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HEALTH & CONSUMER PROTECTION DIRECTORATE-GENERAL

Directorate B - Scientific Health Opinions
Unit B3 - Management of scientific committees II

OPINION OF THE

SCIENTIFIC COMMITTEE ON VETERINARY MEASURES

RELATING TO PUBLIC HEALTH

ON

REVISION OF MEAT INSPECTION PROCEDURES

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24 February 2000

Contents

1. TERMS OF REFERENCE

The Scientific Committee on Veterinary Measures relating to Public Health was asked to provide an opinion concerning revision of ante- and post- mortem inspection procedures for an alternative inspection system for the slaughter of pigs with specific reference to Annex 17 of Council Directive 64/433/EEC.

When making its evaluation the Committee is requested in particular:

1. To review the steps at present mandatory in inspection of pigs as required by Council Directive 64/433/EEC as amended by Directive 91/497/EEC.

2. To determine which defects are, - and which are not -, detectable by current meat inspection practice:

    - by observation;

    - by additional palpation;

    - by additional incisions.

3. To consider the level of cross contamination, including hazardous bacteria, from the current requirements for the handling and incisions of carcass and offal during post-mortem meat inspection.

4. To:

    1) consider the alternative methods of inspection of pigs, which would ensure a level of health equivalent to that provided by present methods and

    2) consider the advantages which are achievable by omitting particular measures

    3) assess the risk connected with the loss of information if particular steps are omitted

    4) consider the advantages which are achievable with the three steps of inspection

    5) consider the advantages of establishing a monitoring system for sub clinical infections by zoonotic agents.

2. INTRODUCTION

The current system of meat inspection has remained largely unchanged since the beginning of the 20th century (Hathaway & McKenzie 1991, Edwards *et al*. 1997). It comprises an inspection at the slaughterhouse of each animal before and after it is slaughtered. Currently each carcass is subjected to the same inspection procedures regardless of origin.

Traditional meat inspection procedures have come under increasing scrutiny over the last 20 years (Berends *et al*. 1993, Harbers *et al*. 1992, and Mousing *et al*. 1999). The main arguments for the need of changes to be made are:

- Most current inspection procedures are directed towards lesions which are of more aesthetic than public health importance, and which may therefore be better handled by the quality control system of the plant than by the public health officials

- The most important goal of meat inspection is to prevent transmission of zoonotic infections and other contaminations to the consumer, and the quality of meat inspection can and should be monitored for its outcome and how this compares to appropriately defined performance standards, rather than being exclusively governed by rigorously prescribed procedures;

- Slaughter and meat inspection processes are integral parts of the meat production chain from farm to table, but this has not been taken fully into account in the planning and operation of the risk assessment imbedded in the meat inspection procedures. It has been suggested that knowledge about the health and management of food animals on the farm could be used to determine which animals entering the abattoir are likely to have gross or sub-clinical abnormalities at slaughter.

- Trace-back to the herd of origin must be secured due to the possible detection of diseases at slaughter, which are reportable to the competent authorities. Not all slaughterhouses, however, report occurrence of other conditions back to the pig producers. Such information may be considered useful in monitoring and controlling production diseases among the pigs on the farm.

- Documented changes in the occurrence and acquired knowledge about the nature and epidemiology of zoonotic infections and other conditions during the past century have not properly influenced the procedures and the focus of meat inspection regulations;

This report will firstly examine these points and will review the current meat inspection system for its ability to cope with these challenges (Part I). Subsequently, the report will consider the alternatives to the current meat inspection system (Part II) and will suggest short term and long term recommendations for improvements of the current system (Part III).

3. PART I: THE CURRENT MEAT INSPECTION SYSTEM FOR FATTENING PIGS

The protection of public health through increased consumer safety is the main objective of meat inspection. Secondary objectives are to provide for a central monitoring of animal diseases and other conditions, which are reportable, such as exotic diseases and conditions associated with mishandling of animals. Procedures to sample for antibiotic and other residues in meat are often combined with meat and slaughter inspection.

For many decades meat inspection has ensured that the carcasses of animals with acute or chronic infections and obvious parasitic infestations were removed from the food chain. Red meat inspection includes a check of each animal ante-mortem, with veterinary clinical examination of suspect animals, as well as a post-mortem inspection for pathological and anatomical abnormalities by observation, palpation and incision.

3.1. Mandatory Meat inspection

The mandatory measures (observation, palpation, incision) according to Directive 64/433/EEC are given in Tables 1-3

Table 1: Mandatory meat Inspection: Fattening Pigs – Carcass

	Observation	Palpation	Incision	Remarks
Skin and surface of carcass	+		**(+)**	Systematically for injection sites
Ear ground		+	**(+)**	Palpating for abscesses, incision if suspicion
Head, mouth, tonsils, pharynx	+			Tonsils to be removed
Nll. mandibulares	+		+	
Nll. retropharyngei medd.		+	**(+)**	Palpating for abscesses, incision if suspicion
Pleura and peritoneum	+			
Connective and fatty tissue	+			
Diaphragm	+			
Visible muscles, sep. Tongue, thigh, belly, loins rib's muscles	+			(*)
Bones esp. cute spine, joints, sternum	+			
Kidneys	+		**(+)**	Incision if necessary
Nll. Renales		+	**(+)**	Incision if necessary
Mammary gland	+			
Nll. Inguinales supff. (females)	+			
Navel, joints (in young animals)	+	+	**(+)**	Incision if in doubt
Male/female sexual organs	+			

(*) systematic examination for cysticercosis by observation
Nll. *Nodulus lymphaticus*
(+) On a case by case basis when considered necessary

Table 2: Mandatory Meat Inspection: Fattening Pigs - Plucks

	Observation	Palpation	Incision	Remarks
Muscles of tongue, pharynx, oesophagus	+			(*)
Trachea	+	+	**(+)**	Longitudinal cut into trachea and main bronchi
Lungs	+	+	**(+)**	Incision into the caudal part if for human consumption
Nll. Bifurcat.sinn.	+	+		
Nll. Bifurcat.medd.	+	+		Palpating for abscesses, incision if suspicion
Nll. Bifurcat dextr.	+	+		
Nll. Tracheobronch.crann.	+	+		
Nll. Mediast.crann.	+	+		
Heart and pericardium	+		+	Open chambers and cut the septum(*)
Blood	+			Color, clotting ability
Diaphragm	+			(*)
Liver and Nll. Hepici.	+	+		Incision if necessary
Bile bladder and *Nll.pancreat.*	+			

(*) systematic examination for cysticercosis by observation
Nll. *Nodulus lymphaticus*
(+) On a case by case basis when considered necessary

Table 3: Mandatory Meat inspection: Gutset, Fattening Pigs

	Observation	Palpation	Incision	Remarks
Stomach, intestines,	+			
Spleen	+	(+)	(+)	Palpating, if necessary
Nll. Gastrici	+	+	(+)	
Nll. Jejunales.	+	+	(+)	Lymphnodes: if necessary cut these lymphnodes
Nll. Ileocolici	+	+	(+)	"
Nll. Colici.	+	+	(+)	"
Nll. Mesenterici caudd..	+	+	(+)	"
Nll. Anorectales	+	+	(+)	"

Nll. *Nodulus lymphaticus*
(+) On a case by case basis when considered necessary

In addition there are requirements for routine laboratory investigations *e.g. Trichinella*, with the provision in the regulations for taking of samples for laboratory from suspect animals.

