Meat inspection: a key tool to assess health and welfare at farm level

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4. ‘Omics’ technologies
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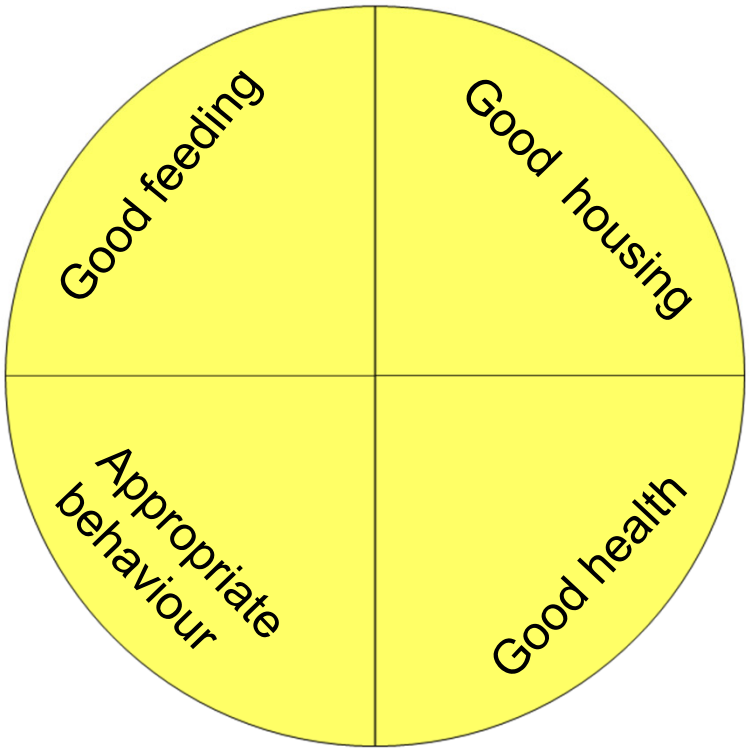
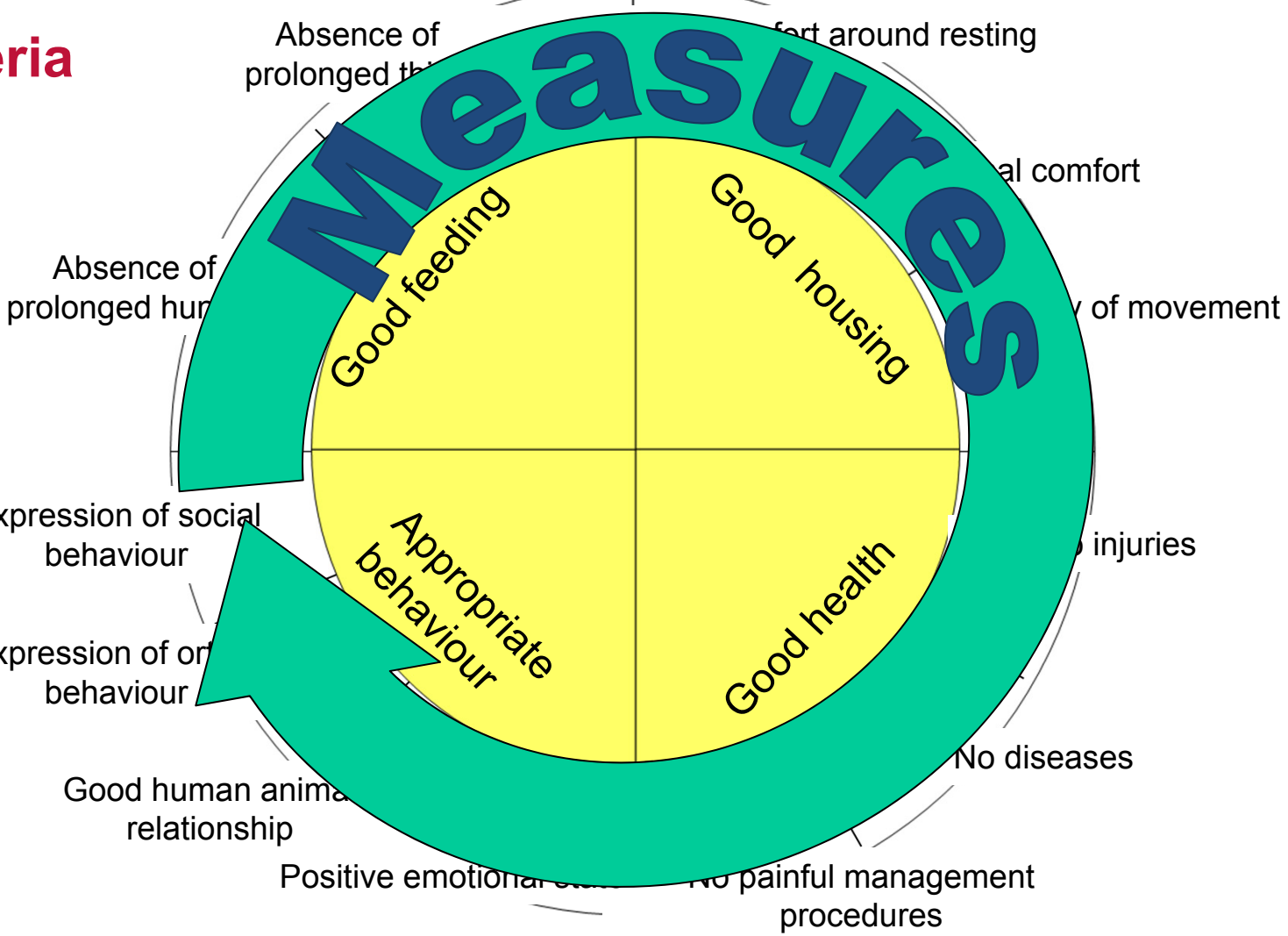
Animal Welfare

4 Principles



Multidimensional assessment

12 Criteria



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Properties

- **Validity:**
  - Meaningful in terms of providing information on the welfare of an animal or a group of animals

- **Reliability**
  - Inter-observer
  - Intra-observer
  - Test-retest

- **Feasibility**
  - Limited amounts of animal handling, time, cost, skills,…

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Bursitis

12 Criteria

Absence of prolonged thirst

Comfort around resting

rmal comfort

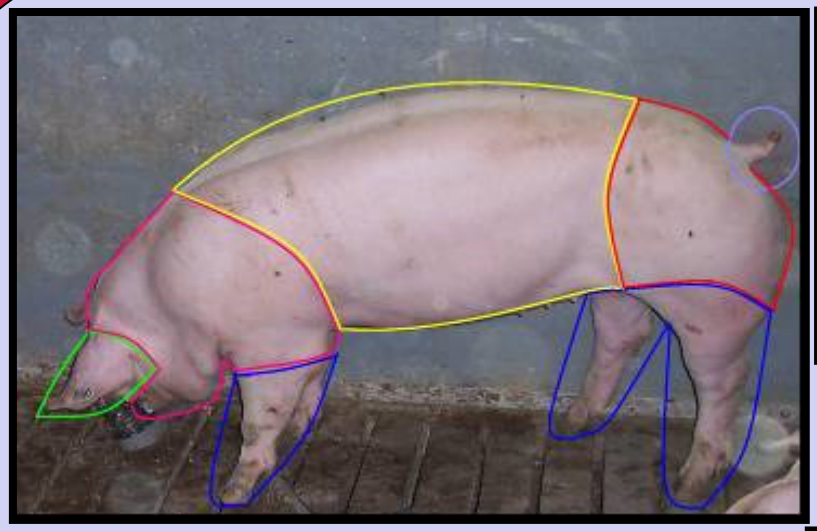
Easy of movement

0 – no evidence of bursae,

1 – one or several small bursae on the same leg or one large bursa

2 – several large bursae, or one extremely large bursa or any bursa that is eroded

