



Improved animal welfare, the right technology  
and increased business

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# Danish Meat Research Institute



Meat Technology

Food Safety

Measurement  
Systems & IT

Slaughterhouse  
Technologies

Automation

Business  
Development



# From farm to slaughter

## Why animal welfare?

## Pre-slaughter handling

Pigs

- The group-based principle
- Transport, Lairage, Stunning

Poultry

- *Collection*, Transport, Stunning

## Surveillance and documentation of animal welfare

Pigs

Poultry

## Improved value of the livestock



# Why animal welfare?

- Ethical responsibility
- Demands from the market and authorities
- Improvement of value/less loss due to injuries

## Points of action

- ✓ Documentation of animal welfare
- ✓ Optimization of handling on the day of slaughter
  - Transport and delivery to the slaughterhouse
  - Lairage
  - Stunning and sticking



# Regulations



## ***Council Regulation (EC) No 1099/2009 of 24 September 2009 - on the protection of animals at the time of killing***

### **General requirements**

- Animals shall be spared any avoidable pain, distress or suffering during killing and related operations
- Business operators shall take the necessary measures to ensure compliance with the obligation mentioned above
- Facilities used for killing and related operations shall be designed, constructed, maintained and operated so as to ensure compliance with the obligations mentioned above

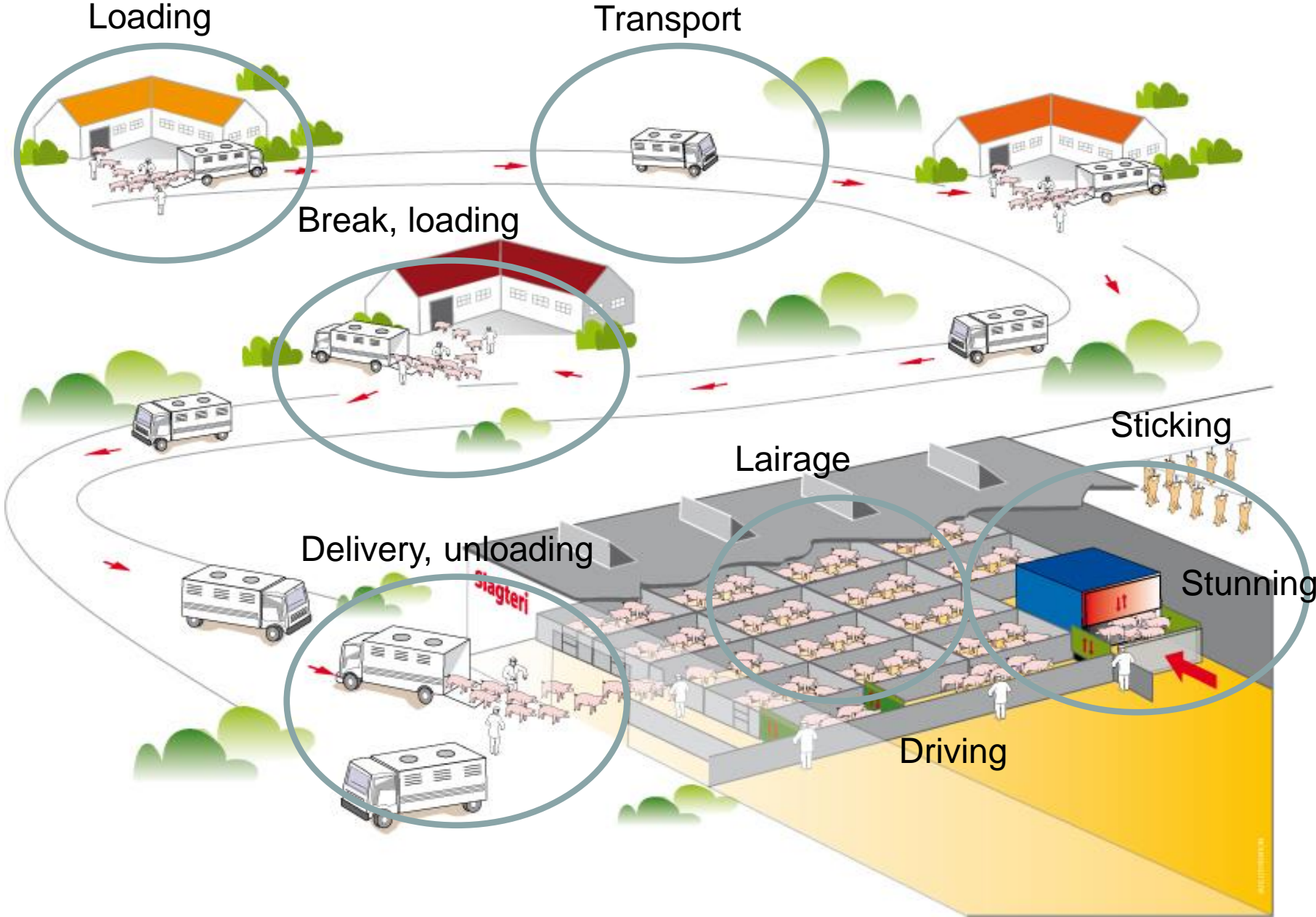


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A good animal welfare standard is good business