Examination of the animal, visual in the first instance under the present system, does give the inspector much general guidance as to the general health of the pig. The major public health risk is traditionally considered to

come from animals with septicaemia, bacteraemia or toxaemia. Evidence that such a disorder(s) might be present is also first identified on visual inspection of the live animal with evidence, which would support the diagnosis being found during the detailed examination carcass and offal.

3.2. "Visual only" versus traditional post-mortem inspection in pigs

Following the slaughter process the present requirements of physical meat inspection identify the obvious pathological change(s) present. Examples of defects, which occur frequently in the inspection of fattening pigs, and which are detectable on macroscopic inspection are given in Table 4. Animals with a low level of a parasitic infestation and or with lesions only in the lymph nodes, which are not significantly enlarged, would not be identified by visual inspection or possibly by palpation.

Table 4: Which Defect Would be Detected Using One of the Three Techniques of Macroscopic Meat Inspection?

Topography	Detectable only by			Possible risk with respect to human health if not detected
	cutting	palpating	observation	
Plucks:				
Pericarditis acute			+	Yes
chronic			+	No
Endocarditis	+			Yes
Pneumonia acute	+		+	Yes
chronic			+	No
Pleuris acute			+	Yes
chronic			+	Yes
Lungworm lesions		+		No
Water damage (lung)	+			No
Liver discolouration (mycotox. susp).			+	Yes
Hepatitis acute				Yes
chronic			+	Yes
Milkspots < 3			+	No
> 3			+	No
Gutset:				
Metritis	+			Yes
Abnormalities in the ovaries			+	No
Filled stomach		+		Yes
Spleen haemostatic			+	No
Caseous lymphadenitis guts	+			Yes

Table 4: Which Defect Would be Detected Using One of the Three Techniques of Macroscopic Meat Inspection? (continued)

Topography	Detectable only by			Possible risk with respect to human health if not detected
	cutting	palpating	observation	
Carcass organs:				
Nephritis			+	Yes
Kidney discolouration (mycotox.susp.)			+	Yes
Infarct			+	No
Hydronephrosis			+	No
Mammarcomplex enlargment			+	Yes
Mammarcomplex indurations		+		Yes
Cryptorchism			+	No
Carcass head:				
Rhinitis atrophicans			+	No
Caseous lymphadenitis head	+			Yes
Carcass				
Pleurisy			+	Yes
Peritonitis			+	Yes
Fracture recent		(+)	+	No
old		(+)	+	No
Arthritis acute	+	+	+	Yes
chronic		(+)	+	Yes
multiple			+	Yes
lymphadenitis	(+)		+	Yes
Tail bitings	(+)		+	Yes
Muscles PSE	+		+	No
DFD	+		+	No
Degeneration (M. long.dorsi)			+	Yes
Electrocution damage			+	No
Skin lesions infected			+	Yes
Mechanical lesions			+	No
Hematomas			+	No
Parasites			+	Yes
Eczema				No
Fecal contamination			+	Yes
Bile contamination			+	Yes
Grease contamination			+	Yes

Table 4: Which Defect Would be Detected Using One of the Three Techniques of Macroscopic Meat Inspection? (continued)

Topography	Detectable only by			Possible risk with respect to human health if not detected
	cutting	palpating	observation	
Multilocular findings:				
Poor exsanguination			+	No
Underweight			+	No
Emaciation			+	Yes
Tumors	+ (depends)		+	Yes
Abscesses single	+ (depends)		+	Yes
multilocular	+ (depends)		+	Yes
*head			+	Yes
*muscles	+ (depends)		+	Yes
*organs			+	Yes
*surfaces			+	Yes
*tail/spine			+	Yes
Lymphadenitis multilocular	(+)		+	Yes
Mechanical damage			+	No

(data selected from BETTINI *et al*. 1996; FRIES *et al*. 1997; HARBERS *et al*. 1992b; MOUSING *et al*. 1997; BERENDS *et al* 1993)

The mandatory physical incision system of inspection requires a limited number of cuts. The result is therefore that lesions associated with disease or parasitic infestations may not be identified in every case. Of particular concern with pigs is whether there is the presence of abscesses, which is reflected in the requirements of the current regulations. When an obvious lesion is found at visual inspection further investigation may reveal that an abscess is present. What is open to question is the relevance of any lesions, which are missed by current meat inspection practice. The recent paper by Sorensen and Petersen (1999) reports a survey of 3,221,332 slaughter pigs of which 3495 (0.11%) were identified as having lesions in the mouth/throat/tongue. These lesions did not influence the assessment of the carcass and offal for fitness for human consumption in 3316 of cases. It was also found that if the head was not split, which is not a requirement of EU regulations, the lesions would not have been detected in 37 of the remaining carcasses which had been held back for further investigation. In nine animals there were various lesion of the carcass, which would have required the condemnation of the carcass and offal regardless of findings during the mouth, tongue and throat inspection.

Much work has been put into comparing lesion detection frequencies between visual ('hands off') inspection and traditional meat inspection that includes palpation and incision. The findings of the most recent European research on this work were presented to the Terrigal Congress in Australia February 1999 by Mousing *et al*. (1999). Despite differences in the type of

lesions recorded in the projects it is possible to make some comparison of the results.

In the Danish group a method was developed to estimate approximate differences in non-detection rates (ADNDR) as a way to overcome the problem of not knowing the true status of the tissues. Using the ADNDR principle Table 5 indicates (among the different lesion codes included in the four studies) how often the visual method was found superior to the traditional (ADNDR<0), equal to the traditional (95% confidence interval of ADNDR for a particular code included 0.0), or less efficient than the traditional (ADNDR>0)[1]. (Mousing *et al* (1999))

Table 5. The sensitivity of "visual only" versus traditional post-mortem inspection in pigs

Research Group	Which inspection type was most efficient (% of lesion codes in study)		
	visual	equal	traditional
I. The Netherlands	22.2	33.3	44.5
II. Denmark	3.5	22.4	74.1
III. Italy	11.6	19.2	69.2
IV. Germany	24.0	20.0	56.0

As may also be deduced from Table 5, the sensitivities of the meat inspection procedures are only moderate. In the Danish data detection sensitivities ranged from 0.2 to 0.9 for the visual inspection (depending on the type of lesion), and 0.4 to 0.9 for the traditional inspection system. Also, since very different coding systems were applied among the four research groups, it is not possible to formally assess if a general pattern exists as to which lesions are systematically better detected using visual or traditional inspection.