Skin lesions



5 body areas

Scratches

Deep wound

resting

mal comfort

Easy of movement

No injuries

o diseases

lagement

procedures

Tail biting

a – No evidence of tail biting

b – Indication of superficial biting along the length of the tail, but no evidence of fresh blood or of any swelling

c – Fresh blood is visible on the tail; there is evidence of some swelling and infection; part of the tail tissue is missing.

Clinical observation

- Validity high

Reliability and feasibility low when:

- Overcrowded pen
- Insufficient light
- Dirty animals
- Animals lying

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Diseases

Clinical examination: Behavioural changes

Other symptoms

- Validity high

  (if pigs inspected routinely)

- Reliability high/medium

  (some signs not easy to observe)

- Feasibility medium/low

  (handling of the animal)

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Clinical examination

Subclinical disease ??

Symptomless carriers of pathogens may not be detected

- Validity low

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Logbook

- Data on productivity
- Data on mortality
- Veterinary treatments records
    - Validity ???
    - Reliability ???

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Post mortem inspection

- Visual examination
- Palpation
- Incision
- Laboratory analysis

→

- Bursitis
- Skin damage
- Tail and ear wounds
- Diseases

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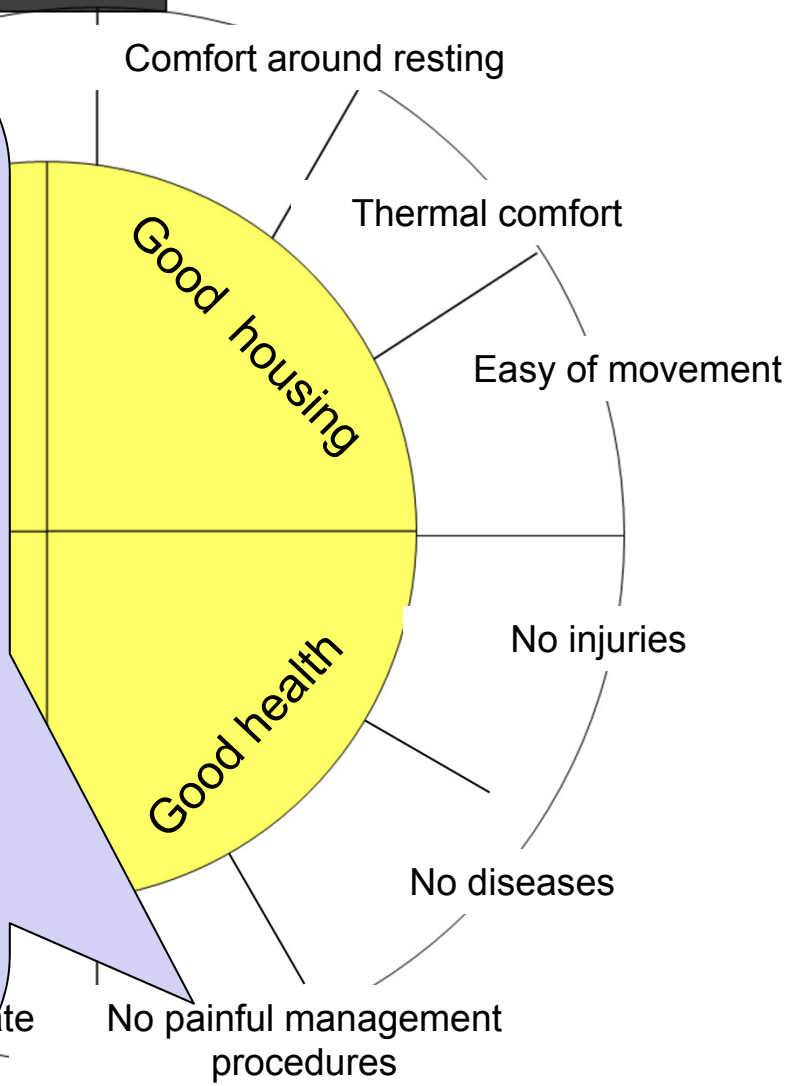
Skin lesions



Skin lesions

- Source by type of damage and location

Fighting

Poor handling or poor design of facilities

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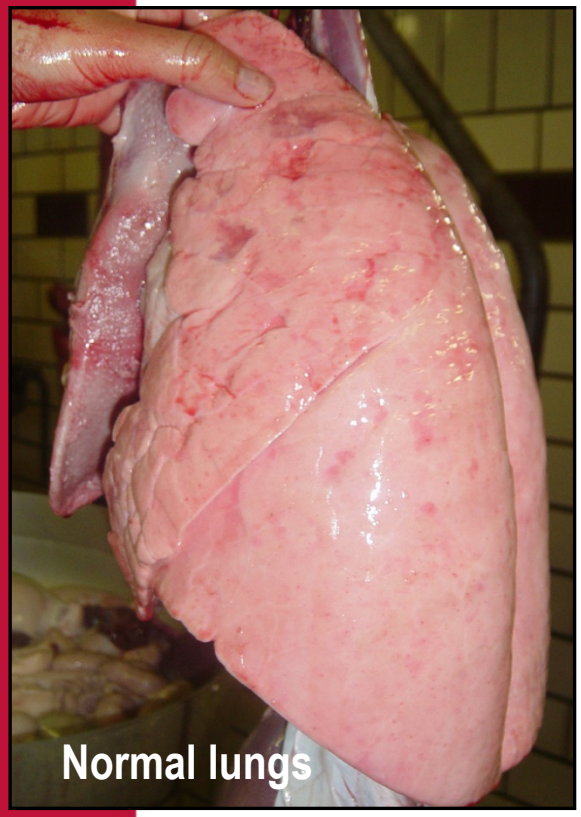
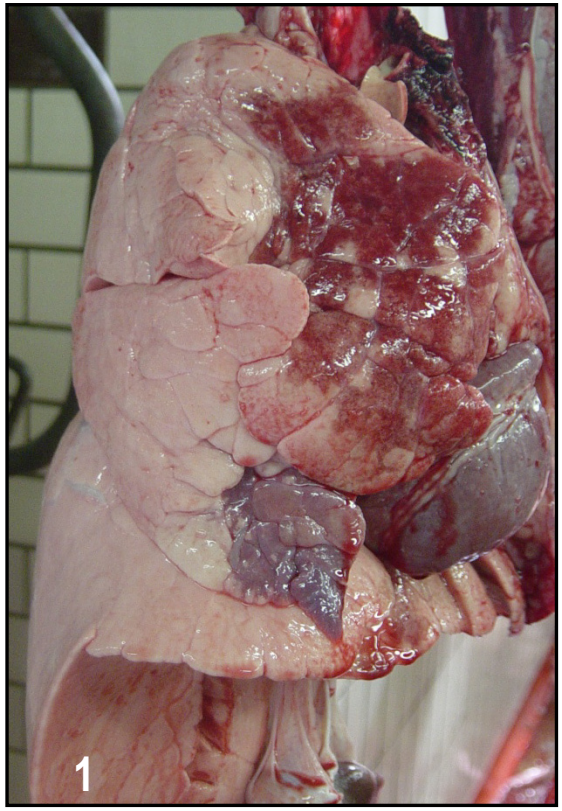
Tail and ear wounds