# Pre-slaughter handling - Pigs



# From farm to slaughterhouse

- Pigs in smaller groups (15)
- Groups only mixed once when loaded on the transport vehicle
- Uniform delivery at the abattoir
- Little mixing of pigs
- Low incidence of fighting



## Transport/lairage

Group size \ Skin damage	15	45
Legs	3.9%	5.2%
Shoulder	16.1%	23.7%

Gade & Christensen, 1999

Uses the instinct of the animals

Considerate treatment

Improves meat quality

Pre-slaughter handling  
**Pigs**



# Group-based principle



The handling of pigs at the Danish slaughterhouses are optimized with respect for the animal

DMRI

Pre-slaughter handling  
**Pigs**

# Transport



Animals must be suited for the intended transport.

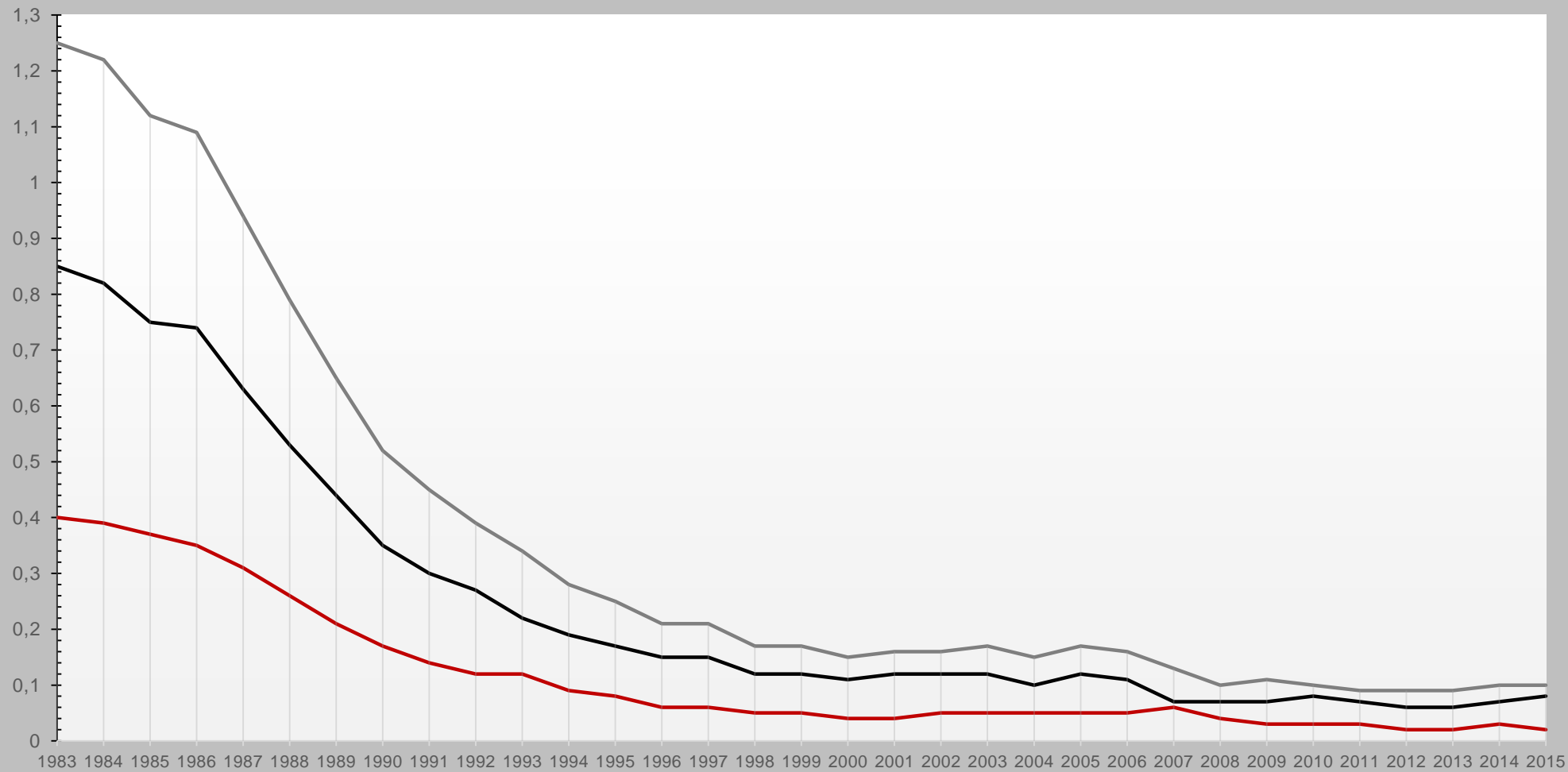
## Factors of importance

- Journey duration
- Climate - ambient temperature, CO<sub>2</sub>-concentration, humidity
- Animal location in the vehicle
- Stocking density
- Vehicle design
- Floor type and bedding
- Driving style
- Mixing with unfamiliar pigs

