, as a rule, treated as discrete units and consequently a single read was judged by the LAA to be sufficient. The prospect of a second reading was not well received. Any deviations to the structure of the original sale lot, for example to allow for the withdrawal of lame or poor sheep removed on the request of the purchaser, could then be dealt with as exceptions.

Particular concerns were expressed regarding the levels of IT literacy among sheep farmers as the successful implementation of the legislation was seen to rest largely in their hands. Reflecting the desire for a simple approach in the livestock auction market, there was agreement that implementation of a simple baseline system at farm level would be key to achieving compliance with the legislation for primary producers.

Concerns were expressed over the performance of tags and boluses – in particular the relative reliability and retention rates of each system. Against this background, current approaches to selecting sheep for market could give rise to potential problems, in terms of obtaining replacement electronic identifiers.

> *"One problem that we do have is that people will tend to go into their cattle sheds and draw their cattle 5 or 6 days before market. With sheep at certain times of year, you take them off the fodder and bring them in for sorting – for example sorting on Monday for a Tuesday sale. We're going to hit a massive problem on-farm of getting replacement tags in time for sending on to the market, to the abattoir or whatever the next port of call might be. Sheep are in such massive volumes there just isn't enough time."*

Reassurance was sought that an electronic device should represent the minimum acceptable identification, in order to safeguard against lost electronic identifiers being replaced with manual devices, which would then present the markets with the task of reading both manual and electronic devices side-by-side.

The lead-in time to 2008 was described as tight given the required further development of the systems, and the need to disseminate information to the wider industry. May was the preferred cut off month for implementation of EID, to minimise distortion of the market when first applied. A January introduction date could encourage disproportionately high sales of lamb in November and December.

Although aware of the impending requirement for Food Chain Information contained in Food Hygiene Regulation, the LAA as yet do not have a clear view of the detail. There could well be legislative elements to the Regulation which might impact on how EID was viewed and applied.

15.3.4 Abattoir view

Traceability

Traceability is potentially less complicated for the abattoir sector - once animals arrive at the meat plant, they will never leave the premises. In addition, farmers themselves are generally conscientious in ensuring lambs arrive with tags.

At present there is no drive from the volume retail markets supplied by the abattoir for greater traceability of individual animals, or even batches, back to farm level. The numbers of lambs being moved by the large multiples would make information on individual animals meaningless. Marketing information linked to provenance could be put together without the use of EID. Retail packs have a ‘use by date’ and carcasses have a kill number. From kill number it would be possible to work back to a farm, but there is little retailer pressure for it, apart from some of the smaller niche markets, and organically produced lamb. At present, individual traceability begins to disappear once the carcass is cut.

Even for the larger specialist sheep plants, approximately 10% of farmers currently request feedback of carcass data on an individual basis. These tend to be farmers who are keen on breeding and improving their genetic pool. There is usually no extra charge for this service. In contrast, the vast majority of finishers are only interested on how lambs perform and grade on a group basis - the first question often being whether any were rejected. Pressure on time means that most larger producers/finishers are not interested on performance (or traceability) at an individual level. Therefore, the abattoirs see little advantage in pursuing individual identification for all producers.

The alternative to EID

If the law requires that each lamb is read, and EID is not available on all stock, the alternative at the abattoir is to read tags manually. Though less efficient, manual reading would not be as impractical for most abattoirs, when compared with markets. Pressure would increase on existing staff, or an additional person would need to be employed (at circa £14,000-15,000 total cost per annum) specifically to read tags.

Interpretation and implementation of the Regulation

The Regulation is not greatly debated within the meat industry. Compared to the sheep industry at large, there is far less interest in the legislation by the abattoirs at present. The main question for processors would be whether costs will increase due to the implementation of EID.

There is considerable confusion, and uncertainty, as how the legislation will be interpreted. Legislation will need to be clearer, particularly regarding protocols for misreads and animals with devices which do not read. Hypothetically, the biggest problem would be if slaughter were prohibited in the absence of a positive read. The alternative is extra labour, required to check every lamb before it enters the line. In addition, provision will have to be made for carcasses which leave the kill order, by accident or are detained by the meat inspector.

Current understanding by the abattoirs is that for lambs under 12 months, electronic devices are not required, i.e. the derogation is likely to be exercised in the UK. The question was raised as how to guarantee that a lamb is less than 12 months of age at slaughter.

From an abattoir perspective, full electronic identification would be preferable because of the potential to feed back data to the producer more quickly and easily. However, of greater concern is the potential impact of increased production costs on the farmer supply base. Some big producers are already saying that unworkable regulation would see them decide to leave the industry. If no derogation were applied, volume might drive down the price of tags, to work in the favour of producers.

At present there is little knowledge or discussion of the impending Food Hygiene Regulation.

The feeling is that for the sheep sector as a whole, 2008 is very optimistic both in terms of equipment and legislation. In particular, there is scepticism as to the likely effectiveness of a national register, given the practicalities of sheep farming.

> *'Gaps in any National Sheep Register would make a mockery of the system, and destroy the credibility of the whole scheme'*

While useful disease control data might be held on a national database, there are strong reservations about holding any more comprehensive production or economic records, which could be viewed as commercial in confidence between the abattoir and its dedicated producers.

15.3.5 Overview and implications for sheep EID

The sheep industry is very sceptical of the practicality and value of tracing individual sheep. Many farmers are at a loss to understand what the legislation hopes to achieve, and believe that enforcement of the legislation could have potentially catastrophic consequences for the English sheep farming industry. Uncertainty over the specific implementation of the Regulation, limits the extent to which the industry can project the physical and financial implications for their own circumstances, and may also generate higher levels of apprehension through 'fear of the unknown'. Sheep farmers were concerned about the potential impact on costs of production, and wanted reassurance that domestic producers would not be placed at a competitive disadvantage relative to their overseas competitors.

Although unconvinced about the need for individual traceability, the sheep sector is unanimous in the view that only electronic methods could cope with the volumes of records involved. Therefore, if electronic systems could be put in a place which meet the levels of performance required, resistance to EID within the industry may be reduced. Although most respondents believed that accuracy in tracing individual sheep diminished post farm gate, more 'automatic' methods of feedback on carcass data from the abattoir were viewed positively, if nothing else to provide reassurance and greater transparency. Some participants were frustrated at seeing the potential for management benefits but being prevented from achieving them, through shortcomings associated with the technology.

While each level (farm, market and abattoir) is conscious of its own situation, the interrelationships that exist within the industry were also recognised. Therefore, primary producers are mindful of impacts on livestock markets, on breeders and finishers. Equally the markets and abattoirs were sensitive to any adverse effect on their supply base, for example, should EID encourage a proportion of sheep farmers to leave the industry.

Several key points for policymakers were noted. Developing the framework for UK implementation of EID must take a balanced whole industry perspective. In drawing up the legislation, it is very important that the rationale which underpins the Regulation is consistent, and does not dilute the basis for the legislation in the first place. For example, if the driver of traceability is animal health the derogation for lambs under 12 months going direct to slaughter may be quite acceptable. However, if the driver is traceability on the basis of zoonotic disease and reducing the risk to human health (now or in the future) the derogation is more difficult to rationalise. Further work is required to increase industry confidence in the capabilities and potential benefits of electronic systems, within the legislative framework eventually set.

16 PROMOTION

16.1 Objective

During the period of the study a specific objective was to disseminate and promote the results of the Pilot Trial to the wider sheep industry.

16.2 Approach

At the start of the trial, a communications plan was developed with Defra, and commented on by the Industry Steering Group. A promotional programme was agreed, using a number of routes.

16.2.1 Results

As the trial developed, it became clear that promotional activities would need to be constrained until data collection was completed and the final report published. Nevertheless, opportunities were taken to promote the work being undertaken.

During the autumn of 2004, live demonstrations were held on three participating farms – North (Cumbria, October 26th), Midlands (Derbyshire, October 29th), and South West (Devon, November 2nd).