Pneumonia





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Pleurisy

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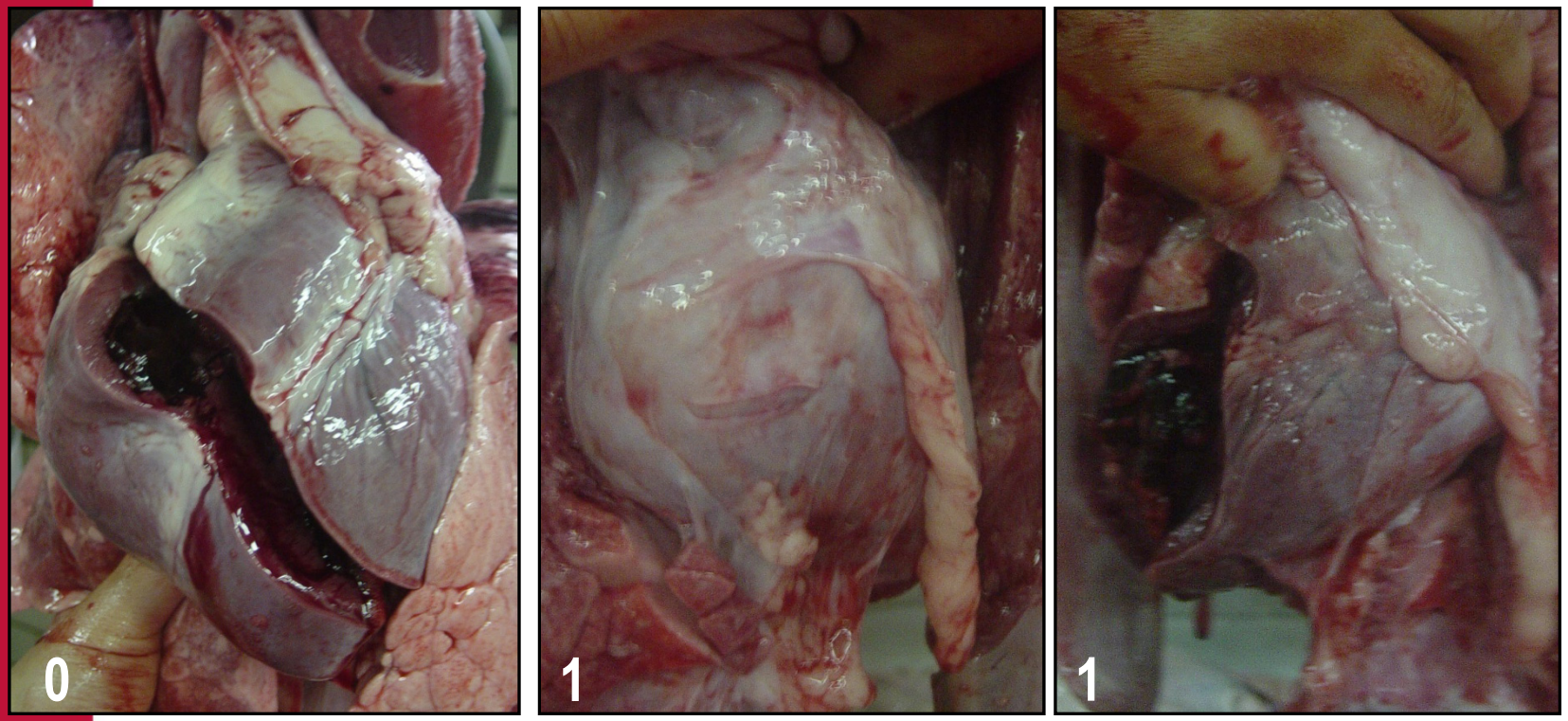
Pericarditis



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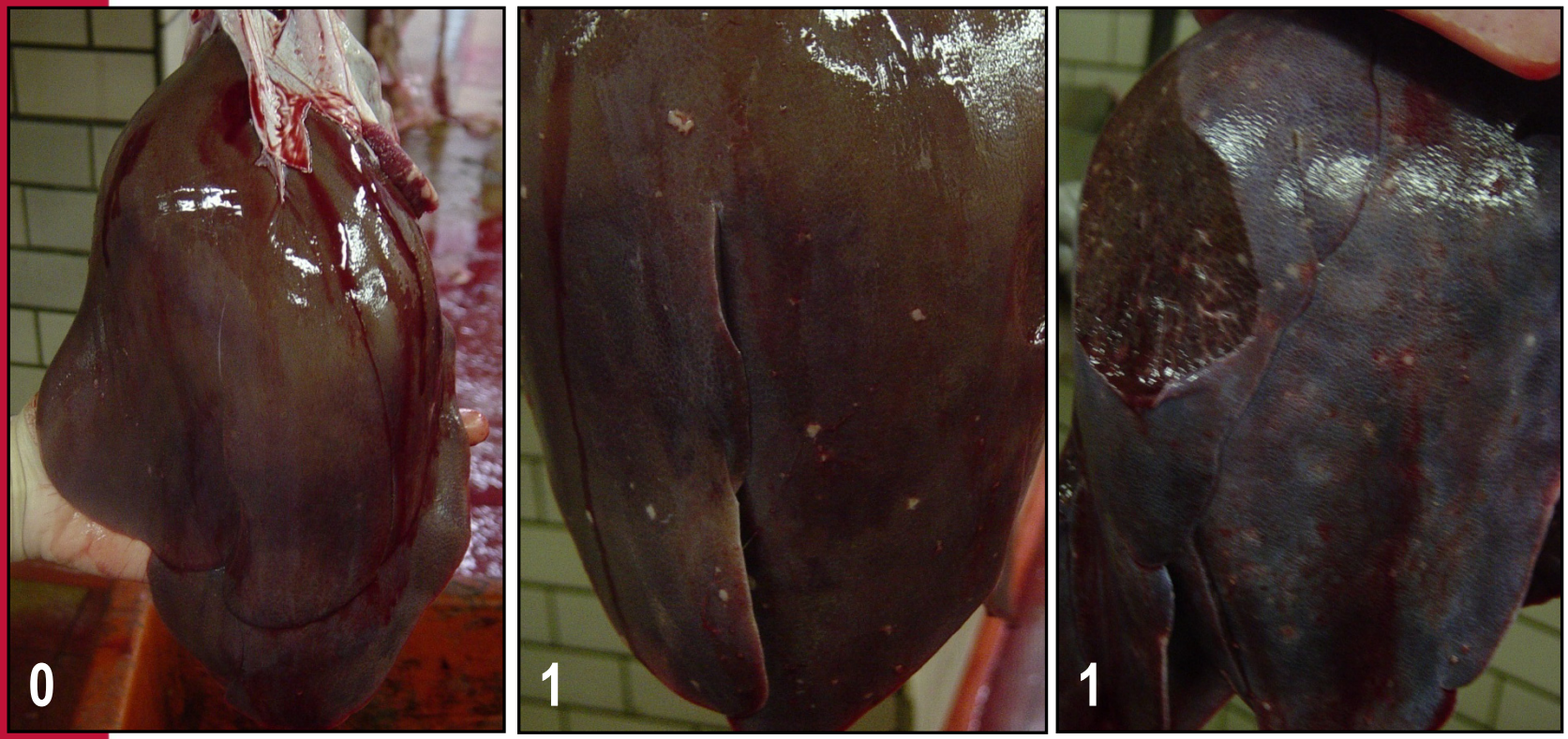
Ascaridiosis