Pre-slaughter handling  
**Pigs**

# Mortality during transportation and lairaging Slaughter pigs

Mortality o/oo



Year

— Transport slaughter pigs

— Lairage slaughter pigs

— Total slaughter pigs

Pre-slaughter handling  
**Pigs**

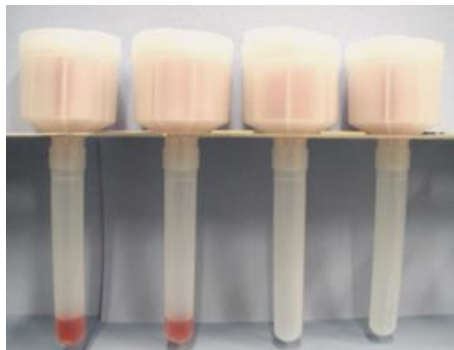
# Lairage



Lairage time to optimize production or as short as possible



Aggressions increase after three hours



=



Pre-slaughter handling  
**Pigs**

# CO<sub>2</sub> stunning

- Allows the group-based principle
- Avoid restraining of pigs
- Improve meat quality (fewer haemorrhages, lower drip loss)
- Signs of aversion to the gas a few seconds before unconsciousness occurs



## Stunning procedure

- CO<sub>2</sub> concentration
- Stunning time
- Stun to stick interval

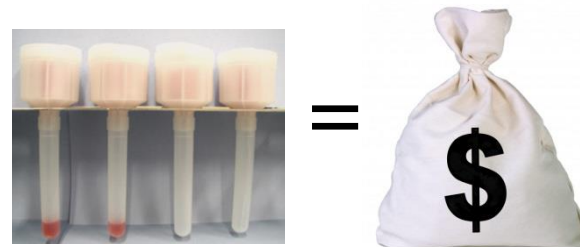
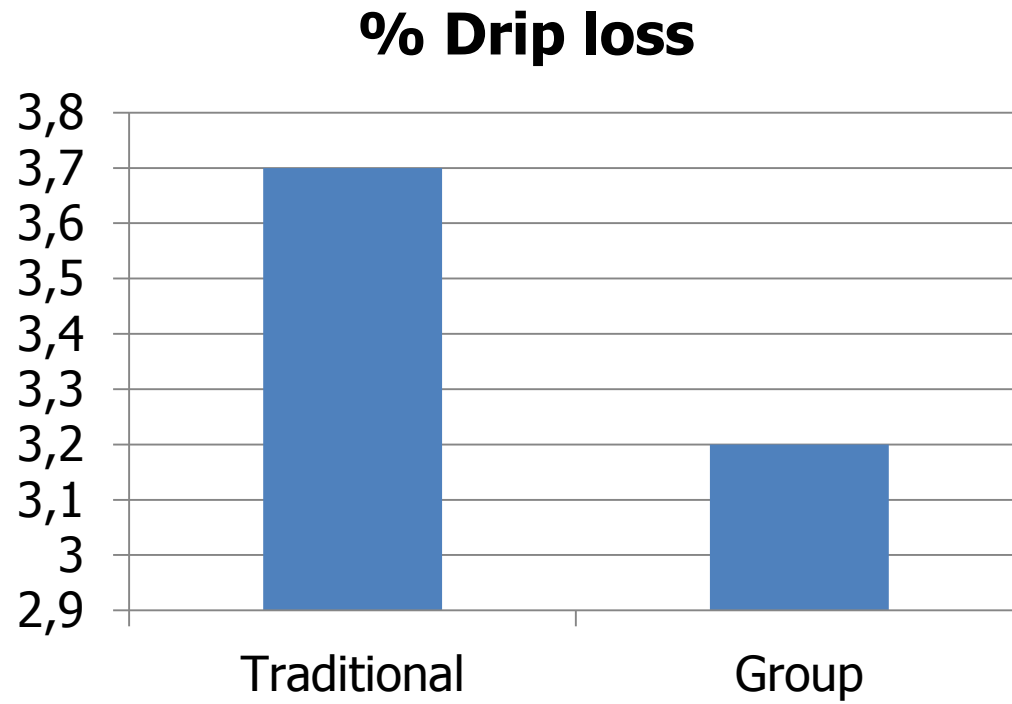
## Stunning quality