Agricultural shows and events attended by project staff included;- Devon and Cornwall Show, Royal Show, Great Yorkshire Show, Smithfield, South West Sheep Event, North Sheep, Northern and Borders Sheep Fair.

Presentations were given at five meetings - NFU (Harrogate), Oxford Sheep Group (Hook Norton), NFU (Shrewsbury), Midlands Sheep Group (Staffordshire).

Updates appeared in the regular newsletter publicising Defra's livestock data programme. In addition, a paper was accepted for presentation at a European meeting on EID during summer 2005.

The intention is to meet the remaining publication commitments from the considerable body of information, to be produced and agreed as part of the final published report. A specific open day demonstrating EID systems and equipment, and promoting the results of the Pilot Trial, is planned for the autumn of 2005 to coincide with the publication of the final report.

16.3 Overview and implications for the uptake of EID

Considerable promotional activity will be required over the next 12-18 months to increase awareness amongst sheep farmers of the EU Regulation. The aim should be to allow the industry to consider the implications for management of their flocks, as negotiations progress towards the detailed implementation. As demonstrated by the marked increase in response rate between the first and second industry surveys, English sheep producers are now much more aware than they were at the start of the Pilot Trial. However, farmers will remain sceptical until they are convinced of the practical application of EID, demonstrated at a high level of performance. Effective dissemination of the information which becomes available from this, and ongoing work on sheep EID, will be an important factor for the potential uptake of EID.

17 CONCLUSIONS AND RECOMMENDATIONS

Introduction of the EU Regulation on EID in sheep could have a bigger potential impact on the UK sheep industry than CAP reform and the introduction of the Single Farm Payment.

While most farmers see EID as an additional cost and regulatory burden, it also offers potential opportunities to exploit future ergonomic and data flow benefits. From the information collected during the Pilot Trial, sheep EID systems require further development and improvement to allow these benefits to be fully realised.

A basic framework needs to be developed which addresses the minimum requirements of the Regulation. Government have a clear role in helping to define these requirements, and putting in place arrangements to support data capture, data flow and data management. This structure needs to be sufficiently flexible to accommodate the most diverse sheep industry in Europe. If not, there is the very real possibility of paralysing the sheep sector, either at specific points within the production chain, or at the level of individual producer.

17.1 Legislation

The key factor in affecting the industry view of EID is how legislation evolves. Current uncertainty over the specific requirements (and Defra interpretation) of the Regulation, affects perceptions of how feasible the introduction of EID is likely to be for the English sheep industry. These perceptions apply across the primary production chain at producer, market and abattoir levels.

Furthermore, lack of clarity on legislation does not give a clear view to manufacturers of the potential market. Without clear signals, there is less incentive to invest in production capacity or to develop new products and equipment. Therefore the benefits of improved equipment, better software and price economies of scale will also be delayed. This will have a knock-on effect on cost:benefit across the industry.

Farmers recognise the challenge in interpreting the current sheep identification rules. The legislation imposed relating to sheep EID must be workable. Participants sent clear messages that they did not want to be ‘turned into criminals’ by legislation they could not practically adhere to, or be driven out of the industry because they could not comply.

Market and abattoir sectors are also very concerned about the impact disproportionate legislation could have on their supply base, either through loss of producers from the industry, or increased production costs in an increasingly difficult market.

A major concern for the auction markets is having to deal with EID and non-EID animals coming into the same market. The logistics, associated costs, and potential for error in individually reading visual and electronic tags could put the markets at a serious competitive disadvantage relative to the abattoir sector. Without the certainty brought about by a dedicated slaughter sale (currently less than 5% of all sales) there is no guarantee that an animal presented in ‘finished’ condition under 12 months of age is going directly to slaughter. A requirement to read both into and out of markets would pose additional logistical difficulties and significantly increase direct and indirect costs.

A different set of circumstances apply in the abattoirs, in that animals will never leave for another destination, and the throughput required to maintain the slaughter line is a fraction of that needed at the market. Clear guidance is needed on how the legislation will be applied, so that appropriate protocols can be developed. A hypothetical stipulation that only animals carrying a functioning electronic device could be slaughtered would create considerable problems.

17.2 Equipment performance and reliability

The equipment used on farms within the Pilot Trial was ISO compliant, off-the-shelf equipment available in 2004.

The Pilot Trial had to be rolled out quickly. This created significant supply problems with equipment and devices, which without adequate planning and lead-in time, could be repeated during a national roll-out.

The performance of some of the technology was particularly disappointing, with the failure of the Aboca hand reader to perform adequately an important element in compromising the overall effectiveness of that system. The reliability of the Anilog was significantly better, but even here 32% of farms returned the unit because of technical problems. This level of reliability is not sustainable at farm level, and would require manufacturers to hold significant stocks of replacement equipment which could be swapped out at short notice. Within the trial, turn around speeds for equipment repairs varied from 1 – 18 weeks. Given the way farms operate, and depending on how the legislation is implemented, even short-term failure of equipment at a critical stage, e.g. before a specific sale or farm collection, could have major financial and operational consequences.

Even where the equipment worked well, participant feedback supported by the specific ergonomic studies indicated that the speed and ease of use did not meet farmer expectations. In terms of farm application there were two opposing views, one indicating a requirement for a very simple system that, for example, would read sheep quickly and with a minimum of button presses. The other view aspired to quick and easy use, but also the ability to call up detailed data relating to specific sheep held on the reader itself. This trade off between simplicity and functionality, is a consideration for manufacturers, with cost as well as technical implications.

A consistent view was that the equipment was not well adapted to the farm environment, which often probes the limits of normal working conditions, for cleanliness, temperature, moisture, shock absorbency, and adverse human and animal interaction generally. A greater measure of robustness, reduction in leads and cables, improvements in battery performance, would make the equipment better suited to on-farm use.

Reliance on data collection via a crate or hand reader, relaying data back to a PC, for subsequent transfer to a central database, all controlled by software, and facilitated by wires and connectors, means the overall system is vulnerable to technical or human error at several points. It is likely that further technical development will eliminate the need for an expensive field computer. Simpler and cheaper systems are being developed to link a panel antenna siting in a race to a more sophisticated dual-purpose hand reader. The better design of crates, optimal positioning of antennae to read both tags and bolus, and adoption of Bluetooth technology, are some of the elements where tangible improvements in performance could be made.

The approach taken in the trial was to provide a fixed inventory of equipment depending on the role required within the project – EID farms had a hand reader with which to read devices, management farms had an electronic weigh crate. With limitations on the range of equipment available, there was little opportunity to try and match the equipment supplied to the application required by the farmer. Based on the experience gained within the trial it is now easier to consider how different and evolving EID equipment might be optimised for farm-specific applications. For example, reading large flocks of bolused sheep with a hand reader is slow and difficult. Race reading equipment developed for the market evaluations, could be used on farm for rapid reading of groups of sheep, whether carrying tags or bolus. The integration of EID into sheep handling and shedding systems, could bring additional ergonomic benefits to the use of EID. Currently available Bluetooth technology has got the potential to eliminate the need for cumbersome and often vulnerable cabling arrangements.

17.3 Cross referencing electronic and management numbers

At present the 16-digit electronic number in the chip is cross-referenced to a simpler official or management number, printed on the tag as a visual identifier. Although carefully managed within the trial these cross-reference files have been a major potential problem. In some cases, late provision of the files delayed initial reads on farm. In the case of FDX-B boluses, no cross reference files were produced for several months, which meant farmers had to manually enter the management number, a labour intensive and error prone process. Errors in file format had the potential to create havoc for the operation of readers, in the flock management software and project database transfer routines.

Depending on supplier, some data files were in decimal format; some in hexadecimal. This meant that when master data files were required for abattoir or market evaluations, the data had to be transformed to suit each supplier. Animals were either read by Project Staff with the other manufacturer's equipment, or an overall data file was supplied which had to be transformed. This transformation was not always 100% consistent, which created a degree of nervousness, particularly as the performance of one supplier, e.g. for a market or abattoir test, was to some degree dependent on the integrity of the cross referencing file produced by a different manufacturer.