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[1] *I. The Netherlands.* The study comprised 31,692 pigs processed in one slaughterhouse. The study was split in two experiments. In each of these, several comparisons were made (visual vs. traditional vs. "standard" = traditional with extra inspection time). For sake of simplicity we have -- very roughly -- aggregated the two possible comparisons of visual vs. traditional in experiment 1 with the one comparison of visual vs. traditional in experiment 2. Eighteen different codes were recorded. Line speed was 420 per hour.

II. Denmark. The study comprised 183,383 pigs and one slaughterhouse. A week-long period of training was allowed before data capture was begun. A special EDP data capture system was developed and used for both types of inspection. Fifty-eight different lesions were recorded. Line speed was about 300 per hour.

III. Italy. The study comprised 4,300 lungs and gutsets, and 4,666 submaxillary lymph nodes, from Italian heavy pigs. Twenty-two lesions were recorded from the former material and 4 from the latter. The results are here aggregated across the 26 lesions. The study included one slaughterhouse.

IV. Germany. The study comprised 22,643 pigs processed at 3 different slaughterhouses. Twenty-six (different) codes were included. Line speed was 120-280 per hour. Some differences were noted among the 3 slaughterhouses. In the one with the lowest line speed -- 120 per hour -- the visual inspection on the average detected more lesions than the traditional inspection.

However, aside from the logical consequence associated with a visual inspection of not being able to detect lesions within lymph nodes without an incision, it appeared that there was no such general pattern. Accordingly the ADNDR values for comparable lesions varied quite substantially (Mousing *et al* (1999))

The recent study from Australia by Pointon *et al*., (1999) is a good example of a relevant study despite the Australian data being unlikely to apply for European countries.

The Danish group studied the more intrinsic microbiology of lesions, in an attempt to assess the lesion-related additional hazard associated with a change from traditional to visual inspection. It was estimated that per 1,000 carcasses, an additional 2.5 lesions in edible tissue containing *Staphylococcus aureus*, 0.2 with arthritis due to *Erysipelothrix rhusiopathiae*, 0.1 with caseous lymphadenitis, 0.7 contaminated with *Salmonella enterica* and 3.4 with *Yersinia enterocolitica* would remain undetected. In the Italian group, however, a study was made of 450 left submaxillary lymph nodes (from pigs - with no apparent abnormalities in their right submaxillary lymph nodes). The results showed that omitting an incision of the submaxillary lymph nodes would give rise to 2.24 per 1000 undetected cases of *Mycobacterium avium* - infection. This should be balanced at the risk of cross-contamination due to infection with *Yersinia enterocolitica*, which here occurred at a prevalence of 11.1 per 1,000 carcasses.

The differences in prevalence of lesions with hazardous[a] pathogens when changing from a traditional to a visual inspection post-mortem system is given in Table 6.

Table 6: Differences in prevalence of lesions with serious pathogens

Research Group	Mean and (95% CI) per 10,000 pigs				
	Chronic Arthritis	Abscesses, lungs only [b]	Abscesses, Total [b]	Submaxillary Lnn Affection	Ileofemoral Lnn Affection
I. The Netherlands	0.4 (0-2.7)	0.7 (-0.3-4.2)	-	-	-
II. Denmark	1.2 (0.1-4.5)	- 0.07 (-0.03-0)	4.8 (0.9-14.4)	-	-
III. Italy	-	1.2 (0.1-5.5)	-	2.3 (0.9-4.8)	-
IV. Germany	-1.3 (-1.4-(-0.2))	-	3.1 (0.5-11.1)	-	-2.52 (-4.5-(-1.0))

[a] *Salmonella enterica* and *Yersinia enterocolitica* for submaxillary lymph nodes, plus enterotoxigenic *Staphylococcus aureus*, *Campylobacter jejuni/coli*, *E. coli* O157.

[b] It was assumed that the prevalence of the hazardous pathogens was the same in lung abscesses and abscesses in total

3.3. Discussion

Since the Second World War there have been improvements in animal husbandry, preventive medicine and disease control programmes with increased growth rates of the animals as well as increased intensity of production and increasing herd sizes. This has led to a significant rise in the number of slaughter of animals at a younger age in relatively uniform groups

with a reduction in age related diseases and conditions (Grossklaus 1983, 1987). However modern husbandry may also facilitate the presence of bacterial zoonotic agents in slaughter animals and current traditional meat inspection is unable to detect the symptomless carriage of pathogenic organisms (Mousing *et al*., 1997; Nielsen and Wegener 1997; Snijders *et al*. 1989; Hathaway and Richards 1993).

Several factors can be considered to restrict the value of ante-mortem inspection as required at present. This includes the current lack of information about the history of the farm of origin, the animals presented for slaughter and the working conditions in the slaughter plant. At present there also tends to be variation in action taken at ante-mortem inspection as for most of the working day only healthy animals are being inspected and in the present system of inspection there will be an inevitable reduction in attentiveness by the inspector which may lead to diseases being missed.

The scale of operation and speed of the slaughter line has also increased dramatically with a result that the efficiency of detection of pathological-anatomical abnormalities may have declined. At modern slaughter plants the available time for mandatory meat inspection procedures according to Directives 64/433/EEC and 91/497/EEC is limited to some 12 to 13 seconds per pig. This is insufficient to adequately assess the tissue state and detect lesions; especially when there is a requirement for detailed inspection of a lymph node when each cut surface should be observed. There is therefore already a tendency in slaughter plants to spontaneously operate as in a preselection system when the pigs come from a known producer.

Gross lesions such as parasitic cysts and kidney conditions can be missed by current inspection techniques (Samuel *et al*. 1979; Hathaway and McKenzie, 1991; Berends *et al*. 1993) and the efficacy of physical (organoleptic) meat inspection has also been questioned especially in high-throughput abattoirs (Madie 1992). Traditional meat inspection will not reveal the presence of zoonotic agents such as *Salmonella*, *Campylobacter* and *Yersinia* species, *Trichinella spiralis* and *Toxoplasma gondii* (Grossklaus, 1987, Hathaway and Pullen 1988, Hathaway et. al. 1987, Hathaway and McKenzie 1991) unless, as is currently required, specific investigation is carried out as for *Trichinella spiralis*.

In the context of potential lack of control with hazards in undetected lesions, the Danish work showed only little influence of changing to a visual system (except for slaughter faults causing contamination). However, these results will not be applicable to all countries (*e.g.* an example of region-specific conditions is that *Mycobacterium avium* is still prevalent in Italian pigs).

There is no doubt that some lesions will remain additionally undetected following a change from traditional organoleptic post-mortem inspection to a visual system. This conclusion was reached in all European studies. However the studies also showed that not all lesions were best detected in a traditional system, and the pattern of which lesions were detected with the highest sensitivity in the visual or traditional system varied. This means that if a regulatory agency seeks documentation for the effects of changing from one

system to another, region-specific studies are necessary, perhaps even repeatedly.

