

Full Project Title: **Extension of the method to verify meat from traditional cattle and pig breeds using SNP DNA markers**

Working Title: **Breed identification project**

Contractor: **TRACE Wildlife Forensics Network Limited**

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FINAL REPORT - DRAFT

Executive Summary

The labelling and sale of meat by traditional breed of origin is widely used within the retail industry in the United Kingdom to promote the quality and authenticity of meats and attract a premium price in the marketplace. Both cattle and pig breed societies have expressed concern that mislabelled beef and pork products are being sold in the UK, undermining the business of traditional breed producers and defrauding the consumer.

Defra research project Q01130, completed in 2011, developed a DNA method for verifying the authenticity of four traditional cattle breeds (Aberdeen Angus, Welsh Black, Red Poll, Hereford) and four traditional pig breeds (Berkshire, Hampshire, Gloucester Old Spot, Welsh and Wild Boar). However due to a number of factors relating to the population genetics of the breeds, the method was not considered suitable for Traditional Hereford cattle or Hampshire pig. In addition the British Pig Association formally requested the addition of the Oxford Sandy and Black pig breed. The current extension project (FA0112) was subsequently established to address these issues.

This report details the results of work to extend the existing methods. The method employed is based on a technique known as SNP genotyping that exploit genetic differences among breeds to assign a sample to its breed of origin. Following the collection of additional reference material, DNA samples were analysed using the original laboratory assay and the results were examined to assess whether or not the assay could be successfully extended.

A set of reference samples was collected and genotyped for the Oxford Sandy & Black pig breed. The results showed that it was possible to distinguish these pigs from other pig breeds with a high degree of certainty.

Additional Hampshire pig samples were obtained from varied sources, analysed and combined with the original Hampshire pig reference data. The results showed an increase in genetic diversity within the Hampshire reference data that led to improved assignment performance of market samples.

A set of reference samples was collected and genotyped for the Traditional Hereford cattle breed. The results showed that it was possible to distinguish Traditional Hereford from the US-derived commercial Hereford reference breed used in the original project. Traditional Hereford was incorporated into the method as a separate cattle breed that can be distinguished from other cattle breeds with a high degree of certainty.

The original Standard Operating Procedure for porcine (pork) products was updated to include the Oxford Sandy & Black and expanded Hampshire breed data.

A new Standard Operating Procedure was produced for Hereford beef that includes both Traditional and Commercial Hereford breed assignment.

A number of market samples were taken and tested using the assay. As noted in the original project some mislabelling was discovered.

The research undertaken during this phase of the project is largely novel and is suitable for peer-reviewed publication. One manuscript has already been published, a second manuscript has recently been accepted for publication.

While sufficiently robust, the scientific approach developed and demonstrated in this project is relatively complicated to perform; in order to increase its uptake and application it is recommended that further work be undertaken to simplify the implementation of the breed authentication assay.

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Introduction

This report describes the work undertaken during Defra project FA0112 that aimed to extend the existing DNA methods for the verification of meat from traditional cattle and pig breeds. Specifically, the project focussed on the improvement of the technique for Traditional Hereford cattle and Hampshire pigs and the addition of the Oxford Sandy & Black pig breed.

Project Background

The labelling and sale of meat by traditional breed of origin is widely used within the retail industry in the United Kingdom to promote the quality and authenticity of meats and attract a premium price in the marketplace. This situation provides an opportunity for fraudulent traders to gain financial advantage by deliberately mislabelling meat as originating from a traditional breed. Both cattle and pig breed societies have expressed concern that mislabelled beef and pork products are being sold in the UK, undermining the business of traditional breed producers and defrauding the consumer.

Methods for authenticating the species of meat are now widely available, however the identification of individual breeds within the recognized species of domestic cow and pig are a much more recent development. In 2008 the UK Food Standards Agency (FSA) initiated a research and development project (Project Q01130) to produce a molecular genetic test capable of verifying the breed of cattle or pig meat sold in the the UK. The project, undertaken by Gen-Probe Life Sciences and transferred from FSA to Defra management midway through, concluded in 2011 and was largely successful, delivering Standard Operating Procedures for meat testing applicable to most target breeds.

The original project was established to develop methods for verifying the authenticity of four traditional cattle breeds and four traditional pig breeds. However due to a number of factors relating to the population genetics of the breeds, the resulting method was not considered suitable for Traditional Hereford cattle or Hampshire pig. In addition the British Pig Association had formally requested the addition of the Oxford Sandy and Black pig breed. The current extension project (FA0112) was subsequently established to address these issues.