Similarly, on several occasions data transformations had to be carried out to capture the electronic identification of animals participating in the National Scrapie Plan (NSP) so they could be absorbed into the flock management software. The data supplied by the NSP was not always presented in exactly the same format, or with wholly consistent column headings. This too created some problems with automatic data transformation.

If a relational numbering system were adopted for a national roll-out, it would be essential that a standard file format is available, preferably with the cross reference files held centrally, from the range of manufacturers supplying electronic devices.

17.4 Flock management software

EID is simply a method to capture the identity of an individual animal, make an association with registration (e.g. sex, date of birth) or management information (e.g. weight, parentage), and transfer that data rapidly to a file siting in a database within flock management software. In the context of the Pilot Trial, a further feature required of the management software was the ability to connect to the project database. In software terms this ought not to have been difficult to achieve.

The original software supplied by Earlsmere created problems at two levels. Pedigree Stockminder, recently purchased by Earlsmere and supplied to management and two EID farms, contained programming faults, which needed to be managed for the duration of the project. The five management farms, supported by technical staff from Earlsmere, made it through to the end of the trial. Therefore, the potential management benefits of what might otherwise have been useful flock management software were significantly limited by technical deficiencies in the programme. Standard Stockminder, a version containing fewer features than Pedigree and more suited to non-pedigree flocks, was rolled out to Earlsmere-supplied EID farms. After several months of problems, the Stockminder Standard was withdrawn. It was replaced with a much simpler programme (SP2004), rebuilt from the ground up. This contained very limited functionality, but was much more stable and user friendly, and remained in use until the end of the Pilot Trial. Once a stable platform was established through SP2004, the comment from participants was that they now wished to see more functionality, so they could pursue some management benefit. SP2004 also resolved some of the problems experienced in connecting to the Pilot Trial database.

The Anidata programme proved to be stable in use with good connectivity to the project database. Several upgrades were issued during the course of the Pilot Trial. Participant feedback was that they did not find the programme particularly easy to use, or to interrogate the data captured.

Reporting facilities were underused. The overall impression was one of disappointment that the programme was not particularly well orientated towards analysing management data on a flock basis. In theory, this could be a feature of the programme, the quality of cascade training given or the ability of the participant to interact effectively with the software. However, if a flock management programme does not allow for easy assimilation of how to input and manipulate data, this is likely to limit its application and potential benefit on farm. Issues with the flock management software, increased further the challenge in providing any cost:benefit data during the period of the Pilot Trial.

17.5 Device technology

There are differing views regarding the relative merits of tags and boluses. These centre round the priorities given to cost, retention rates, ease of use, animal welfare aspects, and the need or otherwise for device recovery at the abattoir. Tags were the option preferred by most farmers, especially given the specific requirement within the Pilot Trial to provide an additional tag for sheep carrying a bolus. Where boluses were used they were usually inserted in breeding stock. One farm inserted 800 midi boluses in lambs without incident, in each of two lambing seasons. Although boluses are more expensive than tags, in breeding stock the cost can be written off over several years of productive life.

For ease of operation, abattoirs and markets prefer tags over boluses, or a single approach rather than mixed devices. Tags are more visible, and easier to determine if the device does not read. With boluses, a non-read may be due to device loss, device failure or an intermittent read. On at least one recorded occasion, an animal thought to have lost a bolus was given a second device.

While the magnitude of tags losses has been established within the Pilot Trial, the data for loss of boluses is less definitive. It might be expected that loss rates would be considerably lower than with tags. During summer 2005, it is planned to purchase a number of sheep originally bolused, but which are now not registering a read. A definitive answer as to whether the bolus has been lost, or ceased to function, will be obtained following *post mortem* examination.

In terms of the technology streams used, the Pilot Trial was able to demonstrate that the equipment could read either HDX or FDX-B, as single technologies (on farm) or in mixed groups of sheep (auction marts). There were indications from the auction mart test that reading a single technology was marginally quicker. In terms of cost, FDX-B is significantly cheaper. However, from the abattoir tests, there was also circumstantial evidence that FDX-B may be more susceptible to mains noise. Tuning appeared to be more of an issue with farm-based weigh crates where FDX-B midi boluses were used.

17.6 Electronic data transfer/Project database

In terms of the ultimate outcome, one of the weakest elements in the Pilot Trial appeared to be the integrity of the data as it appeared on the Project database. A large number of risk factors were identified, which could compromise the accuracy of data on the database at any one time. These factors included technical (hardware and software), communications (Internet connection), database design, and other spurious and human error. The database itself was not a prototype for a national livestock register, and so did not have the luxury of extensive testing before use. However, the difficulties experienced even in achieving sample data transactions, signifies the scale of task involved in constructing a live national livestock register.

17.7 Training and support

Overall, participants received through farm visits and telephone access a total of 35.8 hrs/farm and 61.0 hrs/farm training and support for cascade and directly supported farms respectively. By comparison Project Officers provided a total of 28 hrs/farm of support on paper comparator farms. Direct contact with Project Officers was the preferred method for receiving training and support.

For the Allflex installed system, which in the main functioned well using a cascade approach to training and support, a more detailed analysis showed that Project Officer training visits and telephone contacts and duration peaked in the period June 2004 – August 2004. This coincided with the period immediately following equipment installation. The analysis also showed that a relatively high input of training was required following this initial peak. This reflected the fact that it took participants quite a long time to learn and become competent in specific tasks, as they used the system relatively infrequently, and refresher training was often needed. The more advanced features of the system were in the main used only towards the end of the trial.

There was considerable variation in the amount of training and support individuals received, ranging from 4.5 hrs to 34.7 hrs for training, and from 1.7hrs to 27.3hrs for support. Surprisingly, there was not a strong relationship between participants' starting computer competency, and the amount of training and support they received.

The majority of participants using the cascade training approach characterised the support and training they had received as being 'at the right level' and to a satisfactory quality. They also had installed an EID system that in the main worked effectively. Given this background participants were asked to express their confidence in performing each of three tasks – transferring records between the farm computer and the reader, using the reader in the field and downloading records from the farm computer to the central project database. After 12 months training, not all participants considered themselves fully confident to perform these three fundamental EID tasks. While confidence is not a measure of training and knowledge acquired *per se* (as it also reflects usage and familiarity), the finding of this trial would suggest that the requirement for training will be a major issue at a UK wide roll-out of EID. While the participant group was reflective of the industry, it is certain that a significant proportion of sheep farmers will have even less experience and aptitude for electronic systems than those at the lower end of the scale within the Pilot Trial. The results would suggest that there would be some, possibly very many, within the industry who could never be fully trained.

Current EID systems are considered by most (66% of participants) to be overly complicated and this level of complication adds considerably to both the need for, and the amounts of, training and support required. The approach taken to training and support in the Pilot Trial is unlikely to be appropriate or effective for a UK wide roll-out of EID. It is too labour intensive, and hence expensive, and given the skill sets needed to deliver all facets of the training it is probably not achievable by any one supplier. It is felt that simpler and more user friendly systems of EID would reduce the need for training and support dramatically, thereby making training and support less of a major constraint for the effective UK wide roll-out of EID. In addition, it would also help alleviate the problem of infrequent use. Where systems are used infrequently, the requirement to remember more complex initiation and data manipulation procedures is likely to be problematic.

The need for training could also be influenced considerably by the complexity with which the impending legislation is implemented in the UK. From a training and support perspective, a phased approach to complying fully with the legislation would benefit the roll-out of EID. For example, legislation which requires animals to be identified electronically, but with a requirement for minimal data capture and transfer initially, would help reduce the training burden at the outset.

The 'cascade' training model worked well with Project Officers being able to focus specifically on training and support, with the suppliers' own staff dealing in the main with solving any technical problems with the EID equipment. Nationally, suitable training models could be envisaged using resources and bodies such as the county Colleges of Agriculture or LANTRA.