For an effective change to *post mortem* meat inspection there must be the assessment of risks. Any future system must be based on a scientifically based analysis and should be designed to have quality control and safety systems. This requires the categorisation of both the likely risks and the possible magnitude of any such risk. Directive 64/433/EEC focuses on human health as well as animal health. The official veterinarian has to declare unfit for human consumption not only on the basis of health risks but also on qualitative (cosmetic) characteristics *e.g.* anomalies as regards colour, smell, sexual odour.

Possibly one reason of the present difficulties in deciding on an alternative form of meat inspection emerges from different standpoints with regard to risk. The question can only be answered if the risk is determined. Possibly several different definitions of risk should be used. In the recent amendments the greatest part of incision has already shifted to palpation (*e.g.* removal of the routine multiple incision of mesenteric lymph nodes to reduce the possible spread of *Salmonella* (Peel & Simmons, 1978)) yet accepting, following an assessment of risk, that omitting incision of intestinal lymph nodes might miss evidence of Mycobacteria. The additional gain to the knowledge of the fitness, or freedom from indicators of unfitness, achieved by means of incisions in addition to palpation is considered small, abscesses being an exception. However abscesses in deep tissues are normally neither detected with incision nor palpation but mostly in the cutting room.

More work needs to be done on the microbiological consequences associated with traditional or alternative post-mortem inspection systems. This should include a systematic, epidemiologically well founded assessment of the prevalence of human health hazards in abnormal or apparently normal tissues, and a microbiologically based evaluation of alternative inspection and removal methods (*e.g.* visual inspection). Studies of the type by Edwards *et al*. (1999) and Fries *et al*. (1997) are required to provide the basis for any alternative system of integrate meat inspection. Such studies might give background for designing a truly targeted organoleptic post-mortem inspection system that yields a net benefit to consumers.

3.4. Conclusion

The steps required by the present mandatory inspection of pigs as required by the Council Directive 64/433/EEC as amended were considered. The Committee considers that the present meat inspection system has major limitations in terms of preventing zoonotic infections in humans. Indeed if the defects identified in Table 4 are found in pigs at slaughter using the observation, palpation and incision techniques of *post mortem* inspection the risk to human health from the conditions is in many instances none: ("No"). There is also a risk of cross contamination, including hazardous bacteria, from the current requirements for handling and incising the carcass and offal during *post mortem* inspection.

Any decision which are taken by the meat inspection system must also consider chemical and toxicological risk.

An alternative system must be based on a scientific assessment of any risk, accepting that ‘zero risk’ associated with the production of meat is not possible. Any change to a vertically integrated system will rely on audit of all production stages. The use of Hazard Analysis, Critical Control Point (HACCP) or even of HACCP-like principles “behind the farm gate” in itself requires audit and specifies the action to be taken if necessary

Any meat inspection scheme must protect the public health. The present requirements of the Directive 64/433/EEC however do not satisfy these requirements for public health protection in respect of modern farming and slaughter methods.

4. PART II : ALTERNATIVES TO THE CURRENT MEAT INSPECTION SYSTEM FOR FATTENING PIGS

4.1. Introduction

4.1.1. The role of meat inspection

The role and position of meat inspection must be defined in the dual perspective of providing the consumer with safe wholesome meat yet with the knowledge that the level of "zero risk" remains unachievable. However it is essential that the hygiene at all stages of the slaughter operation is of the highest level. The meat inspection system must adapt to the changing technologies in each stage of the food chain. Any meat inspection system of the future must consider the reduction/eradication of zoonotic agents as of prior importance. Microbiological consideration must not preclude detection of undesirable chemical substances.

In the Part I it was recognised that many of the current actions at meat inspection do not contribute anymore to consumer health protection. The requirements of the system of inspection can increase the microbial load, including bacterial pathogens, on the carcass and offal. The proposal is that a future meat inspection system should be based on an assessment of the actual risk. Meat inspection is a management system and not an analytical measure, but it should be deduced from an analytic procedure. The objectives must be set under the aspects of political objectives within the particular society, where the food animals are kept and where the meat is about to be produced. As a consequence, in a worldwide comparison the goals of meat inspection are set in very different ways. This must be kept in mind, when future systems are considered.

4.1.2. Hazards to be expected

The assumptions of hazards the Committee had to look at are limited to those that might have an impact on human health. It means that other aspects like animal welfare, which are part of the missions of veterinary inspection at the slaughterhouse according to 64/433/EEC Directive, will not be dealt with in detail here. The *post mortem* meat inspection ends when the Health Mark has been placed onto the carcass. On the other hand the question of hygiene maintenance within the slaughter plant can be debated since there can be a link with food safety.

In Table 7 the Committee has provided a list of examples of assumed hazards for human health associated with pig meat manipulation and consumption. This list is far from exhaustive and it must be recognised that the hazards change *e.g.* the emergence of Nipah virus in pig herds in the Far East. It is also essential to know of the region or country of origin of the slaughter pigs as this may introduce a different hazard. Attention is also drawn to the fact that the hazard is localised in different parts of the pig depending on the agent. Microorganisms are also present in abscesses and/or other area of

inflammation. For example the risk of getting infected by *Erysipelothrix rhusiopathiae* and *Streptococcus suis* is during handling of the pig or pig meat. For these agents, to our knowledge, no evidence of contamination from the consumption of pork has been reported up to now. On the contrary Salmonella infection can be contracted through the consumption of meat. On the slaughter line the hazard may be suspected *e.g. Mycobacterium avium* or as in the case of *Ascaris* larvae migration detected during current *post mortem* inspection. Pigs heavily infested by *Taenia* should also show warning signals perceivable to the inspector. Apart from these three, the inspector remains inefficient in detecting the direct risks for human health listed in Table 7. On the other hand the inspector will state on the actual status of the pig at *ante mortem* and then of the carcass at *post mortem* examination.

Table 7: Examples of potential risks for human health of pig meat handling or consumption.