Project Aims

1. to extend the existing cattle method to distinguish 'Traditional' from 'Commercial' Hereford cattle.
2. to extend the existing pig method to distinguish the Oxford Sandy & Black pig breed from all other pig breeds within the original project.
3. to investigate the issue of assignment in relation to the Hampshire pig breed and where possible improve performance of the method.

Project Design

Scientific Rationale

From a biological perspective, breed identification is equivalent to population assignment. Populations can be defined as groups of individuals that share greater genetic similarity with each other than they do with members of other populations. DNA markers can be used to differentiate populations and assign unknown samples to their correct population of origin. The work undertaken in the initial project demonstrated the use of SNP DNA markers for this purpose, with a panel of 192 SNP markers eventually being identified for the verification of cattle and pig breeds (96 SNPs per breed) (Wilkinson *et al.* 2011 & 2012).

For the current extension project the three separate target breeds were selected for three different reasons.

The Oxford Sandy & Black (OSB) was the simplest breed in terms of scientific rationale, as it was simply an additional breed for which no reference data were previously available. A breed sample therefore needed to be generated using the existing porcine 96-SNP method.

For Hampshire pigs, the initial work had successfully distinguished Hampshire pigs from other breeds in the reference population and control samples; however when market samples were tested their assignment back to Hampshire was poor. One possible reason for this was that the original Hampshire reference samples did not sufficiently represent the genetic diversity that exists within the breed. Further Hampshire samples were therefore sought to examine this issue.

The Hereford cattle had a similar issue; however in this case the authenticated positive control samples were not assigned back to the reference population during validation. The reason for this was considered to be that the reference data was taken from US Commercial Hereford cattle, while the control samples were from UK Traditional Hereford cattle. 'Traditional' and 'Commercial' Hereford in the UK are recognised differently by different cattle stakeholder groups; regardless of the definitions, it was apparent that the two groups were genetically distinct and that genetic diversity within the 'Traditional' Hereford required representation in the reference data; samples were therefore sought to do this.

Once the samples were collected and genotyped, the data would be incorporated into the previous data sets to evaluate the power of the existing 96-SNP panels to differentiate the three target breeds.

Implementation

The project plan was divided into four Tasks (Table 1), running consecutively. Tasks 1-3 were performed by the project partner Minton, Treharne and Davies Ltd (MTD), under subcontract. Genotyping services were provided by ARK Genomics at the Roslin Institute, Edinburgh.

Table 1 List of project Tasks from original proposal

Task	Sub-Task	Description	Activity	Participant
01	01	Sample collection	R&D	MTD
02	01	DNA extraction	R&D	MTD
	02	Genotyping using existing 96-SNP chip	R&D	MTD
03	01	Data analysis and power evaluation	R&D	TRACE
04	01	SOP update and final report preparation	Application	TRACE/MTD

Project Activities

Task 1. Sample Collection

Authenticated reference samples

Reference samples for the three breeds were obtained from a number of holders in the UK. In particular, the British Pig Association provided a great deal of assistance in obtaining OSB and Hampshire pig samples.

A list of the reference samples provided to the project is detailed in Appendix I.

Market samples

In addition to the samples genotyped for the initial reference data sets, a number of market samples were obtained for testing. These included samples sold by breed (predominantly the target breeds) but also generic pork and beef products in order to examine the likely breed origin of non-breed labelled meat.

A list of the market samples obtained for the project is detailed in Appendix I.

2. DNA extraction and SNP genotyping

A total of 132 samples were obtained for the project. DNA was extracted, quantified and the concentration standardized for each sample. Some samples were rejected at this stage due to insufficient DNA recovery.

A total of 116 DNA samples were subsequently genotyped using the Illumina custom SNP chip, containing 96 pig and 96 cattle SNPs. The resulting data were analysed to generate individual DNA profiles for each sample.

3. Data analysis and power evaluation

The data from the three breeds was incorporated into the larger reference data set available from the initial project and then subjected to assignment analysis to examine how the additional samples were distributed relative to the existing breed data. Estimates of assignment power were calculated to evaluate the likely strength of probability with which a meat sample could be assigned to breed origin.