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Meat inspection procedures

Regulation (EC) No 854/2004 art. 5

to assess if the meat is fit for human consumption

- Checks and analysis of food chain information
- *Ante-mortem inspection*
- Animal welfare
- *Post-mortem inspection*
- Specified risk material and other by-products
- Laboratory testing

Address a number of specific hazards: cysticercosis, trichinosis, tuberculosis, brucellosis, contaminants (e.g. heavy metals), residues of veterinary drugs and unauthorised substances or products.

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Terms of reference

- Identify and rank the main risks for public health that should be addressed by meat inspection.
- Assess the strengths and weaknesses of the current meat inspection methodology
- Recommend possible alternative methods, taking into account implications for animal health and welfare.

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Approach

- Hazards from scientific literature were ranked qualitatively based on:
  - their prevalence in carcasses,
  - source attribution of human cases to pork
  - incidence and severity in humans

→Resulting in a shortlist of hazards

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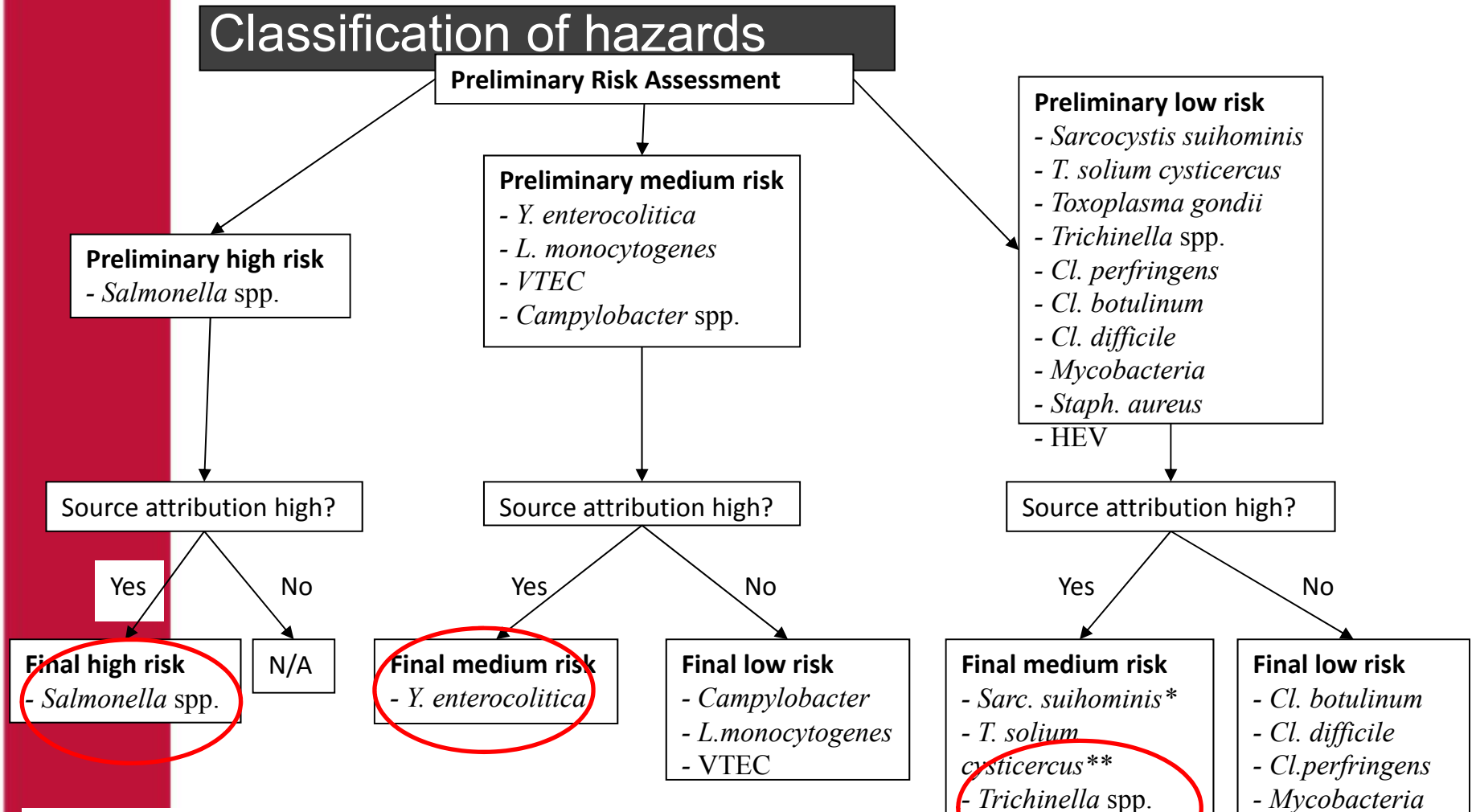
Classification of hazards



*No information on occurrence in carcasses and human cases in EU, so actual relevance in EU unknown; excluded from further considerations but to be monitored in future

**Not currently considered relevant in the EU pig population; excluded from further considerations but to be monitored in future

Current meat inspection system

Strengths

***Ante-mortem* inspection enables**:

- Using food chain information (FCI)
- Detection of clinically observable zoonoses
- Animal identification and traceability, and evaluation of cleanliness of pigs.

***Post-mortem* inspection enables**:

- Detection of visible faecal contamination, macroscopic lesions caused by some zoonotic agents
- To detect *Trichinella* spp. by laboratory examination.