17.8 The Bureau model

Among non-bureau users in the Pilot Trial there was general agreement that a bureau style alternative would be a pre-requisite for effective implementation of individual animal identification across the English sheep industry. In particular, this service was anticipated as likely to meet the needs of both the computer-averse producers who would not have the inclination to adopt the required skills, and the smaller producers for whom the required level of investment in EID/EDT technology may not be justified.

Paradoxically, after 12 months experience the bureau group had an entirely opposite view. The logistical and equipment problems encountered accentuated the difficulty in getting sufficient cover and flexibility through third party provision. Even a local provider, possibly even a computer literate farmer, would struggle at peak times given current management practice on sheep farms, particularly prior to a large sale. If stock were required to be read electronically off farm, a farmer may as well have his own reading equipment, which would increase overall flexibility.

However, there may still be applications where a bureau approach could work. For example, if the whole sheep flock were required to be read electronically at an annual gather, a service could be provided with specialist reading equipment, in a similar way to a pregnancy scanning contractor. Given greater flexibility over dates (in contrast to meeting a specific sale day), the logistics of service provision would be easier. In addition, flock recording services such as Signet, could relatively easily enhance their core activities to include EID. Logistics will always be difficult for the larger and more commercial producers, but a bureau or co-operative approach could be more workable for small and hobby sheep keepers.

Within the bureau farms, the physical parameters of equipment performance, tag retention rates, and proportion of non-reading devices, were very consistent with those of EID farms using the same system. For efficient working, better reader functionality and field performance is required. Rapid throughput race readers would also have a role for larger flocks, and where boluses are used or suspected to be present in a proportion of stock.

17.9 Markets and abattoirs

It is worth noting that in the most difficult environment tested within the Pilot (the abattoirs), the equipment used did not have the benefit of permanent installation and the additional refinement that would entail. That too, may have reduced reading performance. The abattoir tests indicate that robust lairage race reading, or Bluetooth stick reading, systems could be achieved. Panel reading post kill, would be the least invasive in terms of impinging on existing plant operations. The poorest reading performance experienced within the Pilot Trial was obtained from the Midlands abattoir test, in an older and inherently more 'noisy' plant. There may also have been an interaction with the type of technology used. The results emphasise the need for a thorough site survey, a permanent installation, and a period of commissioning and refinement to meet the greater challenge of reading in a more adverse environment. Permanent installations will need to be sufficiently well protected to withstand extended use and washing down procedures. As with the auction market the reading position chosen by the abattoir will depend on the legislation. Definitive protocols will be required to deal with non-reading or non-EID animals on the kill line. If the Regulation were to state that only animals with a reading EID device could be slaughtered, this would pose major logistical problems for the abattoir.

The LAA believe that an EID system is the only option for the auction markets, if individual recording is required for sheep movements. From a position of no development of market EID equipment for sheep, prototype systems were successfully produced and tested as proof of principle, in one auction market. Capability was demonstrated to accurately read groups of sheep carrying mixed technologies (tag/bolus; FDX/FDX-B), at speeds equivalent to 1200 per hour, and to automatically shed out those carrying non-reading devices, or carrying no EID device at all. A stick reading system, using Bluetooth technology, relaying data back to a base station, was also successfully demonstrated as an alternative to a race reader. While further development and validation is required for auction market systems, the LAA feel the main limitations to the use of EID at the auction market are not technological, but lie in the implementation of the legislation

17.10 Cost:benefit

Given the duration of data collection (15 months) and effective start date of farm work (April 04), cost:benefit was expected to be difficult to quantify. However, little or no quantifiable benefits were found. Many participants commented that the extra time involved in recording individual sheep was time lost in management and husbandry.

Feedback from the three participants acting as paper comparators, indicated that with sufficient farmer motivation, a paper-based system was workable, but only up to a point. Transcription errors were recorded, and would have to be compared with the potential for missing data, data loss or corruption with the current generation of EID equipment. Fundamental to these findings is that the three participants were highly motivated individuals (almost a self-selecting group), in some instances using three or four digit management numbers as the basis of recording. Limited ergonomic studies comparing manual and electronic systems, indicated no real advantage in the speed of data collection. This was mainly down to the use of short three-digit numbers for manually read management tags, small groups sizes (49 sheep), and the usability of the reading systems tested. As group size, and the number of digits required to be read (six or twelve) increases, there will eventually be a point where manual reading will fall over. The benefit of improving the speed of data collection is limited, unless the data is subsequently used to underpin better management decisions or improve individual animal selection.

How devices are presented and packaged, two piece tags as against foldover, applicator performance and ease of use, also have a bearing on time inputs, and the opportunity cost of tagging. Given the range between farms in recorded times for tagging and bolusing, robust comparative data can only be generated under the same controlled conditions.

Many participants recognised the potential for cost:benefit, if not for them, then for others within the industry. The greatest potential benefits were thought to apply to those interested in improving the genetic make up of their flocks, either pedigree producers or commercial flocks seeking to improve the quality and value of the finished product. At present, many felt this was constrained by the performance of the equipment and/or the flexibility of the flock management software used.

At farm level, cost:benefit could be viewed from two perspectives. Firstly an intensive approach, driving data collection and manipulation on an individual basis, in pursuit of greater biological or agronomic efficiency. Secondly, more efficient handling for reading individual numbers simply to meet legislative requirements. Farmers at present have not been required to read individual numbers. Therefore their benchmark in viewing the potential benefits of EID (which could include costs in labour saved) may be more attuned to current circumstances, rather than what could be required in the future.

From the introduction of the legislation, an efficient system of physically reading and handling EID stock is essential for the continuing operation of the auction market sector. The relative cost will depend on current operation of individual auction sites, and the type of legislation adopted. There may be theoretical benefits, again depending on the legislation, if EID data collection can be harnessed to produce statutory outputs (e.g. movement records) from the auction office in digital format, rather than relying on paper systems. Innovative methods of adding value from the use of EID through the auction market system would be welcome.

Currently, the abattoir sector sees little scope to add value to the volume retail trade by providing traceability on an individual animal basis. Demonstrating the provenance of each animal may provide some additional market value in specific, low volume outlets such as butchery shops and selected export markets. However, there appears to be very little debate at present regarding the impending Food Hygiene Regulations. These may have the potential to drive greater traceability at an individual animal level, because of statutory requirements, risk reduction through HACCP, or quality assurance by multiple retailers.

There could be wider economic benefit in providing an effective individual tracking and monitoring system to potentially improve disease control measures in the national flock.

Within the Pilot Trial information and feedback has only been collected directly from the industry. The impact of the EID Regulation could also have indirect but nevertheless significant effects on groups such as the livestock hauliers. These groups also need to be studied in any RIA for electronic identification.

17.11 Industry perceptions

Pre and post-trial industry opinion surveys were conducted to establish the perceptions of the wider sheep-farming population. With approximately 30 months until the Regulation is due to come into force, around half of those respondents to the industry opinion survey remained unaware of the impending changes to the legislation. Given that the survey was undertaken among members of the NSA, it might be expected that awareness elsewhere in the industry could be lower still. The volume of replies received to the second industry survey and the concerns that were voiced in the telephone enquiries generated, combine to suggest a growing engagement at the industry's grass-roots in discussing the potential impact of the Regulation.

The majority of farmers do not want individual traceability in sheep. Most believe it is unworkable, given their experience of tag loss and other potential sources of data or identity loss. Experience of using BCMS for cattle movements, suggest that to apply an accurate individual tracing system to sheep, where the numbers and movements are so much greater, would be impossible. For animal disease control many in the industry think that the current batch tracing system is effective and workable.

Two-thirds of respondents to the industry opinion survey indicated that the legislation represented a moderate to high risk to the continued viability of their sheep enterprise. These sentiments were echoed in the participant discussion groups where some participants' themselves voiced doubts about the likelihood of their continuing in sheep production if faced with implementation of individual animal identification. In considering the wider implications of the legislation, grave concerns were expressed, to the extent of a possible collapse in the English sheep industry. It was also noted that cross-compliance measures under the reformed CAP would have a bearing on the likely response of farmers to implementation of the EID legislation. A robust regulatory impact assessment is required which is representative of the English sheep industry to quantify the potential impacts of the legislation on the production base. The assessment should take into account the stratified nature of the sheep industry, and explore related impacts of one sector on another.