Assignment results

Oxford sandy and black pig

The OSB samples formed a distinct genetic cluster within the result data with 100% assignment of individual samples back to breed. Exclusion tests supported this assignment with no OSB samples excluded from the breed.

Hampshire pig

The additional Hampshire reference samples (Hants_extension) were analysed separately to the original Hampshire samples (Hants_original). All individuals were assigned back to their reference population. The second most likely population for all Hants_original samples was Hants_extension. The converse was not always the case, with the second ranked population for 6 of 15 Hants_extension samples being non-Hampshire pigs. This suggests that the Hants_original reference data did not

represent the full variation within the breed, as suspected, and supports the addition of Hampshire samples from multiple UK sources within this extension project.

To investigate whether the additional Hampshire reference samples had improved assignment of market samples from the original project, all Hampshire references (Hants_original and Hants_extension) were combined to form a single reference population. The market samples were then re-assigned against this large reference population.

In the original project, none of the seven Hampshire market meat samples was assigned to Hampshire as the most likely breed. In the re-assignment, five of the seven samples were assigned to Hampshire. These results strongly support the increase in the size and sample diversity of the Hampshire reference population, as more market samples are now being identified to breed. However it is worth noting that all of these market samples also had multiple SNPs missing from their DNA profiles (between 8 and 12 SNP markers per sample). This results in an elevated exclusion probability, meaning that even though the most likely breed was usually Hampshire, the level of confidence in any assignment was fairly low. In an applied situation, with a threshold cut-off of no more than six SNP markers missing from a sample profile, these breed assignments would not be considered valid.

Traditional Hereford cattle

The results for Traditional Hereford samples showed that this group formed a distinct genetic population to the Commercial Hereford originally used as Hereford reference data. The Traditional Hereford samples were therefore treated as a separate 'breed' for the purposes of assignment. All but one of the Traditional Hereford samples was assigned to Traditional Hereford rather than the Commercial Hereford or any other cattle breed. A single sample was excluded from all breeds. In addition, the Traditional Hereford samples from the original project were also assigned to the newly created Traditional Hereford reference population.

These results support the establishment of a separate reference population for Traditional Hereford and highlight that the use of US derived population data alone was inadequate and not representative of the meat sold under the Hereford breed label in the UK.

Market samples

A number of pork and beef market samples were analysed to examine breed assignment in breed-labelled meat products and also meat products that had no breed designation. The results for beef and pork products are displayed in Tables 1 and 2, respectively.

For beef, breed-labelled Aberdeen Angus, Hereford and Welsh Black products were tested. For each breed the results indicated that a number of products were consistent with their breed label, while others were not. Non-labelled products were assigned to a range of breeds, although in most cases there was the possibility that the animals were of mixed breed origin.

For pork, only two of the seven breed-labelled products were verified using the DNA test (both Hampshire products). The remaining five products returned mixed breed results, three of which were not labelled as cross breed products and which did not conform to their breed label.

A further sixteen pork products without breed labels were tested in an attempt to understand the composition of standard pork products in the UK marketplace. The

results showed a mixture of the common commercial breeds, particularly large white and landrace, but once again, the tests indicated that many products were likely to be from cross bred animals. The one surprising result was a sample identified as wild boar, but which was labelled as British pork. Wild boar is normally a premium product and is expected to be labelled accordingly, rather than used as a standard product. The results for this sample were very clear cut and cannot be easily explained.

Power analysis

In order to evaluate the power of assignment following the inclusion of new reference data, the calculations performed in the original project were updated. Following the original assay design, the ability to identify individual pig breeds was assessed, whereas for cattle, the ability to distinguish target breed from non-target breed was evaluated. The results show that the probability of correct assignment was >99.9% for OSB and Hampshire pigs when compared against all other breeds on a pairwise basis. For cattle, the probabilities of correct assignment among Traditional Hereford, Commercial Hereford and non-Hereford cattle are shown in Table 3. These results show that the strength of all tests is greater than 99% in all cases.

These figures indicate the level of confidence that is to be expected when applying the test in an applied context, e.g. for enforcement purposes.

Table 1 Results of market samples for bovine (beef) testing. Results not corresponding to breed label are highlighted in the right hand column.