	Potential cross-contamination when handling meat on the production line	**Possible risk when eating meat**	**Relevance of detection at inspection of the** carcass **on the slaughter line**
Bacteria (alphabetic order)			
- *Brucella*	+	-	**No**
- *Campylobacter*	+	+	**No**
- *Erysipelothrix*	+	-	**No**
- *Listeria*	+	+	**No**
- *Mycobacterium*	+	+	**Yes / No**
- *Salmonella*	+	+	**No**
- *Streptococcus suis*	+	-	**Yes / No**
- *Staphylococcus aureus*	+	+	**No**
- *Yersinia*	+	+	**No**
- Antibiotic resistant microbes	+	+	**No**
Parasites			
- *Ascaris*	-	+	**Yes**
- *Cryptosporidium*	-	+	**No**
- *Taenia*	-	+	**Yes / No**
- *Trichinella*	-	+	**No**
- *Toxoplasma*	-	+	**No**
Toxicity risks			
- Residues and Contaminants	-	+	**No**

4.1.3. Meat production chain

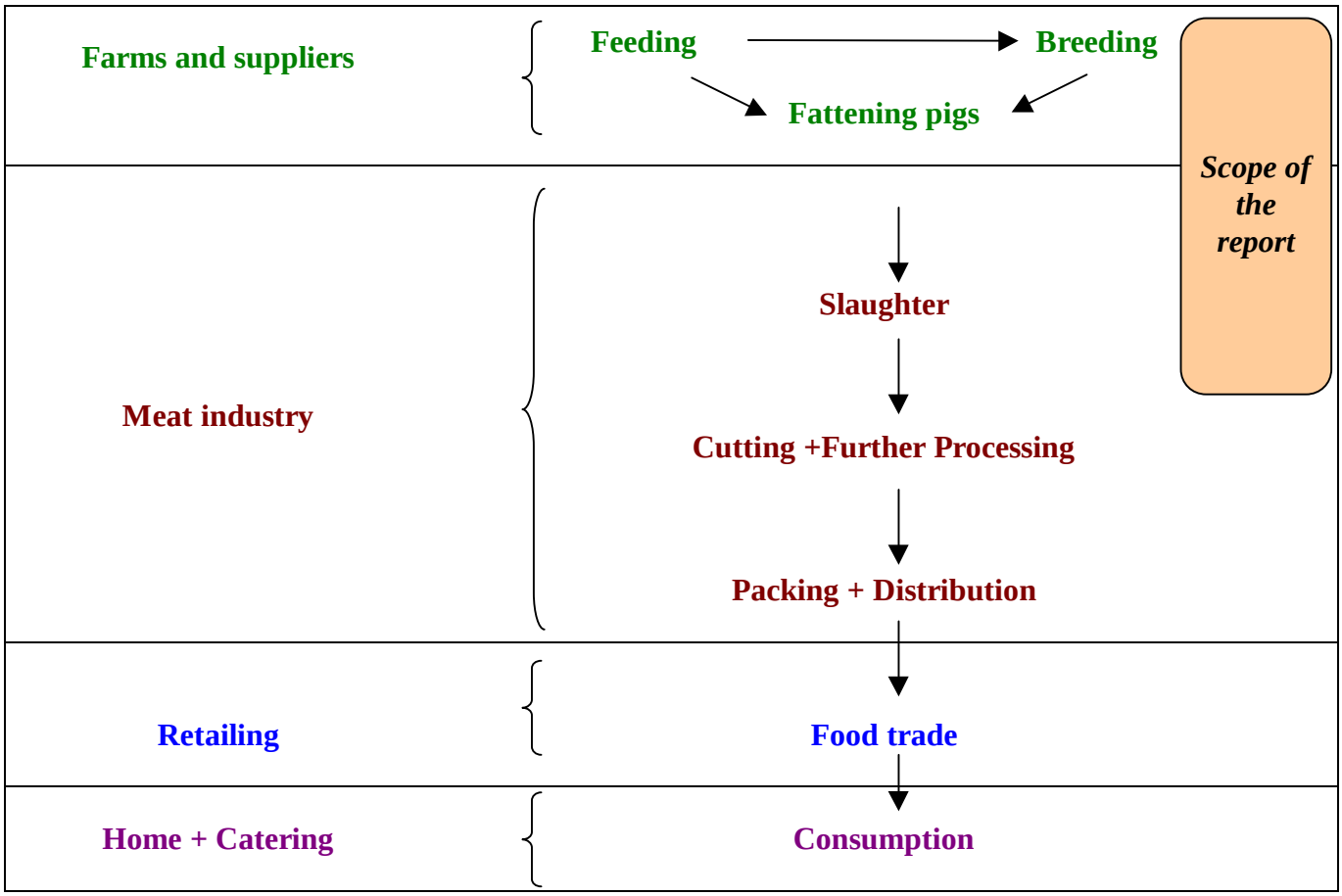
In addition to the hazard identification and location of the exposure, there is the need to investigate along the food chain the critical steps where contamination occurs. The decision must be taken, where to situate inspection and what is the best way to ensure human health. The "stable-to-table" concept relies on the evidence that the final product that is consumed results from subsequent steps of a longitudinal process.

The use of HACCP principles in slaughtering plant may be difficult due to the specific issues relating to conversion of the live animal to carcass meat. Application of the HACCP principles in a slaughter plant therefore must recognise these issues and the valid role of good hygiene practice. The whole food chain must be integrated with application of these principles with full traceability. The use of good husbandry practices on the farm is critical in the production of pigs intended for slaughter. While the aim must be to apply HACCP like principles on the farm there is a practical limit to the number of critical control points which can be applied.

Figure 1 illustrates the chaining process regarding pig meat. Some bacterial contaminations only occur from handling meat especially in the last stages of the process, whereas the pig carries other bacteria when entering the slaughterhouse. In the latter case, there is no doubt that preharvest food safety is to be emphasised. By integrating Total Quality Management and HACCP, significant improvements can be expected (Barendsz, 1998 ; Declan *et al*, 1999). The Danish experience on *Salmonella enterica* carriage by the pigs can be mentioned here (Christensen *et al*, 1999). An extensive epidemio-surveillance scheme was designed nation-wide to detect through meat juice analyses *Salmonella* infection at the herd level. In parallel a monitoring programme was set-up on the farms in an attempt of reducing Salmonella load.

Meat inspection must be based on sound scientific evidence concerning risk assessment. Tools are already available to help the participants in the pork chain to achieve the goal of a non-compromised human health. An example of recent experience is the *Salmonella* testing programme in Denmark. The current knowledge on these methods and technologies and their ability to help when decision-making will be displayed in the following sections. A matter of concern is the wide variation in the pig chain profile depending on the countries within EU. The heterogeneity is even expected to increase if this is to be an expansion of the number of Member States. Alternative systems will be required to consider this and have flexibility to take into account regional risks but must be a vertically integrated production and slaughter chain.

