BOV 92N

SEAC 31/1

THE RISK OF TRANSMISSION OF BSE TO SHEEP VIA FEED

The committee has previously received papers on the risk to man from sheep (SEAC 24/3 incorporating earlier papers, and later 25/5). This document contains additional information requested at the meeting of 4 April, and is divided into 4 parts as follows:-

Part A - details of the production of concentrate feed for sheep and other species.
This section addresses the risk of exposure via feed.

Part B - an overview of the management systems and their effect on the risk of exposure if concentrate feed contained BSE agent.
This section briefly describes how certain flocks would have been at greater risk than others.

Part C - further detail of the transmission characteristics of BSE after subpassage through other species, including sheep.
This section is intended to compare the efficiency of transmission of BSE to mice according to the intermediate species through which it may have passed.

Part D - an overview of scrapie in sheep.
This section summarises available data on scrapie incidence, and discusses the options for targeting flocks that may be infected with BSE, and for determining the true incidence of scrapie.

Index of figures and tables

BOV 92 N

PART A - THE RISK OF EXPOSURE THROUGH FEED.

How much feed is produced and consumed

Annual production figures for concentrate feed from 1980 to 1994 are summarised in Figure 1 and Tables 1-3. These figures were abstracted from MAFF published statistics which are themselves derived from statutory returns made by feed manufacturers. Unfortunately there have been changes in the format of returns over the years and therefore all the details that would have been helpful are not available. One vital piece of information that is not held centrally is the extent to which meat and bone meal was used in sheep rations (see below).

Production of sheep concentrates has steadily increased since 1980. This reflects two major changes during this period - an increase in the sheep population and a trend towards earlier lambing with consequent need to house and provide supplementary feed. The sheep population statistics national slaughter figures are summarised in Table 5, and indicate that while the total population is rising slaughter trends are down, due to the exportation of sheep for slaughter in other member states. The current maximum population, taking all adults and lambs into account, is approximately 41 million. The greatest amount of sheep concentrate produced in any year was 567,200 tonnes in 1994. This compares with a peak of 4,556,000 tonnes in 1981 for cattle, 2,281,800 tonnes for pigs in 1994, and 3.501,600 for poultry, also in 1994. Although it is possible to calculate average consumption figures per sheep, it will be clear later that feeding practices vary so significantly that averaging would underestimate the risk in certain flocks.

Table 2 gives a better indication of the type of sheep feed produced, with rations for breeding ewes comprising some 65 per cent of the total. Small quantities of protein concentrate would be used for home mixing of rations.

Table 3 gives some detail of the amount of animal products used in finished rations since 1988. In view of the ruminant feed ban it would have been almost exclusively for pig and poultry rations, with small quantities for pet, horse and game rations. Approximately half of the animal products used consists of fish meal. It would of course be illegal to use meat and bone meal in sheep rations since July 1988.

BOV 92 N

Was meat and bone meal incorporated into sheep diets before 18 July 1988?

MAFF statistics do not record inclusion rates for raw materials in sheep rations. UKASTA has therefore been approached with a request that some of their larger member companies search their records for data of inclusion rates. Ration details for the mid-1980s are not plentiful, but it seems as if, as with cattle feed, whether or not meat and bone meal was incorporated into finished rations varied from company to company. Some definitely had a policy of exclusion due to concerns about its palatability to sheep. Others did use meat and bone meal, some regularly and others irregularly depending on price structures of competing raw materials.

Incorporation rates varied according to the intended age group. Breeding sheep rations could have contained 1-5% meat and bone meal, grower/finisher rations - up to 5%, while protein concentrates for subsequent dilution on farm as part of a home mix could have up to 15%. Eventual inclusion rates in the finished feed should have been down to 3% when cereals were added.

Conclusion

While increasing amounts of concentrate feed for sheep will have been produced and consumed over the past 15 years, this did not result in an increase in per capita consumption of feed because demand arose in part because of the rise in sheep population. Inclusion rates were also low, and taking into account the low production vs population ration, the per capita exposure to meat and bone meal would have been significantly lower than for cattle. In certain flocks however exposure should have been significantly greater (see below). In addition, it has to be acknowledged that exposure as a result of accidental contamination of feed in the mill, as has recently been identified in investigations into the ongoing BSE epidemic, would have occurred. This would however be likely to result in single rather than multiple infections in any flock.

BOV 92 N

PART B - AN OVERVIEW OF FLOCK MANAGEMENT SYSTEMS

Table 4 provides data which supports guidance given verbally on previous occasions. Data for 1993 and 1994 are derived from the MLC Sheep Yearbooks published in 1994/1995.