Weaknesses

- Current *ante-* or *post-mortem* inspection cannot macroscopically detect the food-borne hazards of most relevance
- The use of palpation/incision techniques during post-mortem inspection mediates cross-contamination

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Recommend inspection methods fit for new hazards

- The only way to ensure effective control of the hazards of relevance identified is to establish:

A comprehensive pork carcass safety assurance, combining measures applied on-farm and at-abattoir

- A prerequisite for this system is **setting targets** for these hazards to be achieved on carcasses.

- These targets would also inform what has to be achieved earlier in the food chain.

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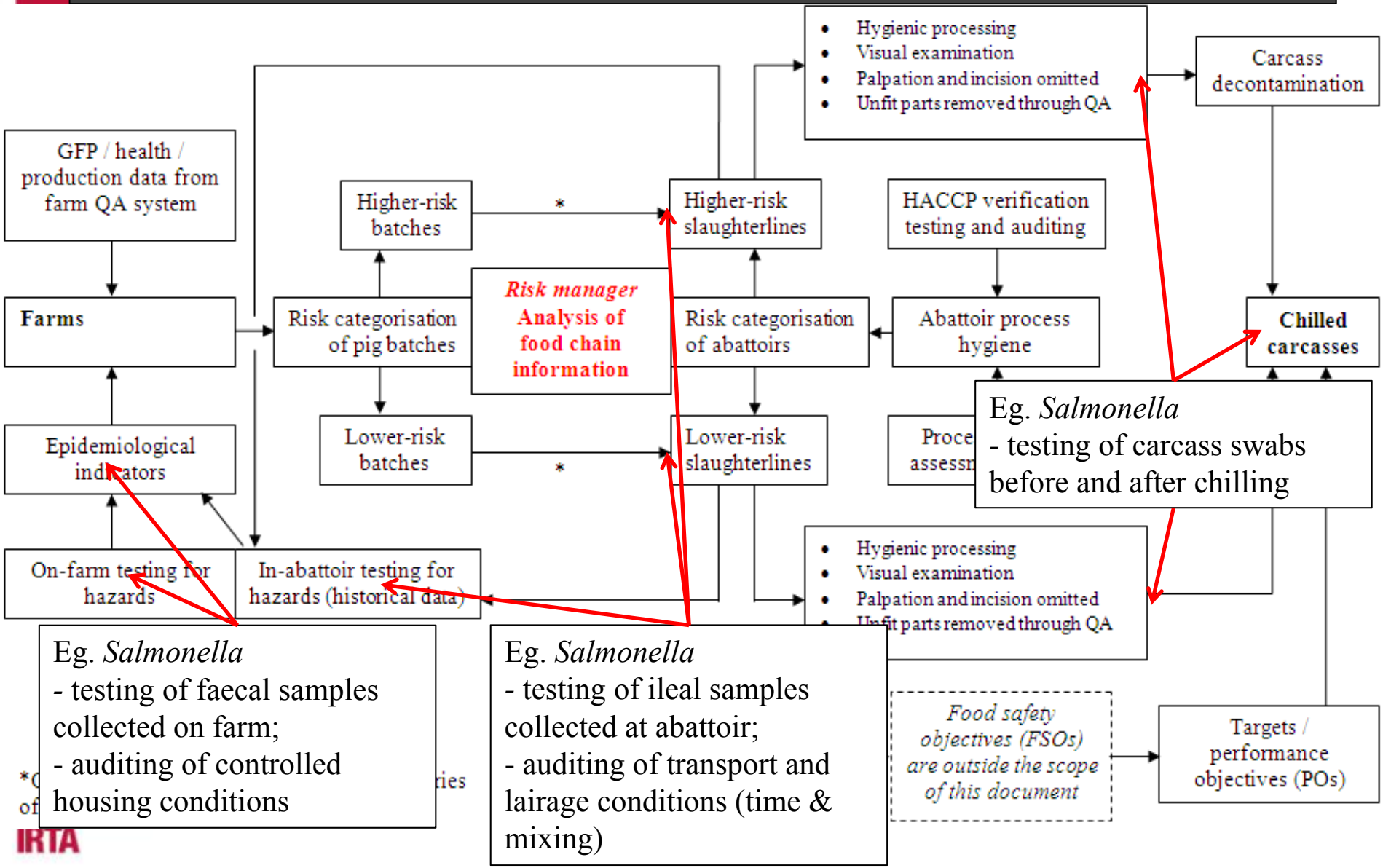
Main elements of generic pork safety assurance with respect to *Salmonella* spp. and *Y. enterocolitica*



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Recommend adaptations of current methods

- Palpation/incisions should be omitted in pigs subjected to routine slaughter, because the risk of microbial cross-contamination is higher than the risk associated with potentially reduced detection of conditions targeted by these techniques.
- The use of these manual techniques should be limited to suspect pigs identified through FCI/*AM* inspection or *PM* visual detection of relevant abnormalities where it would lead to risk reduction.
- *Post-mortem* examination involving palpation and incision, where necessary, should be performed separately from the slaughter line operation and accompanied with laboratory testing as required.
- Elimination of abnormalities on aesthetic/meat quality grounds can be ensured through meat quality assurance systems.

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Meat inspection

- *Proposed removal of palpation*
  - Reduced detection probability for conditions that change organ consistency
    - *Subacute toxic liver damage, interstitual pneumonia*

- *Proposed removal of incision*
  - Reduced detection probability for lesions of small-medium size within organs (normal shape, regular form)
    - *Endocarditis, lung/liver abscess, granulomas, cysticercosis, lung alveolar oedema*