Sample No.	Claimed breed	Source	Assigned breed	Conclusion
11571	A. Angus	Supermarket	sample failed	n/a
11570	A. Angus	Supermarket	sample failed	n/a
12688	A. Angus	Leicestershire CC	Angus	verified
12689	A. Angus	Leicestershire CC	Trad Hereford	Angus excluded
12690	A. Angus	Leicestershire CC	Charolais	Angus excluded
12683	Hereford Beef	Leicestershire CC	Trad Hereford	verified
12684	Hereford Beef	Leicestershire CC	Charolais	Hereford excluded
11804	Uruguayan Hereford	Supermarket	Hereford	verified
11487	Welsh black	Swansea CC	Welsh Black	verified
12377	Welsh Black	Swansea CC	Welsh Black	verified
13126	Welsh Black	Swansea CC	Welsh Black	verified
12803	Welsh Black	Powys CC	Welsh Black	verified
12804	Welsh Black	Powys CC	Limousin	Welsh Black excluded
12808	Welsh Black	Powys CC	Charolais	Welsh Black excluded
11810	Beef Steak	Supermarket	Trad Hereford	n/a
11811	British Beef	Strathvale	Limousin	n/a
11812	British Beef	Gerald David	Piedmontese	n/a
11809	Organic British Beef	Supermarket	Hereford / Angus	n/a

Table 2 Results of market samples for porcine (pork) testing. Results not corresponding to breed label are highlighted in the right hand column.

Sample No.	Claimed breed	Source	Assigned breed	Conclusion
12685	Berkshire cross breed ham	Leicestershire CC	Mixed	Mixed
12686	Cross bred Hampshire ham	Leicestershire CC	Mixed	No sign of Hampshire
12682	Hampshire Gammon ham	Leicestershire CC	Mixed	No sign of Hampshire
11795	Hampshire	Supermarket	Mixed	No sign of Hampshire
10541	Hampshire	Butcher	Hampshire	verified
10542	Hampshire	Butcher	Hampshire	verified
12687	Glos Old spot bacon	Leicestershire CC	Mixed	No sign of GOS
11803	British diced Pork	Butcher	Landrace	Landrace
11562	British Pork	Supermarket	Large white	Mixed
11563	British Pork	Supermarket	Landrace/Welsh	Mixed
11796	British Pork	Supermarket	Large white	Mixed
11797	British Pork	Supermarket	B. Saddleback	Mixed
11798	British Pork	Supermarket	Large white	Mixed
11799	British Pork	Supermarket	Landrace	Mixed
11801	British Pork	Supermarket	Wild Boar	Wild Boar
11560	British Pork Chops	Supermarket	B. Saddleback	Mixed
12681	Free range smoked lardons	Leicestershire CC	Mixed	Mixed
11802	French Belly Pork	Supermarket	Large white	Mixed
11561	Outdoor Bred Pork	Supermarket	Landrace	Mixed
11559	Scottish Outdoor Pork	Supermarket	Landrace	Mixed
11564	Uk Belly Pork	Butcher	Large white	Mixed
11565	Uk Belly Pork	Butcher	B. Saddleback	B. Saddleback
11566	Uk Belly Pork	Butcher	Large white	Mixed

Table 3 Average probabilities for the certainty of an assignment result under different scenarios. The power to exclude non-Hereford samples is relatively reduced due to the increased level of genetic diversity within this multi-breed 'population'.

Claim	Alternative		
	Trad Hereford	Comm Hereford	Non Hereford
Trad Hereford		0.9999823	0.9922043
Comm Hereford	0.999925		0.994078

4. SOP Production & Update

The Standard Operating Procedures (SOPs) produced in the initial project have been subsequently updated to incorporate the data from the extension project. For the porcine SOP this involved adding the Oxford Sandy & Black breed and updating the calculation templates for the Hampshire breed. For the cattle SOP the update required the creation of a procedure for the Hereford (Commercial and Traditional breeds) as this had not been attempted at all in the original project.

The new and revised SOPs can be found in Appendix II.