The table shows that flock sizes tend to be larger in hill flocks, but that these are extensively managed, relying less on supplementary feeding, to the point where lambs rarely receive concentrate feed. Adults in such flocks may receive some concentrates, but usually far less than in lowland flocks. Hill flocks are primarily low input (low cost) and low output business, where low output per ewe is countered by increases in flock size and lower overheads. The hill flock sells few lambs direct for slaughter because they are born later, and can rely solely on grass for feed, but consequently take longer to fatten. Most therefore are sold for breeding or finishing (fattening) before the onset of the next winter, and without having received any concentrates as a routine.

At the other extreme is the early lambing flock, which tends to be smaller in size, requires winter housing, and a considerable amount of supplementary feeding. Where lambing is extremely early (early winter) with a target of Easter for the selling of fat lambs, it is inevitable that the lambs require large quantities of supplementary feed.

Intermediate regimes exist as shown for lowland and upland early/spring lambing, the ability to sell lambs for slaughter depending on early access to grass, as well as the breed. Some flocks act as sources of replacement breeding stock for later cross-breeding, and thus do not need to rely on supplementary feeding prior to sale.

Conclusion

The type of flock most likely to have been exposed to BSE via feed, on the assumption that the feed is contaminated, is the early lambing flock. In such circumstances however, the risk to other flocks is significantly lower because most of the lambs are fed and slaughtered within the first few months of life (at an early stage of pathogenesis if infected) and would not move to other flocks to expose sheep that might not have been challenged via feed. Cull ewes are also more likely to have been slaughtered rather than sold for further breeding.

BOV 92 N

PART C - THE TRANSMISSION CHARACTERISTICS OF BSE AFTER PASSAGE THROUGH SHEEP AND OTHER SPECIES.

Moira Bruce has kindly supplied the data incorporated into Table 10 which indicates that BSE is highly efficient in transmitting to some strains of mice irrespective of intermediate species through which it may have been passaged. In effect the hit-rate is almost 100 per cent for all when deaths due to intercurrent disease are excluded from the negative count.

PART D - AN OVERVIEW OF SCRAPIE IN SHEEP

Have there been any changes in the incidence of scrapie?
The purpose of this review is to assess whether or not there is evidence of an increase in the incidence of scrapie which may be attributable to transmission of BSE via feed. There are several factors however which make interpretation of data difficult.

Historically any submission to a Veterinary Investigation Centre which resulted in a diagnosis of scrapie was recorded on MAFF's VIDA (Veterinary Investigation Diagnosis Analysis) database. Submissions were however infrequent, with many farmers with scrapie affected sheep being capable of recognising the disease without submission for post mortem examination. Most would acknowledge that official statistics did not fully represent the true picture. This was proved when payments were offered for sheep submissions when establishing the scrapie rendering experiment when 2867 brains were collected between October 1990 and August 1992. These submissions were also recorded on the system and have distorted the data slightly by indicating an increase in diagnoses.

Subsequently scrapie became a notifiable disease in 1993, and the effect of this is that within any two year period only the first case in a flock is recorded. The statistics since 1993 therefore denote affected flocks, while the VIDA data relates to cases.

Available statistics are summarised in Tables 7, 8 and 9. The latter makes some attempt at indicating the geographical distribution of affected flocks. Because data recording has been confused as a result of the restructuring of the State Veterinary Service, the figures are sorted according to the new structure in order to permit their rapid production for SEAC.

Conclusion
Statistics on diagnosis do not support the likelihood of rising incidence of scrapie in sheep linked to transmission of BSE from cattle. There are no reports of clinical signs or pathology that suggest any detectable shift from the expected parameters for scrapie which might be attributable to BSE.

BOV92N

How might such transmission be detected?

Proving that BSE can be transmitted experimentally to sheep does not of course prove that such transmission has occurred naturally. There does appear to have been some opportunity for exposure via feed, but at a far lower frequency than to cattle.

The slaughter of some 50 per cent of the sheep population each year reduces the risk of disease becoming endemic after intial transmission via feed. Nevertheless, as pointed out in part B that risk will vary significantly from flock to flock, and as seen in Tables 9 and 10 some sheep are kept for breeding to an equivalent age to cattle.

Any search for scrapie or BSE in sheep is however difficult, and is compromised by the fear of trading penalties while compensation on identification of affected animals would be small. Nevertheless, there are options, some of which have already been implemented, which may be worthy of expansion.