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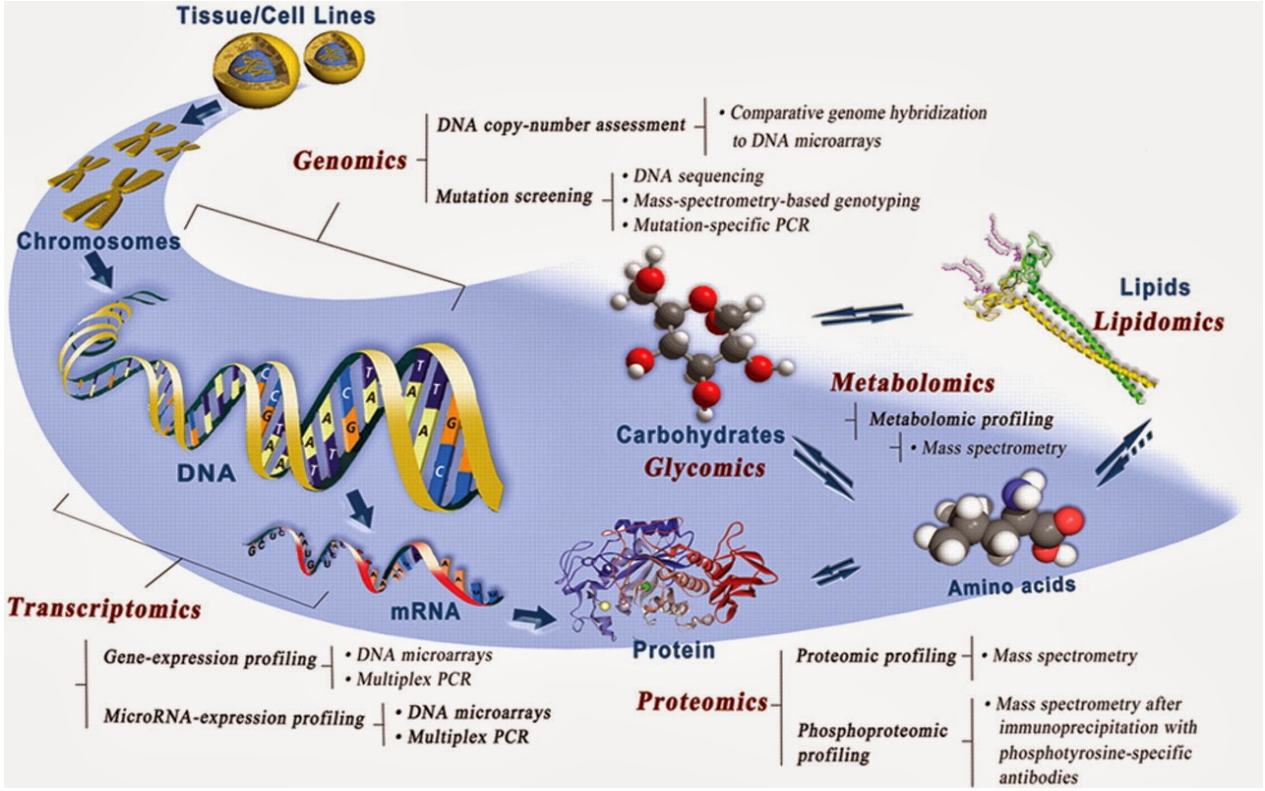
“Omics technologies”

- Technology focused on the identification of novel animal-based biomarkers for health and welfare assessment,.



Taken from Wu et al. (2011) JDR 90: 561-572

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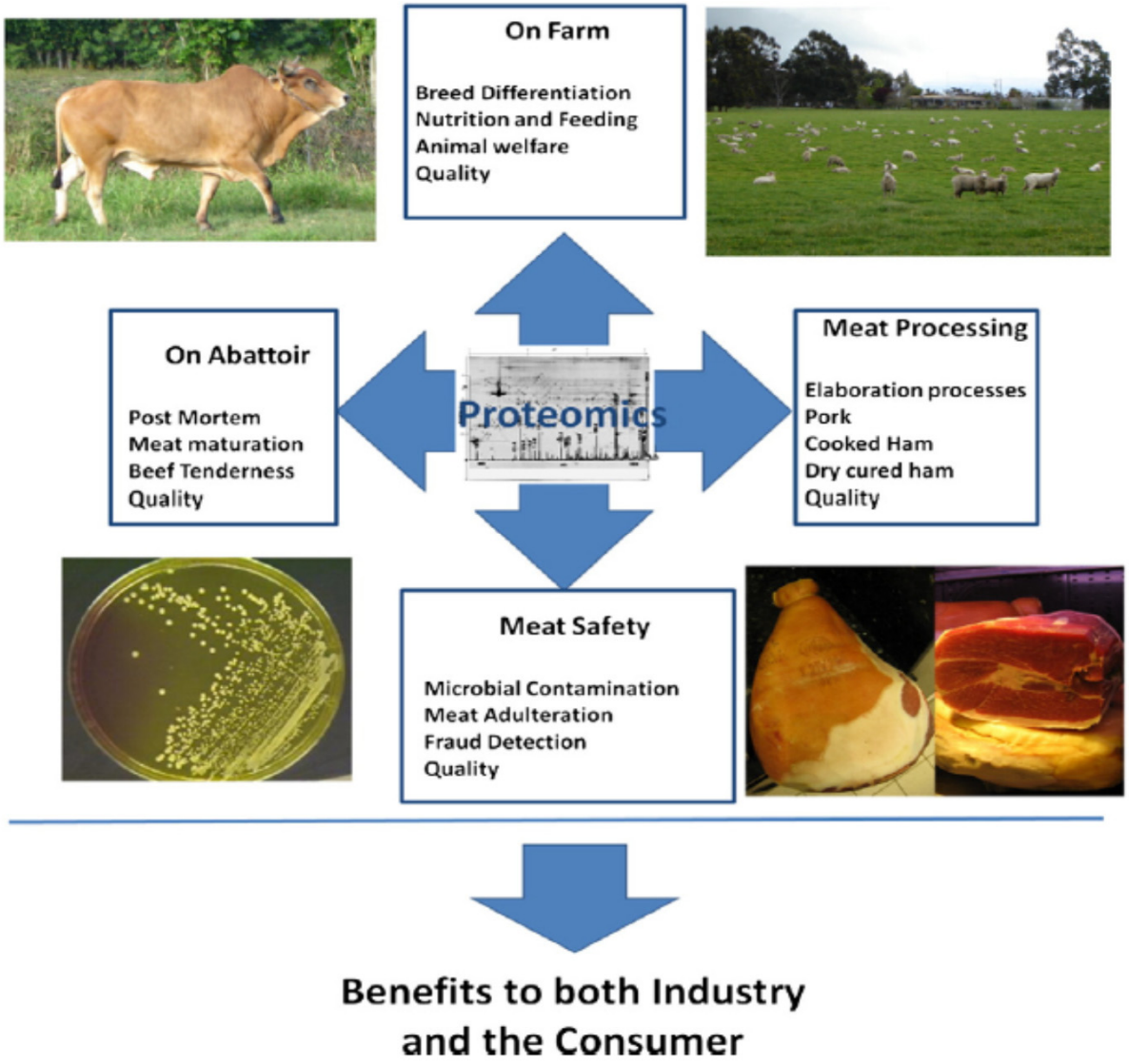
USE OF PROTEOMICS IN MEAT SCIENCE IN A FARM TO FORK PERSPECTIVE



Taken from Paredi et al. (2013) Journal of Proteomics 88: 58-82

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EFFECT OF SEX AND GENOTYPE ON STRESS BIOMARKERS

To identify physiological, biochemical and proteomic biomarkers to assess the individual response to slaughter stress of pigs of different sex (M/F) and halothane genotype (NN/Nn).

48 [(Large White x Landrace) x Pietrain] pigs reared in IRTA-Monells experimental farm (Girona, Spain), simulating commercial conditions, in groups of 6 pigs per pen in duplicate.

M-NN: males; halothane genotype (hg): NN. M-Nn: males; hg: Nn. F-NN: females; hg: NN; F-Nn: females; hg: Nn.

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Materials and methods

***Carcass and meat quality*:**

- In *Semimembranosus* (SM) and *Longissimus dorsi* (LD) muscles):
- pH45, pH24, EC, meat color (L*, a*, b*) and drip loss (% exudates) at 24h *pm*.
- Shear force (Warner Bratzler test) at 1, 3 and 5 days *pm* (WB-1; WB-3; WB-5).
- Skin lesions using the Welfare Quality® protocol.