At 18% there was a decline in the proportion of respondents who described their attitude towards EID as positive (from 25% pre-trial). There was a persistent lack of confidence in paper-based systems to deliver traceability of individual animals, but that was not offset by belief in electronic systems. If anything, there was a shift in favour of paper-based systems. Computer competency did not in itself appear a predictor of attitude towards EID. Mean scores showed a prevailing negativity. Regardless of attitude towards EID, of primary concern to respondents were the potential technology costs to their business of implementing EID.

There is general lack of awareness, at all levels in the production chain, regarding proposed EU legislation on food hygiene, due to be fully implemented by 2012. Requirements under the Food Hygiene Regulations to be able to provide health and veterinary records one up and one down along the supply chain, and for information to flow along with the sale of animals, could be an significant driver for EID and EDT in the future.

17.12 Animal welfare

The start date of the Pilot Trial, and especially the time of year when animals (breeding stock in particular had to be identified) was likely to have been a significant confounding factor in the level of ear infection and tag loss experienced. However, there is sufficient evidence that tag loss and infection rates vary markedly from farm to farm, and in some circumstances can reach very high levels, to the extent of seriously impacting on animal welfare. Tag design may also have a major effect, with three to four-fold differences found in loss rate between different tag types. Issues around tagging in general were highlighted by the problems also experienced by paper comparators, using non-electronic tags.

Establishing a dam:lamb (and subsequently a sire:lamb) link usually requires tagging in early life. The risks of ear damage when tagging very young lambs, was evident both from EID farms and paper comparators. Although no direct association with tagging could be proven, two severe outbreaks of joint-ill on participating farms in the South West, suggest that further work is required to understand whether tagging lambs under four weeks of age poses an additional health risk, from joint-ill or any other disease or condition affecting peri-natal lambs.

Technical performance of the electronic device is only one element of its overall usefulness. It is clear that design issues relating to size, weight, print quality, level of finish and locking action are all equally important factors affecting retention, legibility, and welfare friendliness.

Within the context of the study (trained farmers, participating in a high profile study) the welfare implications of bolusing were minimal. Only one sheep was lost from a population of over 11000 bolused. Some farmers are well used to administering other forms of bolus, e.g. trace element bullets, magnesium bullets or anthelmintic boluses. However, for a national roll-out across a range of farms and competing priorities for the limited time available, it might be expected that the incidence of problems following bolus administration might increase. Neither were there any small lambs (less than 25kg) bolused within the Pilot Trial.

Protocols for tagging and bolusing sheep were produced for this trial. A small proportion of individual ewes could not be bolused (due to breed effects, or individual anatomical differences). The guidance on tagging provided by manufacturers, varies in quality and in some instances is contradictory. More scientific information is required to provide definitive guidelines as to best practice in tagging and bolusing.

17.13 Limitations of the Pilot Trial

Although the Pilot Trial was mainly a field study, many aspects of the EID roll-out were controlled, above and beyond what might happen in practice. For a given farm, one supplier was used for devices, equipment and software. Sheep were not traded between farms, providing a further challenge for traceability, or an opportunity for an animal to inadvertently be given a second bolus or electronic tag. Sheep were screened for an NSP bolus before the insertion of another electronic device. In addition, steps were taken to minimise the risks of differing formats in the data files supplied by different manufacturers. These are only some of the additional confounding factors which would come into play in real life.

Store lamb finishing is an essential component of the English sheep industry, and within Europe, is a feature almost unique to the UK. Some major finishers handle tens of thousands of lambs, moving stock considerable distances for finishing, and further still to a sequence of locations and crop types within the general finishing area. These producers are not interested in individual performance, but in group performance related to farm of origin, finishing crop or accuracy of final selection to meet carcass specifications set by the abattoir. The logistics involved trying to record individual animal identities and movements would be considerable. A system of EID which forced these relatively few, but large store lambs finishers, to cease trading would have a disproportionate effect on the sheep industry, particularly in hill and upland areas. No store lamb finishers or common grazers were included as participants in this Pilot Trial.

18 KEY RECOMMENDATIONS

The impracticality of rolling out a complete, integrated EID system for every sheep producer in the UK in 2008 should be recognised. However, progress can be made towards achieving that objective.

Clear guidance is needed, at the earliest opportunity, as to how the Regulation will be applied, in order to allow sufficient time for all sectors of the sheep industry and the EID manufacturers to plan for wider implementation.

Developing the framework for implementation must take a balanced whole industry perspective, so that no sector (production system, market, abattoir, or ancillary industry) is unnecessarily disadvantaged. Defra and the Devolved Administrations need to ensure consistent application of the legislation across the UK, and ensure in negotiation with their European counterparts that a level playing field applies across the main sheep producing member states.

Based on the results of this Pilot Trial, and ongoing related work, policy makers and the wider sheep industry need to begin a definitive and lateral thinking process. Close co-operation between Government and industry is necessary to put structures in place which meet the Regulation, but which are sufficiently flexible in terms of options and approaches to suit a range of circumstances and critical points in the production chain. These structures need to be robust and wholly reliable, otherwise the whole concept of traceability may be undermined.

A 'gold plating' approach to the application of the Regulation could lead to an unworkable system, with the potential to reduce co-operation from within the sheep industry, increase the likelihood of individual breaches, and encourage some to give up sheep farming. The objectives set need to be proportionate, in balancing the principles of the Regulation and what is feasible in practice, given the scale and diversity of sheep farms and farming systems in the UK. The proposed tolerance of 7% requested by the Irish Farmers Association for sheep producers in Southern Ireland, provides an interesting precedent.

The legislative framework set should be at the most basic, workable level which meets the Regulation. It should then be left to market forces to encourage further technical development of data management and feedback systems within the production chain. Where possible, Defra should facilitate an environment where such developments can take place.

A widespread view within the industry is that 2008 is too optimistic for the delivery of an effective National Register Database. Without an effective live database, the real time traceability of animals is lost. It is recommended that the UK view EID and traceability in sheep on a five-year horizon, and put in place a timetable for a staged progression, collaborating with the sheep industry, towards specific agreed objectives.

While a paper-based system is not workable for most, an interim part–paper system linked to sheep ETAS, might avoid creating an 'underclass' of non-IT literate sheep farmers. IT literacy is a particular concern, given the age profile of sheep farmers in England and the likelihood that the average age will have increased further by the time the Regulation is applied. At its most basic level, this could involve a producer recording the sequence of the tags he is about to put into lambs as they leave the farm.

Greater effort is required to inform the industry of the implications of the Regulation, and in particular the rationale that lies behind it. This is particularly important given scepticism of the feasibility and value of full individual traceability by producers, processors and retailers. It is very important that the rationale presented is consistent, and does not dilute the basis for the legislation in the first place. For example, if the driver of traceability is animal health the derogation for lambs under 12 months going direct to slaughter may be quite acceptable. However, if the driver is traceability for human health (now or in the future) the derogation is difficult to justify. In addition, this will allow sheep farmers to project beyond what are current legislative requirements for sheep ID.

An official numbering system based on WYSIWYG is to be recommended, given experiences within the Pilot Trial of managing a relational numbering system.

An early decision should be given in relation to the derogation for lambs under 12 months going direct to slaughter. It could be that implementation of the derogation is counterproductive. While adoption of the derogation would reduce immediate costs to producers, its existence could create confusion within the wider industry, particularly at the auction markets. A reduction in operating efficiency and increased cost base at markets could be counterproductive, as the auction market is often seen as the price setter within the industry. The impact of an annual market for 18 million electronic ear tags on the supplier base could be expected to be considerable. With a volume market, electronic devices will become much cheaper. Although devices for breeding stock are always likely to be more expensive, the depreciation over several years of productive live would reduce the annual cost to below that of a lamb tag.