- **Project SE 1919** - ***Studies to identify possible homologies between scrapie agents in the British sheep population and the agent of BSE by strain typing (CVL)*** - This project is already under way, but is still at the collection phase having offered payment to owners of flocks already known to have had scrapie confirmed. Brains from sheep born after January 1991 will then be pooled according to sheep genotype (Val_{136}/Gln_{171}; Ala_{136}/Gln_{171}) in order to increase the opportunity of isloating a BSE type strain. Collections are targeting animals born after 1991 is intended to avoid flocks that may be affected by primary BSE transmitted via feed. The sensitivity of the project may be partially compromised by pooling of brains, but it is considered that the success of transmissions to mice with BSE will prove advantageous.

- **A similar project (SE1423) at NPU will attempt isolation from single** sheep, also selected according to genotype in order to increase the possibility of isolating BSE. This project will not provide the nationwide screen that may be needed to detect BSE at low incidence, but will avoid the loss of sensitivity introduced by brain pooling.

- **Target known flocks with scrapie** - especially lowland, early lambing, and scrapie affected. Some such flocks will be included in the trawl for SE1919. Others are part of an epidemiological study at CVL, but identification of flocks generally follows confirmation of disease by statutory means. Other than in SE1919 there are no plans to strain type in such flocks.

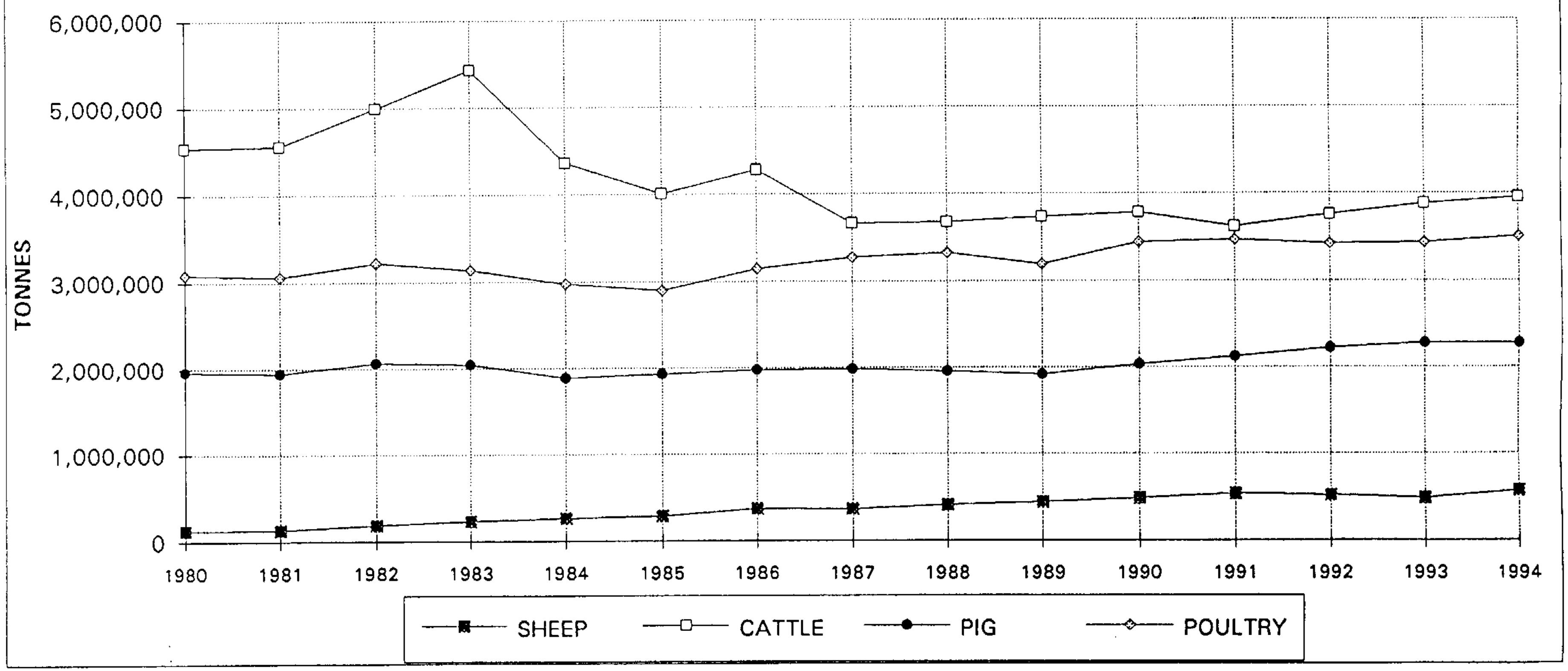
BOV 92 N

- **Collect heads of adult sheep slaughtered for human consumption** - while potentially this could permit nationwide screening, it does suffer from the same difficulties as the screening of cattle at slaughter. These include the possible late appearance of pathology in the CNS relative to onset of clinical disease, and more specific to scrapie the possibility that healthy sheep have vacuolation in their brains, while clinically affected animals may show no lesions. Alternative techniques might be used, such as SAF detection and immunoblotting, but again there would be major difficulties with testing capacity and specificity of tests.