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Materials and methods

Blood biochemical parameters:

glucose, lactate, urea, creatinine, acute phase proteins (C-reactive protein (CRP) and Pig-MAP); skeletal muscle marker (creatine kinase (CK)); and redox marker (glutathione peroxidase (GPx)).

Muscle proteins:

electrophoretic protein profile of sarcoplasmic extracts by SDS-PAGE in *LD*, obtaining stained gel images of the protein bands. The protein spots of interest were excised from gels and analyzed by mass spectrometer.

Results and discussion

Carcass and meat quality:

Sex differences:

Females : ↓ muscle pH45LD and pH24SM

↑ EC

Genotype differences:

Nn : ↓ muscle pH45

↑ EC and drip loss (more exudative)

↑ WB (tougher meat)

Sex x Genotype for the meat color traits a* and b*.

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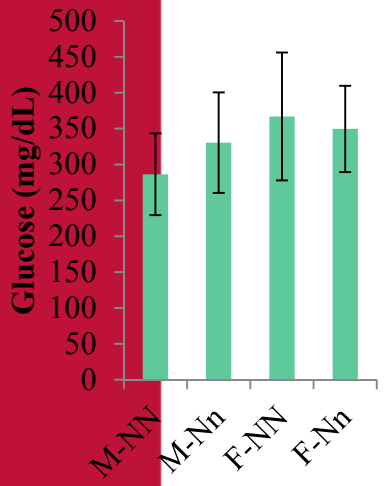
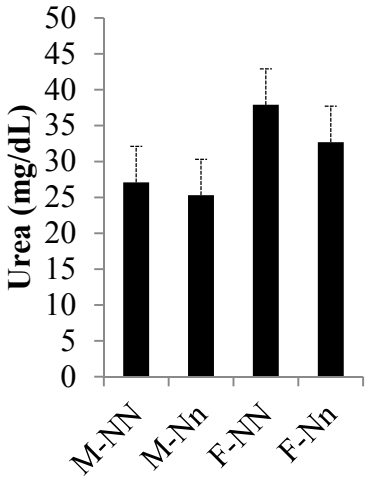
Biochemical parameters

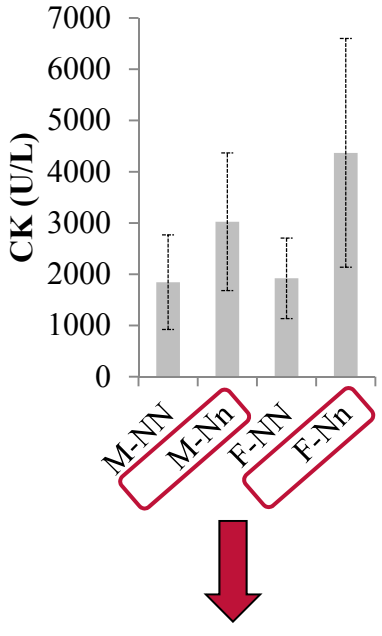
Glucose



Urea

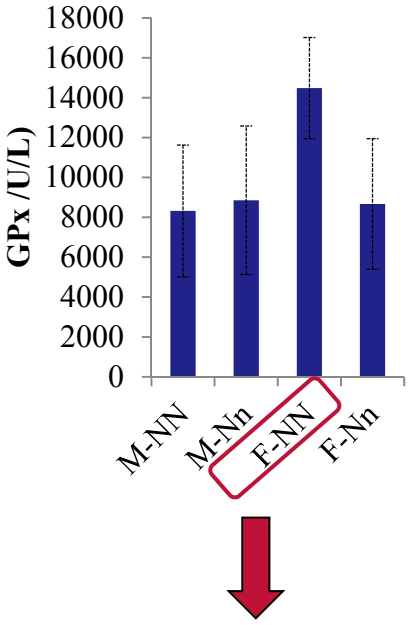


Creatine Kinase



higher susceptibility to muscular lesions

Glutathione peroxidase



higher antioxidant defenses

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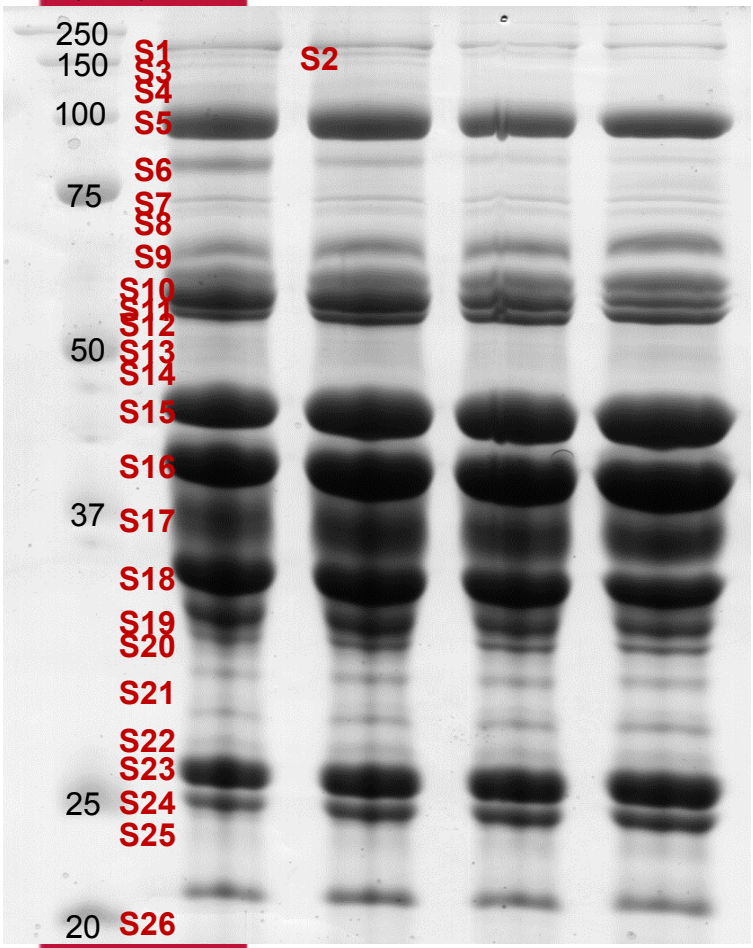
Muscle proteins:



SDS-PAGE gel image of sarcoplasmic extracts of LD muscle. Band denoted by S (sarcoplasmic protein) followed by a number.

26 protein bands differentiated.

Sex differences:

S2 (myosin-binding protein C fast type): ↑ F ($p<0.05$)

S6 (muscle-6-phosphofructokinase: ↓F ($p<0.01$).