Conclusions

- A set of reference samples was collected and genotyped for the Oxford Sandy & Black pig breed. The results showed that it was possible to distinguish these pigs from other pig breeds with a high degree of certainty.
- Additional Hampshire pig samples were obtained from varied sources, analysed and combined with the original Hampshire pig reference data. The results showed an increase in genetic diversity within the Hampshire reference data that led to improved assignment performance of market samples.
- A set of reference samples was collected and genotyped for the Traditional Hereford cattle breed. The results showed that it was possible to distinguish Traditional Hereford from the US-derived commercial Hereford reference breed. Traditional Hereford was established as a separate reference cattle breed that can be distinguished from other cattle breeds with a high degree of certainty.
- The Standard Operating Procedures for porcine (pork) products was updated to include the Oxford Sandy & Black and expanded Hampshire breed methods.
- A new Standard Operating Procedures was produced for Hereford beef that includes both Traditional and Commercial Hereford breed assignment.
- The research undertaken during this phase of the project is largely novel and is suitable for peer-reviewed publication. One manuscript has already been published in the journal BMC Genetics, focussing on the selection and assessment of SNP panels for breed identification in cattle (Wilkinson *et al.* 2011). A second manuscript, focussing on the development of a SNP assay for breed identification in pigs, has recently been accepted for publication in BMC Genomics (Wilkinson *et al.* 2012).

Acknowledgements

The work was funded by Defra's food authenticity programme. The project is grateful to the British Pig Association for help with the collection and provision of pig samples and to all other individual sample providers who supplied material for testing.

Glossary

FSA	United Kingdom Food Standards Agency.
Illumina	Illumina Inc. is a US-based company that produces molecular genetic assays for genotyping large numbers of SNP markers
Beadexpress	The Beadexpress apparatus is an Illumina platform for genotyping up to 384 SNP markers simultaneously for a single sample.
SOP	Standard Operating Procedure
SNP	Single Nucleotide Polymorphism – a type of genetic marker

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Appendix I Samples obtained for the project

Bovine			
Reference samples			
Number	Breed	Source	Additional info
10120	Trad. British polled	Helen Macloed	UK310606
10119	Traditional Hereford	Helen Macloed	Killed 9/09
10121	Traditional Hereford	Helen Macloed	Killed 2/11
10122	Traditional Hereford	Helen Macloed	Killed 7/11
10123	Traditional Hereford	Mr Powell	Kill 5 15/9/11
10124	Traditional Hereford	Mr Powell	Kill 6 15/9/11
10125	Traditional Hereford	Mr Powell	Kill 7 15/9/11
10544	Traditional Hereford	Keith Siddorn	UK160152300275
10545	Traditional Hereford	Keith Siddorn	UK160152500277
10546	Traditional Hereford	Keith Siddorn	UK160152400276
10547	Traditional Hereford	Keith Siddorn	
10548	Traditional Hereford	J & N Beavan	
11292	Traditional Hereford	Happy Herefords	UK288863100002
11665	Traditional Hereford	E. Brunskill	
11813	Traditional Hereford	Peter Talbot	UK171718-600014
11814	Traditional Hereford	Peter Talbot	UK171718-700016
11815	Traditional Hereford	Peter Talbot	UK171718-700015
11816	Traditional Hereford	Peter Talbot	
12707	Traditional Hereford	Treberdd Farm	
RBC10/006	A. Angus control	Reference	
RBC10/047	Welsh Black control	Reference	
Market samples			
11570	A. Angus	Co-operative	
11571	A. Angus	Marks & Spencer	
12688	A. Angus	Leicestershire CC	
12689	A. Angus	Leicestershire CC	
12690	A. Angus	Leicestershire CC	
11810	Beef Steak	Asda smart price	
11568	British Beef	Asda	
11569	British Beef	Asda	
11572	British Beef	Frank Lee & Son	
11573	British Beef	AR Edwards Butchers	
11574	British Beef	A Sykes Butchers	
11800	British Beef	Moordale	
11806	British Beef	Marks & Spencer	
11807	British Beef	Sainsbury	
11808	British Beef	Morrisons	
11811	British Beef	Strathvale	
11812	British Beef	Gerald David & Family	
11567	British beef	Sainsbury	
11805	British Beef	Tesco Market value	
12683	Hereford Beef	Leicestershire CC	
12684	Hereford Beef	Leicestershire CC	
11809	Organic British Beef	Waitrose	
11804	Uruguayan Hereford	Asda	
11487	Welsh black	Swansea CC	
12377	Welsh Black	Swansea CC	
12803	Welsh Black	Powys CC	
12804	Welsh Black	Powys CC	
12808	Welsh Black	Powys CC	
13126	Welsh Black	Swansea CC	