D Matthews

D Matthews

FIGURE 1 - ANNUAL PRODUCTION OF FEED FOR FARM LIVESTOCK



BOV 92 N

BOV 92N

TABLE 1

ANNUAL PRODUCTION OF FEED FOR FARM LIVESTOCK (TONNES)

	SHEEP	CATTLE	PIG	POULTRY
1980	131,000	4,539,900	1,962,700	3,088,200
1981	136,200	4,556,000	1,947,400	3,062,500
1982	189,900	4,994,800	2,066,700	3,220,900
1983	236,500	5,433,900	2,048,700	3,135,300
1984	267,400	4,361,600	1,889,200	2,975,600
1985	293,400	4,008,500	1,931,100	2,898,300
1986	373,900	4,281,200	1,975,100	3,142,300
1987	368,000	3,660,000	1,985,800	3,269,100
1988	413,800	3,671,600	1,959,100	3,322,600
1989	445,900	3,730,700	1,916,800	3,188,800
1990	485,000	3,783,700	2,032,300	3,437,100
1991	537,300	3,615,900	2,119,200	3,465,300
1992	519,100	3,756,200	2,221,600	3,423,500
1993	487,200	3,884,500	2,279,200	3,436,600
1994	567,200	3,953,700	2,281,800	3,501,600

TABLE 2

SHEEP RATIONS BY CATEGORY

	BREEDING	GROWER FINISHER	PROTEIN CONC	TOTAL
1992	341,000	171,100	7,000	519,100
1993	334,400	145,300	7,500	487,200
1994	364,200	196,700	6,300	567,200

TABLE 3

USE OF ANIMAL PRODUCTS IN ALL ANIMAL FEED

	ANIMAL PRODUCTS	MEAT & BONE	PROTEIN CONC	OIL/FAT
1988	450,100		84,300	222,800
1989	439,000		78,400	236,300
1990				
1991	363,300		38,900	172,200
1992	195,600	184,400	30,500	277,500
1993	206,300	185,700	28,200	283,100
1994	211,300	184,000	27,400	260,300

BOV 92 N

TABLE 4

SOME PRODUCTION DATA FOR CATEGORIES OF SHEEP FLOCKS

(average annual figures given - based on 1993 data (1994 in brackets))

		LOWLAND SPRING LAMBING	EARLY LAMBING	UPLAND SPRING LAMBING	HILL
FLOCK SIZE		537	250	738	736
EWE DEATHS %		5	5	4	
LAMB DESTINATION %					
	SLAUGHTER	58.8	92.6	57.6	19.4
	BREEDING	6.8	4	16.5	37.2
	FEEDING	34.5	3.4	25.9	43.4
CONCENTRATES FED					
	EWE (kg)	48 (56)	56 (67)	41 (49)	21 (31)
	LAMB (kg)	15 (18)	76 (81)	NIL	NIL

Based on data from studies of	
LOWLAND SPRING	217 (203) flocks
EARLY LAMBING	33 (32) flocks
UPLAND	128 (97) flocks
HILL	28 (16) flocks

All abstracted from the
MLC Sheep Yearbook 1994 (1995)

TABLE 5 SEAC 31/1

SHEEP POPULATION AND SLAUGHTER STATISTICS

YEAR	TOTAL POPULATION	SLAUGHTERED RAMS & EWES	SLAUGHTERED OTHERS & LAMBS
1980	30,220,758		
1981	30,787,082		
1982	31,655,085		
1983	32,581,270		
1984	33,185,548		
1985	33,870,324		
1986	35,148,284	1,374,265	13,655,028
1987	36,473,111	1,520,000	13,907,518
1988	38,499,124	1,517,788	15,070,807
1989	40,245,556	1,731,870	17,122,010
1990	40,853,875	1,812,178	17,444,766
1991	40,788,844	1,647,402	18,638,850
1992	41,083,400	1,549,722	16,907,120
1993	41,031,771	1,649,756	16,210,446
1994		2,241,395	15,917,066
1995*		2,510,889	16,250,900

* = provisional data

TABLE 6 SEAC 31/1

ESTIMATED AGE DISTRIBUTION OF BREEDING FLOCK IN GREAT BRITAIN IN 1994

Age	1-<2	2-<3	3-<4	4-<5	5+	TOTAL
Rams	132,102	124,846	106,985	62,981	38,236	465,150
Ewes*	3,443,327	5,098,582	5,092,121	3,635,384	2,323,997	19,593,411
Total	3,575,429	5,223,428	5,199,106	3,698,365	2,362,233	20,058,561

*included animals bred from in their first year.