Figure 1. Flowchart illustrating the chaining process of pork products



4.2. Farm level factors and their impact on health of animals intended for slaughter

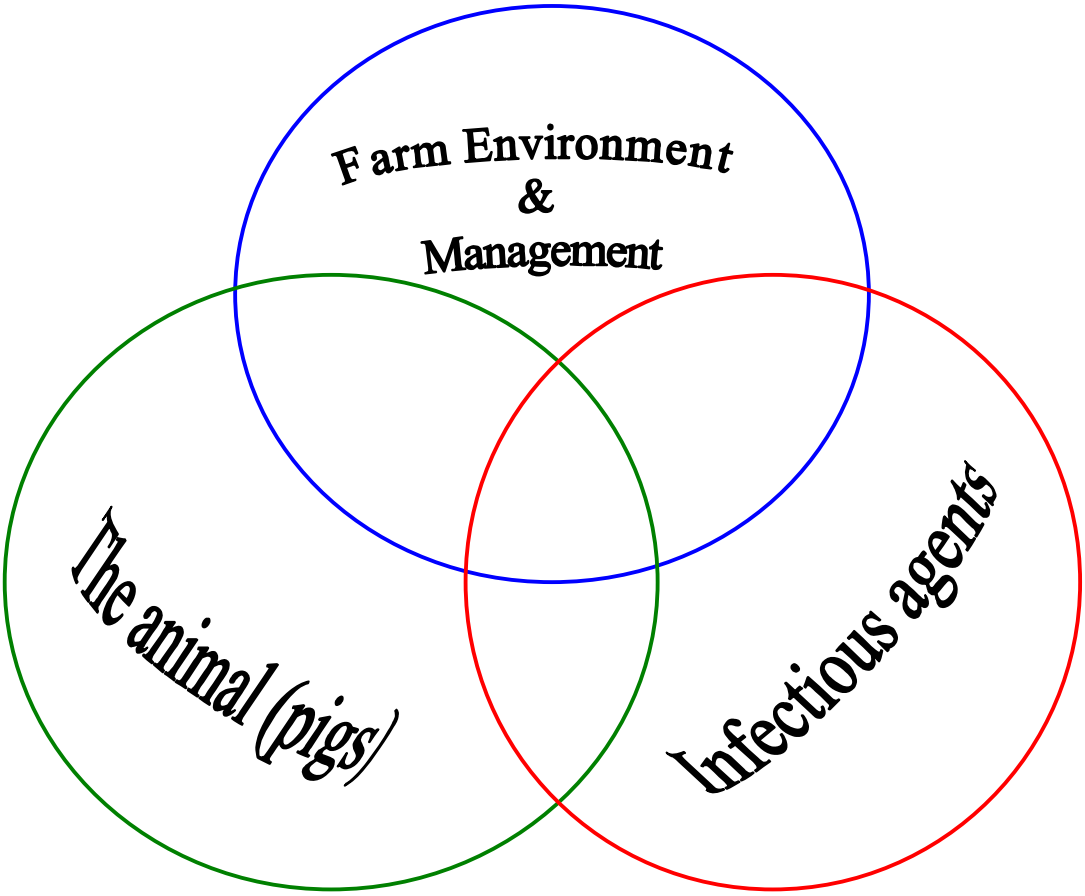
The influence of the farm on the ultimate fitness of the meat is clearly recognised. The term "farm level" includes different points of view but according to Edwards *et al*. (1999) should include the farm environment, management and corrective actions with use of individual data such as diseases which have occurred in the particular group of animals. The close involvement of these different factors in pig production is shown in Figure 2.

It is obvious that a sick animal often may be recognised. However for there to be a clinical outbreak of disease, several factors, including related environmental factors, are of importance and contribute to the outcome, and influence the extent, of a disease. It therefore is necessary to study the relations between environment factors and their impact on animal patho-physiology or possible outbreaks of a disease. It follows that there must be knowledge about management and or environmental factors on the farm of origin, which might impact the performance of an animal during fattening and its health status at all stages of production.

The interrelations between farm level circumstances and the health of animals is well established Aalund *et al*. (1976), Bandick *et al*. (1997), Flesja &

Solberg (1981), Goodall *et al*. (1993), Goodwin (1985), Hurnik *et al*. (1994), Mousing *et al*. (1990), Tuovinen *et al*. (1994 I & II). Similar mechanisms seem to apply also to zoonotic agents and early work supports this (Wong pers comm).

Figure 2 The inter-relationships on a pig production unit which can affect the fitness



There is little doubt that animal health and animal welfare is relevant to the fitness of food for human consumption produced from animals. A number of common findings on the production unit are indicators of the standard of husbandry and the health status of animals on that unit. In addition the type and quality of husbandry affect the level of disease on the production. In addition the use of laboratory tests at slaughter or in the herd increasingly contribute to the understanding of the impact of disease agents during the production phase *e.g.* Mousing, (1990) and Visser *et al*., (1992).

The Committee considered that the application of principles of HACCP on the farm is not fully developed but it will in the future be an important component of the whole infrastructure necessary in a production system. There is already application of the HACCP concept by good working practice and the applications of controls by good breeding practice along with good hygiene and husbandry on the farms. This HACCP system can be applied to units of varying size and would require a number of prerequisites, which includes documentation of:

- Monitoring of pathogens and residues identified and agreed as being appropriate to the production system and to the geographical region in which the pigs are produced

- the herd as a whole including information about administration of medicinal products and immunisation programmes

- the health status, including information from the disease records and the general body condition of the animals going to transport

- data on the performance of each group, and the herd as a whole *e.g.* daily liveweight gain, mortality and morbidity figures

- knowledge about farm environmental factors, which are crucial for a good result of fattening including data on the buildings

- feed quality control at the farm level, including feed supplier quality assurance

- traceability of individual and groups of animals at all times including movements on to the unit

- To this information must be added the "feed back information" from the slaughterhouse, including any the effects of the transport such as the presence of Pale Soft Exudative (PSE) or Dark Firm Dry (DFD) meat or other defects such as injuries, filthiness, fatigue/stress.

It may be that animals raised on small or traditional farms may not be able to provide much relevant veterinary health information. They must therefore be treated differently from those who are part of an integrated system and where the required information would be collected. Farms of the first type still, and will probably continue to, exist in the EU. It should be noted also, that, within the current Member States of the EU and with any extension of the EU, geographical and climate factors are of paramount importance for the particular circumstances of farming and must be considered.

If future herd level ante mortem inspection systems are to contribute to the judgement of the fitness of animals for human consumption it must not be confined to immediately before transport to slaughter. It must be part of the veterinary care system during the whole period of growing and fattening; relying on data that may be collected both from the farm and the slaughterhouse. Responsibility is on the producer of the animals for quality control of all aspects of production at farm level. The system in place must "manage" and not rely on "reaction(s)" to events. No matter how good the data collection system without action it is meaningless.

The Committee has not at this point recommended any specific measure or system for increasing the level of herd-level surveillance as part of a future meat inspection system of pigs. The Committee however was of the opinion that:

Research at herd level surveillance and HACCP systems should be prioritised to investigate systems for ante mortem control in more depth.

Herd level surveillance systems should be targeted to specific hazards (*e.g. Salmonella*) with the aim of flagging problem herds, followed by intervention in these herds utilising all relevant epidemiological information from the herd and the local farm (see chapter 2) as well as the slaughterhouse.