Porcine			
Reference samples			
Number	Breed	Source	Additional info
11958	HAMPSHIRE	Sue Hutson	Anna 35 (1006)
11959	HAMPSHIRE	Sue Hutson	Anna 28 (776)
11960	HAMPSHIRE	Sue Hutson	Judy 16 (726)
11961	HAMPSHIRE	Sue Hutson	Precious (878)
11962	HAMPSHIRE	Sue Hutson	Anna 33 (894)
12355	HAMPSHIRE	Guy Kiddy	Bolsham Precious
12356	HAMPSHIRE	Guy Kiddy	Bolsham Golden Eagle
12357	HAMPSHIRE	Guy Kiddy	Bolsham Anna
12548	HAMPSHIRE	Deerpark Pedigree Pigs	132
12549	HAMPSHIRE	Deerpark Pedigree Pigs	13
12550	HAMPSHIRE	Deerpark Pedigree Pigs	221
12551	HAMPSHIRE	Deerpark Pedigree Pigs	498
12552	HAMPSHIRE	Deerpark Pedigree Pigs	609
12553	HAMPSHIRE	Deerpark Pedigree Pigs	620
12554	HAMPSHIRE	Deerpark Pedigree Pigs	578
12555	HAMPSHIRE	Deerpark Pedigree Pigs	605
12556	HAMPSHIRE	Deerpark Pedigree Pigs	625
12557	HAMPSHIRE	Deerpark Pedigree Pigs	636
12559	HAMPSHIRE	JSR Genetics	5
12560	HAMPSHIRE	JSR Genetics	1330
12561	HAMPSHIRE	JSR Genetics	1358
12562	HAMPSHIRE	JSR Genetics	1359
12563	HAMPSHIRE	JSR Genetics	1366
12564	HAMPSHIRE	JSR Genetics	1385
12565	HAMPSHIRE	JSR Genetics	1387
12566	HAMPSHIRE	JSR Genetics	1379
12567	HAMPSHIRE	JSR Genetics	1424
12568	HAMPSHIRE	JSR Genetics	1431
12569	HAMPSHIRE	JSR Genetics	1436
12570	HAMPSHIRE	JSR Genetics	1460
12121	OSB	Ansty herd	OS0017144
12122	OSB	Ansty herd	OS0018272
12123	OSB	Ansty herd	OS0017986
12124	OSB	Ansty herd	OS0017943
12125	OSB	Ansty herd	OS0018252
12126	OSB	Ansty herd	R002131OS
12127	OSB	Ansty herd	OS0018243
12128	OSB	Ansty herd	R001621OS
12129	OSB	Ansty herd	OS0018257
12130	OSB	Ansty herd	OS0018258
12131	OSB	Ansty herd	R002378OS
12132	OSB	Ansty herd	R001620OS
12133	OSB	Ansty herd	OS0018283
12393	OSB	Henshall	R000898OS
12394	OSB	Henshall	R000745OS
12395	OSB	Henshall	R000655OS
12396	OSB	Henshall	R002353OS
12397	OSB	Henshall	R001506OS
12398	OSB	Henshall	R001818OS
12621	OSB	Mr Park	TPE
12622	OSB	Mr Park	290
12623	OSB	Mr Park	294
12624	OSB	Mr Park	301
12625	OSB	Mr Park	312
12626	OSB	Mr Park	313
12627	OSB	Mr Park	315
12628	OSB	Mr Park	323
12629	OSB	Mr Park	324
12630	OSB	Mr Park	328

Market samples		
Number	Breed	Source
12685	Berkshire cross breed ham	Leicestershire CC
11803	British diced Pork	Gerald David & Family
11562	British Pork	Sainsbury
11563	British Pork	Asda
11796	British Pork	Morrisons
11797	British Pork	Waitrose
11798	British Pork	Marks & Spencer
11799	British Pork	Sainsbury
11801	British Pork	Tesco Market value
11560	British Pork Chops	Co-operative
12686	Cross bred Hampshire ham	Leicestershire CC
12681	Free range smoked lardons	Leicestershire CC
11802	French Belly Pork	Asda smart price
12687	Glos Old spot bacon	Leicestershire CC
10541	Hampshire	Sue Hutson
10542	Hampshire	R & L Waddell
11795	Hampshire	Waitrose
12682	Hampshire Gammon ham	Leicestershire CC
11561	Outdoor Bred Pork	Asda
11559	Scottish Outdoor Pork	Marks & Spencer
11564	Uk Belly Pork	AR Edwards Butchers
11565	Uk Belly Pork	A Sykes Butchers
11566	Uk Belly Pork	Frank Lee & Son

Appendix 2 Bovine and Porcine SOPs

See attached files