Note that this table is calculated by using age structure data from flocks during epidemiological investigations into their scrapie problems.

BOV 92 N

TABLE 7 **SEAC 31/1**

SHEEP SCRAPIE CASES BY YEAR OF DIAGNOSIS PRE-NOTIFICATION

YEAR	NUMBER OF CASES
1980	94
1981	100
1982	129
1983	143
1984	153
1985	143
1986	153
1987	176
1988	211
1989	224
1990	334
1991	896
1992	589
1993*	83
1994*	61

totals for the following years influenced by trawl for heads for rendering experiment

*some will also be recorded under notification details

TABLE 8 **SEAC 31/1**

SHEEP SCRAPIE CASES BY AGE - PRE-NOTIFICATION 1980-1990

Age	<1	1-<2	2-<3	3-<4	4-<5	5+	Total
No. cases	1	137	662	343	123	68	1,334

BOV 92 N

TABLE 9 - SEAC 31/1					
	SCRAPIE NOTIFICATIONS JANUARY 1993 TO APRIL 1996				
ANIMAL HEALTH OFFICE	YEAR OF LABORATORY CONFIRMATION				
	1993	1994	1995	1996	Total
AYR	6	3	5	0	14
BURY ST EDMONDS	9	2	5	2	18
CAERNARFON	6	4	4	2	16
CARDIFF	6	2	0	0	8
CARMARTHEN	9	6	4	0	19
CARLISLE	37	8	13	5	63
CHELMSFORD	2	0	0	0	2
CUMBRIA	0	0	0	1	1
DERBY'S	0	0	1	0	1
DUMFRIES	7	7	2	0	16
EXETER	16	15	10	1	42
GALASHIELS	4	2	1	0	7
GLOUCESTERSHIRE	19	8	7	4	38
INVERNESS	3	1	1	0	5
INVERURIE	33	27	17	3	80
LEEDS	27	21	5	2	55
LEICESTERSHIRE	10	7	2	2	21
LINCOLNSHIRE	8	5	6	1	20
LLANDRINDOD WELLS	11	4	2	0	17
PERTH	3	4	1	0	8
PRESTON	2	4	0	1	7
READING	12	6	8	1	27
REDHILL	16	9	2	0	27
SHREWSBURY	21	10	10	1	42
SOUTH YORKSHIRE	0	0	0	1	1
STAFFORDSHIRE	6	1	4	1	12
TAUNTON	5	6	2	0	13
TRURO	6	4	2	0	12
Grand Total	284	166	114	28	592

TABLE 10

INCIDENCE OF VACUOLAR CHANGES DIAGNOSTIC OF SPONGIFORM ENCEPHALOPATHY IN MOUSE TRANSMISSIONS (POSITIVES : NEGATIVES)

EXPERIMENT	BSE SOURCE	RIII	C57BL	VM	IM	C57BLXVM
203A-1A	-ve line Cheviot; oral challenge; brain	20:0	16:0	19:0	19:0	18:0
203S-1A	-ve line Cheviot; oral challenge;spleen	19:0	17:0	17:0	nd	7:2
213A-1A	-ve line Cheviot; ic challenge; brain	19:0	20:0	15:0	18:0	13:0
213S-1A	-ve line Cheviot; ic challenge; spleen	15:2	18:0	14:0	nd	4:0
406A-1A	pig brain - ic challenge	17:0	18:0	20:0	11:0	15:0
405A-1A	FSE cat brain 1	19:0	19:0	19:0	13:1	10:0
407A-1A	FSE cat brain 2, fixed	16:0	15:0	20:0	16:0	6:0
408A-1A	FSE cat brain 3	18:0	19:0	16:0	14:0	15:0

POSITIVES = any mice showing definite positive pathology in brain together with clinical signs (the great majority) and a few intercurrent deaths that were positive on pathology only.

NEGATIVES = any mice with negative pathology that were sacrificed or died after the last positive in their group.

All other intercurrent deaths have been discounted.