4.3. *Ante mortem* inspection at the slaughterhouse

The Committee considered that there continues to be a need of ante mortem inspection at the slaughterhouse. This is for a number of reasons, which include an assessment of:

– obvious signs of animals which are clinically unwell

– any indication of medication

– adequacy of animal identification and traceability

– the level of cleanliness of the animals

– the level of the effects of the transport

– consideration of the health data from the farm of origin

Ante mortem inspection has an important role in monitoring the welfare of the animals intended for slaughter.

4.4. *Post mortem* inspection

4.4.1. General recommendations

Post mortem meat inspection (*post mortem* inspection) is a sanitary measure that involves the detection of obvious pathological findings or other abnormalities (by visual control aided in some instances by palpation and incision) followed by removal of the lesions detected. Whereas the detection process is carried out at the slaughter line, removal of abnormalities typically is performed at a designated "detain area". *Post mortem* inspection has been the backbone of the entire system for many years, consuming some 70% of all control resources allocated to improve meat safety in general.

Originally, *post mortem* inspection was designed to detect and remove cuts or entire carcasses assessed as being hazardous to human health due to *e.g.* tuberculosis and cysticercosis. Thus, the system was designed with the primary aim of improving meat safety. As documented in the first part of this report, this aim can no longer be pursued with *post mortem* inspection, which is due to a shift in the human health hazards that we are currently facing in fattening pigs from the typical industrial pig production.

It is therefore the view of the Committee, that *post mortem* inspection as a sanitary measure in slaughter pigs from industrialised pig production today

will, regarding recognised microbiological and chemical hazards, assist little in improving meat safety.

Post mortem inspection - probably as a consequence - has gradually put increasing attention on other (both natural and legitimate) areas that have no direct relevance for meat safety or human health. This includes monitoring of animal health (production related disorders relevant only for the pig as well as surveillance for contagious diseases), feedback of production data to the pig producer, surveillance and documentation of animal welfare, and removal of lesions that affects the general wholesomeness of the meat.

It is crucial for the future of any *post mortem* inspection system for fattening pigs that the European Union decides if this sanitary measure should still be mandated as part of the official food safety system of the Member States, or if should be an integrated part of a plant-driven quality assurance system, that is duly audited by the regulatory agency.

The Committee will not give advice as to which direction to choose since this is both a political and managerial question. However, it should be noted that this area is being reviewed worldwide and that there is a trend towards a quality assurance system. In addition, it is recognised that traditional physical meat inspection is not compatible with HACCP principles at the slaughterhouse. Any new system of meat inspection must be compatible with, and be integrated with the slaughter plant HACCP plan.

It is also a relevant observation, that the real benefit in terms of reducing the prevalence of human hazards in the Committee's view mainly lies in hygiene control programmes throughout the slaughter process as to avoid spread and build-up of human pathogens that is prevalent in the porcine intestinal content. Such sanitary measures, typically in the form of HACCP is now mandated worldwide, with the industry as the primary responsible part, and with the regulatory agencies auditing the systems. The committee recognised that auditing the system only once or twice a year might yield unsatisfactory results.

Thus, the revised *post mortem* inspection system for slaughter pigs described below cannot alone be expected to actually improve meat safety, but rather to assist in obtaining other goals, mainly non-related to human health and requires a vertically integrated system.

4.4.2. Future post mortem inspection *system*

Industry-driven or not, the future *post mortem* inspection system for fattening pigs should follow these guidelines:

– The system is limited to slaughter fattening pigs.

– All slaughter pigs must be identifiable to the herd of origin

– To avoid hazardous cross-contamination brought about by manual handling and incision, it is essential to use hands-off, visual inspection.

– The anatomical structures of the carcass and offal that are currently inspected must continue to be visually inspected.

– Visual inspection must be aided by a number of technical facilities. This may include an automated rotating device, mirrors placed as to inspect the back of the carcass or other options. At the present time automated vision inspection systems are in trial in poultry slaughtering. The preliminary results suggest that in the near future automated vision inspection system might be applicable also in pig slaughtering plants.

– No trimming of carcasses or offal (slicing-off small lesions etc.) must be performed at the slaughterline. All carcasses with obvious or suspect lesions must be re-railed to a rectification loop for action. In some cases the carcass and offal should be moved to the detain area for separate inspection and removal of defects, with the use of laboratory analysis as per current rules. At the re-rail and detain areas palpation and incision must be used as necessary, observing strict hygienic routines determined by the regulatory agency (*e.g.* two-knife systems).

– All data recordings of lesions must be stored in a computerised database. This system should fit to the inspection needs and should therefore not represent a limit to the inspection. The recording stations must be user-friendly and computer-based and include a mandatory code for "no lesions observed" for each carcass. One observation must be stored per carcass, including as a minimum herd code and normally 5 different lesion codes, with other data added as needed (gender, weight, quality). The system must provide documentation of the *post mortem* inspection system for external audits and must provide feedback data to the pig producer on the prevalence of lesions recorded at the *post mortem* inspection.

A special plan must be prepared for each slaughterhouse when introducing the revised *post mortem* inspection system. The plan must include:

- Training of the inspectors in recording principles and methods.

- Plans for microbiological testing before and after introducing the alternative *post mortem i*-system, with the purpose of documenting that the new system is microbiologically neutral or better. This testing must be uniform and standardised in order to get comparable results within and between slaughtering plants.

- Alternative(s) to proposed visual based system

Deviations from the visual-only *post mortem* inspection method, or deviations from the anatomical structures that are mandatory to be inspected, may only be allowed as follows:

Palpation and incision of specified parts of the pig carcass or offal may be allowed in a Member State only if the regulatory agency can document, that the benefits (in terms of avoiding a specific human hazard by using palpation and incision to detect it) will exceed the additional risk brought about by the cross-contamination that inevitably follows.

If a new slaughtering method/technique will imply that mandatory *post mortem* inspection of a specific anatomical structure is no longer possible, this slaughtering method/technique is allowed in a Member State only if the regulatory agency can document, that the benefits of the new method or technique (in terms of avoiding or lowing the prevalence of a specific human hazard) will exceed the additional risk caused by omitting the inspection.

4.4.3. Hygiene of the slaughter practice

HACCP is very important and will gain importance in the future. At all stages there must be a HACCP based approach which will require, for validation purposes, a practical testing regime. The requirement to monitor and check that the HACCP plan in place is happening requires a properly applied audit where the system in place and the controls in the laboratory are fully documented. The audit will involve microbiological testing of carcasses and following cleaning and disinfection of surfaces. The tests on carcasses should be limited to total viable counts and/or Enterobacteriaceae. In plant testing for pathogens is not appropriate for checks on the general hygiene conditions of production. The presence or absence of pathogens is dependent on whether they are being carried in or on the animals being processed. There is considerable variation in the current protocols and techniques used for the microbiological sampling of carcasses at present. A check quantitatively for pathogens is essential for consumers health protection. This however would be part of the prerequisite for HACCP plans on the farm and in the abattoir. A number of factors are relevant to the microbiological testing program in the slaughterhouse which include:

- How the samples are collected
- The sites of carcass, both in number and position, sampled
- Frequency of sampling – numbers of samples per month or related to throughput – including the provision for the taking of additional samples if considered necessary
- Laboratory techniques used
- Reporting of results
- Use of the results (recommendations or limits)
- Microbiological testing programmes must be carried out under the direct supervision of the competent authority
- Laboratory working under quality assurance systems

Regardless of the accuracy and reproducibility of the microbiological methods, they can not be used effectively without an appropriate sampling plan. The methods used must be to ISO/CEN standard or equivalent. The eighth publication in the series, “Developments in Microbial Methods” from the Concerted Action CT94-1456, Microbial Control in the Meat Industry, is

concerned with the microbiological methods used to examine meat and meat products provides an overview of the subject.