Electronic devices (tags and bolus) and their respective applicators should be subject to an approval system which sets a minimum performance level for technical performance and animal welfare. Given the risk to the industry in general, an accreditation scheme for EID suppliers could be considered. This would not replicate ISO or ICAR standards, but would aim to ensure a minimum level of performance and consistency in field application. Further work is required to increase industry confidence in the capabilities and potential benefits of electronic systems, within the legislative framework eventually set.

The following areas have been identified where further information is required. These need to be considered in the context of the overall Defra livestock data programme, notably the South West Livestock Pilot and the development of the National Livestock Register. The list is not exhaustive.

- Optimising EID application to farm specific requirements (including cost:benefit)
- Ergonomic/feasibility studies on the potential of interim part-paper systems
- The scope and funding requirements for delivery models based on Bureau or co-operative organisation
- Policy and technical developments in other EU states including results, limitations and relevance of ongoing trial work
- Further development of auction market and abattoir based systems, based on permanent installations and whole site survey
- Methods of bolus recovery and disposal
- Optimising tag design and performance (technical and animal welfare)
- Health and welfare implications of tagging lambs within the first 4 weeks of life.
- Relative performance of HDX and FDX-B technologies in specific environments
- Bolusing thresholds in young sheep
- Long-term bolus retention rates
- Novel methods of determining parentage, or genotype, other than tagging in early life e.g. by genetic marking
- Specific costs and benefits from a series of testable scenarios designed to meet the minimum regulation
- Further work on economic impact of EID, vertically and laterally, at a national level.
- Innovative approaches to exploit cost:benefit from the application of EID in abattoirs and auction markets.

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11 Scottish EID Project
12 Northern Ireland EID Project

21 APPENDIX – PEN PORTRAITS OF PARTICIPATING FARMS

	Region	Farm type	Role in trial	Number of breeding ewes	Lambing	Participating in NSP	Labour fulltime staff equivalents	Participant age range	Partic-ipant gender	IT competency at the start of the trial	Initial attitude to EID	EID device ewes	EID device lambs	Project Officer pen picture of the farm
1	South West	Lowland	EID farm	370	Indoors & outdoors	N	2	31-45	F	Basic	Negative	Tag	Tag	Small sheep only family run farm. Mule ewes selling finished lambs June- Aug
2	South West	Hill & Upland	EID farm	830	Indoors & outdoors	Y	1.2	31-45	M	Competent no formal training	Neutral	Bolus & tag	Tag	A large Exmoor hill farm with 50 suckler cows and 1000 ewes. Swaledale flock used to produce Mule ewes which are retained to produce Suffolk cross. Lambs mainly finished with about 30% sold store.
3	South West	Upland	Management farm	770	Indoors	N	2.1	31-45	M	Competent no formal training	Positive	Tag	Tag	Mixed upland farm dairy/arable and sheep. Mule ewes producing finished lambs June-Nov
4	South West	Upland	EID farm	500	Indoors & outdoors	Y	2.35	46-60	M	Basic	Neutral	none	Tag	Traditional Exmoor hill farm using traditional breeds. 30 Devon single suckler cows and 300 Exmoor ewes. Flock is pedigree in the NSP so most are already bolused. Noted for quality pedigree rams and Exmoor Mule ewe lambs.
5	Midlands	Hill & Upland	EID farm	830	Indoors & outdoors	N	1.67	31-45	M	Basic	Positive	Tag	Tag	Typical mixed farm spread over several sites. Running a mixture of crossbred ewes and selling lambs finished
6	Northeast	Upland	Management farm	300	Indoors & outdoors	N	1.17	46-60	M	Competent some training	Positive	Bolus & tag	Tag	Upland/Hill farm carrying pedigree Suffolks, Blackface and home bred Mule ewes. Suckler cows.
7	Northeast	Upland	EID farm	350	Indoors & outdoors	N	1.17	46-60	M	Nil	Neutral	Tag	Tag	Family beef and sheep farm, predominately running Scottish Blackface ewes with a lesser number of Mules on the better ground.
8	Northeast	Hill & Upland	EID farm	630	Indoors & outdoors	Y	1.35	46-60	M	Basic	Neutral	Tag	Tag	Hill system with suckler cows and sheep enterprises (Lleyn and Scottish Blackface).
9	Midlands	Upland & Lowland	EID farm	870	Indoors	N	1.25	18-30	M	Competent some training	Positive	Tag	Tag	A large family farm, with two brothers and father. Two farms, one rented the other owned. Welsh Mule ewes crossed with Texels for fat lamb production.
10	Midlands	Lowland	Management farm	1300	Indoors	N	1.85	31-45	M	Competent some training	Positive	Bolus	Bolus	One of two farms under common management. Very high standard of management producing Suffolk cross Mule lambs for slaughter

	Region	Farm type	Role in trial	Number of breeding ewes	Lambing	Participating in NSP	Labour fulltime staff equivalents	Participant age range	Participant gender	IT competency at the start of the trial	Initial attitude to EID	EID device ewes	EID device lambs	Project Officer pen picture of the farm
11	Midlands	Lowland	Paper comparator	551	Indoors	N	1.1	46-60	M	N/A	N/A	N/A	N/A	NE Mules producing Suffolk cross lambs for slaughter. A sheep enthusiast working mostly alone. Unusual system, taking numerous small blocks of land at low rents.
12	Midlands	Lowland	Management farm	1086	Indoors	N	2.1	46-60	M	Nil	Positive	Tag	Tag	Father and son (26) working together, well managed unit producing finished lambs from Suffolk cross Mule ewes crossed with Texel.
13	Northeast	Hill	Paper comparator	350	Outdoors	N	1.67	46-60	M	N/A	N/A	N/A	N/A	Typical small hill farm carrying a Swaledale ewe flock and producing Mule gimmers for sale as breeding stock and finished/store lambs - no hired labour
14	Northeast	Lowland	Management farm	1200	Indoors & outdoors	N	2.8	46-60	M	Basic	Positive	Bolus	Tag	Large hill farm (improved) carrying 1150 Mule ewes producing around 1800 finished lambs/year. Also runs 100 sucklers with most calves finished.
15	Northeast	Hill & Lowland	Management farm	2600	Outdoors	N	1.85	46-60	M	Basic	Positive	Tag	Tag	SDA hill farm, 2500 horned ewes on common grazing,1000 store cattle, and buys 20,000 store lambs finished on arable farms
16	Northeast	Hill	EID farm	1080	Indoors	N	2.17	46-60	M	Competent no formal training	Positive	Tag	Tag	Very extensive hill, carrying suckler cow and sheep (Cheviots) enterprises
17	Northeast	Upland	EID farm	1000	Outdoors	N	2.25	31-45	M	Competent no formal training	Neutral	Bolus	Tag	Large arable farm carrying a flock of Mule ewes and a small pedigree suckler herd.
18	Midlands	Upland	EID farm	800	Indoors	Y	1.7	46-60	M	Nil	Positive	Tag	Tag	Relatively small family farm (170 acres) with only sheep. Welsh Mules with small flock of Lleyn ewes. Farming at about 800 feet above sea level, producing finished Texel cross lambs
19	Midlands	Lowland	EID farm	700	Indoors	N	1.4	46-60	M	Competent no formal training	negative	Tag	Tag	A mixed arable and livestock farm. Managed by farm manager. Running Mule and Suffolk x Mule ewes producing finished lambs.
20	Midlands	Lowland	EID farm	200	Outdoors	N	1.5	46-60	M	Nil	Positive	Tag	Tag	A mixed family farm split 1/3 arable 2/3 grassland. Supports suckler herd and ewe flock. Mules and Suff x ewes producing predominantly finished lambs
21	South West	Upland	EID farm	660	Indoors	N	2.2	46-60	M	Nil	negative	Tag	Tag	Upland Exmoor farm using mainly North Country Mule and Suffolk cross ewes producing commercial Texel and Suffolk cross lambs for sale and finished lambs