Genotype differences:

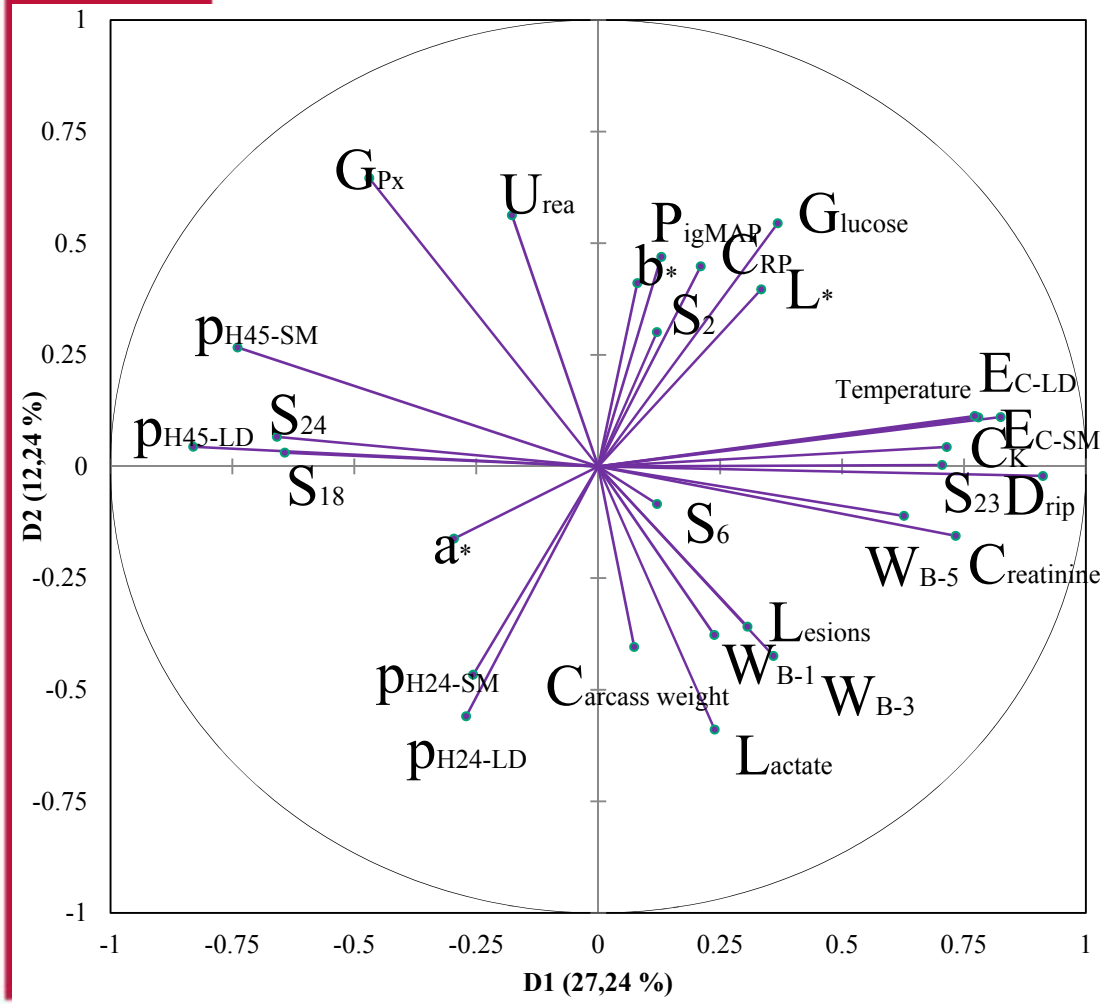
S2(myosin-binding protein C fast type): ↓Nn ($p<0.05$)

S18(glyceraldehyde-3-phosphate dehydrogenase "GAPDH"):): ↓Nn ($p<0.01$)

S23 (beta-enolase) ↑Nn ($p<0.05$)

S24 (carbonic anhydrase) ↓Nn ($p<0.05$)

Multivariate analysis:



- ✓PC1: higher skin lesions and *post mortem* carcass temperature characterized these samples, which seem to indicate higher *peri mortem* stress.
- ✓PC2: distinguished variables indicating an inflammatory and antioxidant response to stress (blood levels of GPx, urea, Pig-MAP and CRP at slaughter).

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Conclusions

- The results of this study showed that sex and genotype affected stress biomarkers in pigs.
- In general, females and animals heterozygous for the halothane mutation (Nn) showed higher susceptibility to stress.
- These differences could be monitored by using some physiological, biochemical and proteomic biomarkers related to muscle fiber composition and oxidative stress.

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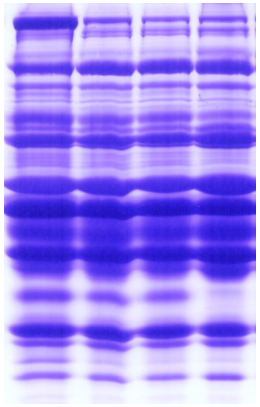
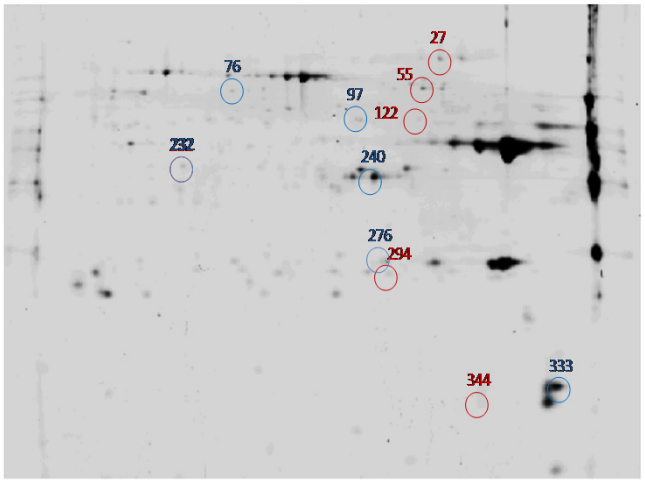
Detection in meat of some key proteins related to pre-slaughter stress

1- Effect of mixing unfamiliar animals



Dependent variable	Predictors (biomarkers)	R^2
Electrical conductivity (drip)	AAT + L-lactate dehydrogenase + myosin light chain + heat-shock 70kDa+ carbonic anhydrase III	0.97

2- Differences between indoor/outdoor



Relationship between meat quality and stress biomarkers in pigs

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Slaughterline records vs. on farm records

- Higher reliability and feasibility
- Minimize the risk of disease transmission on farm
- Several farms can be sampled on the same day

Carcass identification should be kept throughout the process

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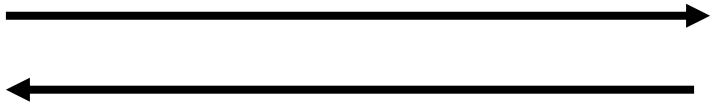
Feedback system of information:

Welfare and disease records
Medical treatments

FARM  **ABATTOIR**

Report with:

- Prevalence of injuries
- Subclinical lesions
- Meat quality results
- Other defects

Key point: Traceability

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Post mortem inspection involves:

- Visual inspection
- Palpation
- Incision

Increase the risk of cross contamination

It has been proposed:

- Minimizing:
  - carcass handling
  - nr of incisions
- Only visual inspection

  Some lesions may remain undetected

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Thank you for your attention

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