The most important point of any microbiological monitoring of carcasses is that it provides a trend for the slaughter plant and enables action levels to be set. It allows performance to be quantitatively assessed and monitored. The use of modern validated rapid methods will allow immediate corrective action to be taken quickly and therefore at a time when there is a problem not just to provide a retrospective view of previous performance. The overall aim must be to control pathogens in the chain and to calculate the risk of pathogens in the product. The outcome(s) of what they are doing therefore must be measured and will require attention to direct pathogen checks.

4.5. Conclusions

A revised *post mortem* inspection system for slaughter pigs, as described above cannot alone be expected to actually improve meat safety, but rather to assist in obtaining other goals, mainly non-related to human health and requires a vertically integrated system. Any such *post mortem* inspection system should be part of the official food safety system of the Member States or a part of an integrated plant-driven quality assurance system that is audited by the regulatory agency.

Reduction in the prevalence of human hazards lies mainly in the hygiene control programmes throughout the whole chain. Sanitary measures, typically in the form of HACCP with the regulatory agencies auditing the systems are essential throughout the slaughter process to avoid spread and build up of human pathogens.

At this time a new system should be implemented and use a hands-off, visual inspection aided by a number of technical facilities, *e.g.* automated turning device, mirrors etc.

Before the revised *post mortem* inspection system is introduced to a slaughterhouse there must be in place microbiological testing of the carcasses which will provide the baseline against which the microbiological standards of the carcasses in the revised system can be compared. There must also be a training programme for the inspectors in methods and recording requirements.

5. PART III: CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

Historically meat inspection was established to ensure healthy and wholesome meat for human consumption, to protect animal health and help to prevent financial losses caused by outbreaks or epidemics. Traditionally, and as a legal requirement, ante mortem inspection in mammals is done after arrival at the slaughterhouse. At present this consists of an inspection of the individual animal, or groups of animals, with the aim of identifying animals which should not immediately go forward for 'normal' slaughter. There is then the requirement for veterinary clinical examination for suspect animals that have been identified at ante mortem inspection. This then enables a decision is made as to when, if at all, and where in the slaughter plant the animal(s) will be slaughtered. Following slaughter there is then *post mortem* inspection, with the taking of samples, including those considered necessary by the inspectors for the judgement of the fitness for human consumption, for laboratory examination. At present the judgement and action in respect of identified faults in the carcass and offal may be carried out on the slaughter line or in the detained area of the slaughterhouse.

1.1. The review of the steps required by the present mandatory inspection of pigs as required by the Council Directive 64/433/EEC are given in part 1 of this Report.

1.2. The defects found at meat inspection are listed according to the three techniques (observation, palpation, and incisions) used in the current system of meat inspection. The Committee considered that for many of the defects the risk to human health was none.

1.3. The Committee also considered that the system has major limitations in terms of consumer health protection as the handling and incisions currently required increase the level of cross-contamination. The cross contamination can be with zoonotic pathogens and would, in many cases, occur due to the requirements of the present mandatory inspection system.

2.1. The Committee considered that there are alternative methods that provide a comparable level, or better, of consumer health protection to that provided by current incision methods.

2.2. The Committee considered that the advantages of omitting particular measures in a meat inspection system are:

- reduction of cross-contamination
- reduction of unnecessary damage to carcasses
- better application of resources to more appropriate sanitary measures.

2.3. If particular steps are omitted there will be a loss of information from the slaughtered animal. This would be a result of it, for example, no longer

being mandatory to make detailed incisions of the submaxillary lymph nodes etc. In the opinion of the Committee this information might be relevant to animal health considerations but not to consumer health protection.

3.1. The advantages, which are achievable with the three steps of inspection, have been identified in 2.2. above. There must be a fully integrated system to guarantee the advantages.

3.2. The Committee considered that an important step is to monitor the occurrence of zoonotic agents both at herd level and in the slaughterhouse. There are already schemes within the EU *e.g.* the existing *Salmonella* control scheme in Danish pig herds. The Committee also recognised that there will be added geographical risk factors. This will be both between Member States and for countries supplying pigs from outside the EU. This does not apply only to the more "common" zoonoses but also to emerging diseases. Consideration of these matters will involve other Groups as it impinges on zoonoses and importation of animals and animal product legislation among others. However the Committee were aware of the early discussions on review of the Zoonosis Directive in considering alternative meat inspection systems.

5.2. Recommendations

- Current inspection system can and should be improved. Higher level of pork safety can be obtained applying already available knowledge and technology. Occurrence of pathogens and unwanted residues at level, compatible with accepted risk for pig carcasses and pork end-products, should be ascertained.

- An integrated inspection and monitoring system, including effective traceability of animals and carcasses, is mandatory in order to assure that the outcome of the control and inspection system is "safe pork". Therefore revised meat inspection systems have to be based on an integration of all facets of modern animal husbandry taking into account biological and toxicological public health risks as well as animal welfare issues. Pre- and post-harvest control measures should be merged into one single holistic procedure.

- *Ante mortem* inspection at farm level must contribute to the judgement of fitness of the animals for human consumption. However, it must not be confined to immediately before transport to slaughter and involve consideration of the animal health information from the complete production chain and the performance indicators e.g. growth rate, mortality/morbidity data etc. The declaration by the veterinarian responsible for the farm should be available in the slaughterhouse when the pigs arrive for slaughter. This requires research on herd level surveillance and HACCP systems to investigate systems for *ante mortem* control in more depth.

- Before a revised meat inspection system is introduced to a slaughterhouse, a baseline study on faecal indicator bacteria should be conducted against which the new system could be compared.

- Introduction of HACCP in the slaughter plant should become mandatory. Regulatory agencies must have measures in place throughout the whole slaughter process to audit the sanitary measures. This must include audit of the HACCP plans for each slaughter plant and a control system that assures that supplying pig producers and the slaughter plant comply with the requirements of the meat inspection system.

- The current requirement for further detailed examination of suspect organs or carcasses, including sampling for laboratory analysis, has to continue.

As a consequence of the rigorous implementation of an integrated quality control system, that can be evaluated on the basis of food safety objectives and can be audited by the authorities, the liability would become transparent of the health mark.

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