	Region	Farm type	Role in trial	Number of breeding ewes	Lambing	Participating in NSP	Labour fulltime staff equivalents	Participant age range	Participant gender	IT competency at the start of the trial	Initial attitude to EID	EID device ewes	EID device lambs	Project Officer pen picture of the farm
22	South West	Upland & Lowland	EID farm	2000	Indoors	N	3.5	18-30	M	Basic	Neutral	Bolus	Tag	Father/son partnership - large mixed farm beef/sheep/arable - Mule ewes selling predominantly finished lambs
23	South West	Lowland	EID farm	154	Indoors	N	1.5	46-60	M	Nil	Positive	Bolus	Bolus	Small part time farmer, with off farm employment. Pedigree Charollais ewes producing breeding ewes/rams
24	South West	Hill	EID farm	379	Outdoors	N	1.4	46-60	M	Nil	Neutral	bolus	Tag	Exmoor hill dairy farm with 150 cows. Uses Scottish Blackface to graze Moorland and fields not available to the dairy herd. Produces mainly Mule lambs
25	South West	Hill	Paper comparator	350	Indoors & outdoors	N	0.67	31-45	M	N/A	N/A	N/A	N/A	Upland sheep only farm. 300 Poll Dorset ewes, mainly bred pure, lambing 3 times in 2 years.
26	South West	Lowland	EID farm	600	Indoors	N	1	31-45	M	Basic	Neutral	Tag	Tag	Large mixed livestock farm producing suckler beef and sheep. Carries Mule ewes, and sells 15-20 finished lambs every week of year to a single butcher.
27	South West	Lowland	EID farm	1400	Indoors	N	1.8	46-60	M	Basic	Neutral	Tag	Tag	50% lowland 50% upland on two sites approximately 5 miles apart. Flock is either Welsh or North Country Mule producing Texel and Suffolk cross lambs all for sale as finished lamb.
28	South West	Upland	Management farm	600	Indoors	N	2	31-45	F	Competent no formal training	Positive	Tag	Tag	A commercial upland flock of 600 North Country Mules all crossed with Charollais to produce finished lambs
29	Northeast	Hill	EID farm	250	Outdoors	N	1.67	46-60	M	Competent some training	Neutral	Bolus	Tag	Small hill farm carrying Swaledale ewes used for Mule ewe lamb production. Wethers sold store. Husband and wife team - also works off farm.
30	Northeast	Hill & Upland	EID farm	680	Outdoors	N	2	31-45	M	Competent some training	negative	Tag	Tag	Medium size hill farm with some lowland 5 miles from steading. Carries Swaledale flock and Texel cross flock for fat lamb production. Also 50 sucklers
31	Midlands	Lowland	EID farm	1060	Indoors	N	1.25	46-60	M	Competent some training	Neutral	Tag	Tag	A manager-run estate with arable, horticultural and pedigree/comm. livestock enterprises. Commercial ewes producing predominantly finished lambs.
32	Northeast	Hill	EID farm	338	Indoors	Y	2.1	46-60	M	Basic	Neutral	Tag	Tag	Upper Wensleydale dairy farmer with a medium size flock, Already double tags. Produces high quality Mule lambs. Sells finished lambs and stores

	Region	Farm type	Role in trial	Number of breeding ewes	Lambing	Participating in NSP	Labour fulltime staff equivalents	Participant age range	Participant gender	IT competency at the start of the trial	Initial attitude to EID	EID device ewes	EID device lambs	Project Officer pen picture of the farm
33	Northeast	Lowland	EID farm	170	Indoors	N	1	46-60	M	Competent some training	Positive	Tag	Tag	Arable farmer who has reduced his ewe flock over the last 2 years. Very typical cinderella enterprise, buys in all replacements - Mules. Stock sold finished
34	Northeast	Lowland	EID farm	470	Indoors & outdoors	Y	2	46-60	M	Competent some training	Positive	Tag	Tag	Lowland flock of various breeds used for fat lamb production, some also sold store. Farm also carries dairy herd and beef finishing unit
35	Northeast	Hill	EID farm	951	Indoors	Y	2	31-45	M	Competent no formal training	Neutral	Tag	Tag	Family dairy farm in SDA area, carrying 800 horned ewes. Sells quality breeding stock. Has very detailed breeding records, double tags, sell wethers mainly as stores
36	Northeast	Lowland	EID farm	380	Indoors	N	0.75	31-45	M	Basic	Neutral	Tag	Tag	Sheep enterprise on mainly a pig farm, with a small arable area. All replacements bought as ewe lambs. Some ewes lamb in Dec. All stock sold finished
37	Midlands	Upland	EID farm	700	Outdoors	Y	2	46-60	M	Basic	Positive	Bolus	Tag	A father & son run beef & sheep farm. Running purebred hill ewes and selling lambs direct to abattoir
38	Midlands	Hill	EID farm	1290	Indoors	Y	4	46-60	F	Basic	negative	Tag	Tag	A very good beef & sheep family farm split between two holdings. Flock consists of Texel and Swaledale ewes. All lambs sold direct to a butcher's abattoir
39	Northeast	Lowland	EID farm	720	Indoors	N	1.43	31-45	M	Basic	Neutral	Tag	Tag	Arable farm mainly with 600 ewes selling finished lambs. Mules crossed with Suffolk, all replacement bought in
40	Midlands	Hill & Upland	EID farm	645	Indoors	N	2.3	46-60	F	Basic	Neutral	Tag	Tag	A well run beef & sheep family farm split between two holdings. The flock consists of a mix of breeds producing lambs for a local abattoir.
41	Midlands	Lowland	EID farm	606	Indoors	N	2.1	31-45	M	Advanced	Positive	Tag	Tag	A family run predominantly grassland farm supporting beef cattle and sheep. Texel cross ewes producing finished lambs, all sold deadweight.
42	Midlands	Lowland	EID farm	1100	Indoors	N	1.4	31-45	F	Basic	Neutral	Bolus	Tag	A family run arable and grassland farm. Running commercial Mule ewes producing predominantly finished lambs, all sold deadweight.
43	Midlands	Upland	EID farm	550	Indoors & outdoors	N	1.35	31-45	M	Basic	Positive	Tag	Tag	Family farm, father and son working together. Texel cross Mule ewes (on trial) crossed with Texel to produce finished lambs after Christmas
44	Northeast	Lowland	EID farm	700	Indoors & outdoors	N	2.17	46-60	M	Competent some training	Positive	Tag	Tag	Lowland flock of various breeds used for fat lamb production. Farm also carries beef finishing unit and grows cereals. Part of larger unit run with brother.

	Region	Farm type	Role in trial	Number of breeding ewes	Lambing	Participating in NSP	Labour fulltime staff equivalents	Participant age range	Participant gender	IT competency at the start of the trial	Initial attitude to EID	EID device ewes	EID device lambs	Project Officer pen picture of the farm
45	Northeast	Hill	EID farm	1100	Outdoors	N	1.67	31-45	M	Nil	Neutral	Tag	Tag	Typical Lakeland farm running Herdwick (landlords flock) and Swaledale ewes. Produces store lambs and breeding stock. Grazes on common land.
46	Midlands	Upland	EID farm	550	Indoors & outdoors	N	4	31-45	M	Competent some training	Positive	Bolus & tag	Tag	A mixed but predominately cattle farm. Run by the family. A mixed crossbred ewe flock producing finished lambs for sale at market
47	Midlands	Lowland	EID farm	270	Indoors	N	2.45	31-45	M	Nil	Positive	Tag	Tag	A relatively small beef & sheep farm with some arable. Farmer keeps very good management records on paper for his Mule flock. All lambs are finished and sent to market
48	Northeast	Hill	EID farm	1250	Indoors & outdoors	Y	2	31-45	F	Competent some training	Positive	Tag	Tag	Mule and Scottish Blackface flocks in addition to a suckler herd. A proportion of homebred Mules gimmers are retained as replacements and the rest sold as breeding stock.
49	North East	Lowland	Bureau	290	Outdoors	N	1.5	46-60	F	Competent some training	Positive	Tag	Tag	Mixed, beef and sheep lowland farm. Commercial and pedigree flocks. Selling store, finished and breeding lambs.
50	South West	Lowland	EID farm	150	Indoors	Y	1.1	31-45	M	Basic	Positive	Tag	Tag	Mother and son partnership. Lowland mixed farm. Finished lambs to market.
51	Midlands	Hill & Upland	EID farm	1650	Indoors & outdoors	Y	3	31-45	M	Basic	Neutral	Tag	Tag	Family hill farm on Welsh borders. Well respected sheep breeder and stock judge. Closed flock of Welsh cross Cheviot ewes.
52	South West	Lowland	EID farm	900	Indoors	Y	1.2	31-45	M	Nil	Neutral	Bolus	Tag	Family run mixed farm. Finished lambs to slaughterhouse. No previous computer experience.
53	South West	Lowland	EID farm	270	Indoors	N	2	46-60	M	Basic	Neutral	Tag	Tag	Mixed farm in West Dorset. Closed flock including Llanwenogs. Sells mainly finished lambs plus some as stores
54	South West	Lowland	EID farm	600	Indoors & outdoors	N	2.1	31-45	M	Nil	Positive	Tag	Tag	Polled Dorset flock with 3 lambings spread from Dec to end April. All lambs are slaughtered locally, and the meat is sold direct to shops/ hotels etc. Has own butchery plant on farm.
55	South West	Lowland	EID farm	280	Indoors & outdoors	N	1	18-30	M	Competent no formal training	Positive	Tag	Tag	Young farmer, recently graduated and has started own business which includes a sheep contracting enterprise. Flock mainly Mules plus a small pedigree flock of Dorsets. Breeds some of own replacements, rest sold as finished lambs.

	Region	Farm type	Role in trial	Number of breeding ewes	Lambing	Participating in NSP	Labour fulltime staff equivalents	Participant age range	Participant gender	IT competency at the start of the trial	Initial attitude to EID	EID device ewes	EID device lambs	Project Officer pen picture of the farm
56	South West	Lowland	EID farm	1600	Indoors	N	2	31-45	M	Competent but no formal training	Positive	Tag	Tag	Farm is large estate in Dorset. Other enterprises include arable, beef and dairy. Flying flock of Welsh Mules, crossed with Beltex and Suffolk to produce fat lambs. Participant in trial is the shepherd/flockmaster.
57	North	Hill	Reference farm	250	Indoors & outdoors	N	N/A	N/A	N/A	N/A	N/A	Tag	Tag	A flock of purebred Swaledale ewes acting as one of two reference flocks for the project.
58	North East	Hill	Bureau	330	Outdoors	Y	1.1	46-60	M	Competent no formal training	Neutral	Tag	Tag	Sheep flock only enterprise, producing pedigree ewe lambs for breeding, and finished lambs.
59	South West	Lowland	EID farm	380	Indoors	N	2	46-60	M	Competent some training	Positive	Tag	Tag	Mixed farm. Breeds own replacements, rest sold as finished lambs
60	South West	Lowland	EID farm	420	Indoors	N	1	46-60	M	Basic	Positive	Tag	Tag	Lowland sheep farm. Single handed owner occupied farm. Finished lambs to market.
61	South West	Upland	EID farm	350	Indoors	N	1.1	61-75	M	Nil	Neutral	Tag	Tag	Beef and sheep farm with upland flock. Finished lambs direct to slaughterhouse. Husband and wife partnership.
62	South West	Lowland	Management farm	200	Indoors	N	2	46-60	M	very Competent	Positive	Bolus	Tag	Sheep sole enterprise on small Dorset farm. Sells finished lambs.
63	Northeast	Lowland	EID farm	535	Indoors	N	2.2	61-75	M	Basic	Positive	Tag	Tag	Lowland arable farm, also carrying a small pedigree cattle herd. Mule ewes purchased as replacements, put to Suffolk and Charollais sires.
64	South West	Upland	EID farm	1250	Outdoors	N	2.1	31-45	F	Competent no formal training	Positive	Bolus	Bolus	This beef and sheep farm is a husband and wife partnership. Hill flocks using common grazing. Some lambs are sold as stores and some are finished.
65	South West	hill & Upland	EID farm	388	Indoors & outdoors	Y	1.6	31-45	M	Competent no formal training	Neutral	Tag	Tag	Hill flock on beef and sheep farm. Finishes all lambs and sells direct to slaughterhouse. Lies within Dartmoor ESA. Tenanted farm. Grazing over common land.
66	North East	Lowland	Bureau	905	Indoors	N	1	31-45	M	Basic	Neutral	No ewes entered	Tag	Mixed beef and sheep farm, producing cross bred breeding sheep for private sale and finished lambs.
67	North East	Hill & Upland & Lowland	Bureau	850	Indoors & outdoors	Y	3	46-60	M	Competent no formal training	Positive	Tag	Tag	Mixed beef and sheep farm, currently rebuilding flock after F&M. Commercial herd producing finished lambs.

	Region	Farm type	Role in trial	Number of breeding ewes	Lambing	Participating in NSP	Labour (fulltime staff equivalents)	Participant age range	Participant gender	IT competency at the start of the trial	Initial attitude to EID	EID device ewes	EID device lambs	Project Officer pen picture of the farm
68	North East	Upland & Lowland	Bureau	1400	Outdoors	N	3	46-60	F	Competent no formal training	Positive	Tag	Tag	Beef and sheep enterprises managed on upland and inbye pastures. Approx 800 sheep committed to the study; mixture of Scottish Blackface and Mules
69	Midlands	Lowland	Reference farm	650	Indoors	N	N/A	N/A	N/A	N/A	N/A	Bolus	Tag	Lowland Mule flock producing crossbred finished lambs, acting as one of two reference flocks for the project

22 APPENDIX – SAMPLE WEIGHTS OF EID DEVICES USED IN 2004

Device	Supplier	Type	HDX/ FDX-B	Total (g)	Male (g)	Female (g)
Bolus	Earlsmere	Midi (15mm x 42mm)	FDX-B	21.3	n/a	n/a
Bolus	Earlsmere	Standard (19mm x 65mm)	FDX-B	56.7	n/a	n/a
Bolus	Allflex	Standard (20mm x 65 mm)	HDX	66.0	n/a	n/a
Tag	Earlsmere	Foldover	FDX-B	3.3	n/a	n/a
Tag	Earlsmere	Closed end	FDX-B	9.8	1.7	8.1
Tag	Allflex	Light weight button	HDX	5.7	1.8	3.9
Tag	Allflex	Light weight button	FDX-B	5.1	1.8	3.3

23 GLOSSARY

Aboca	Earlsmere supplied handheld reader
AMLS	Animal Movement Licensing System
Anidata ES	Allflex flock management software
Anilog	Allflex supplied hand held reader
Bluetooth	An industry specification standard for wireless communication
Bolus	Ceramic coated electronic device placed in the stomach of animals
BMPA	British Meat Processors Association
DIO	Digital Input Output
EDT	Electronic Data Transfer
EID	Electronic Identification Device
ETAS	Ear tag allocation system
Extranet	Web based, closed-user group site
HACCP	Hazard analysis critical control points
HDX	Half duplex
FDX-B	Full duplex
ID	Identification
LAA	Livestock Auctioneers Association
NFU	National Farmers Union
NSP	National Scrapie Plan
NSA	National Sheep Association
Relational system	Numbering system based on cross referencing electronic numbers on the chip, to the external number used for visual animal identification
RFID	Radio Frequency Identification Device
RIA	Regulatory Impact Assessment
Stockminder	Earlsmere-supplied flock management programme
S tag	Secondary tag. An additional tag, inserted following movement to another holding, bearing the flock mark of the new holding
WYSIWYG	Numbering system where the external visual number is the same as that carried electronically in the chip (WhatYouSeeIsWhatYouGet).
Zoonotic	Disease capable of transmission from animals to humans

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