- No conscious movements
- No respiration
- Cornea reflex
- No vocalisation

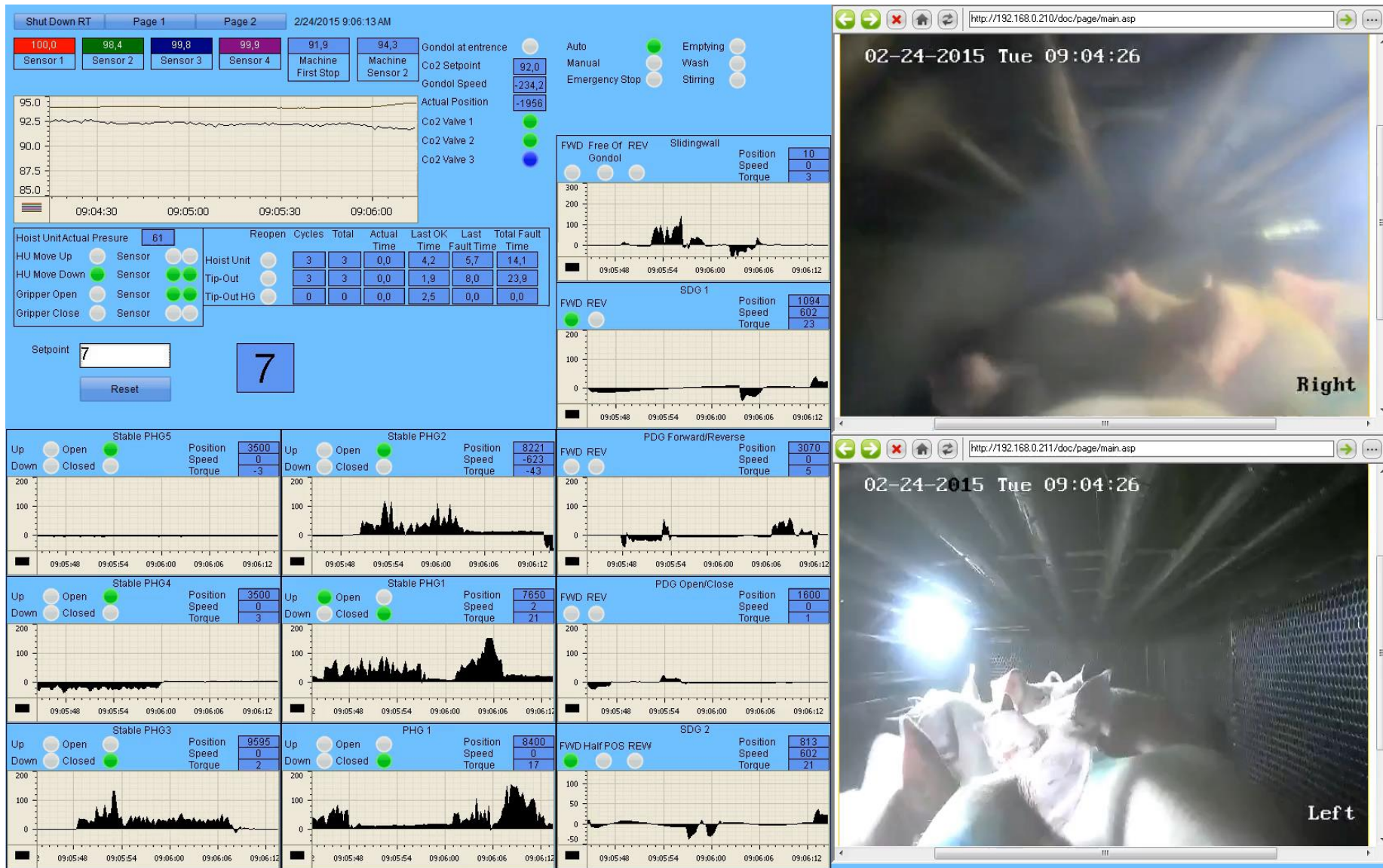


Pre-slaughter handling  
**Pigs**

# Driving and stunning



Pre-slaughter handling  
**Pigs**



Box position: 7 = entrance, 6 = first stop after entrance.....1 = tip out

Pre-slaughter handling  
Pigs

# Muscular haemorrhages in pork

- A haemorrhage indicates that there has been a strain on the pig
- A haemorrhage causes trimming
- The most common types of haemorrhages observed in pork:
  - Blood spots in tenderloin tip or head
  - Point haemorrhages in ham muscles
- Most haemorrhages occur during the last two hours before sticking
- Best practice for driving and stunning minimize the incidence of haemorrhages



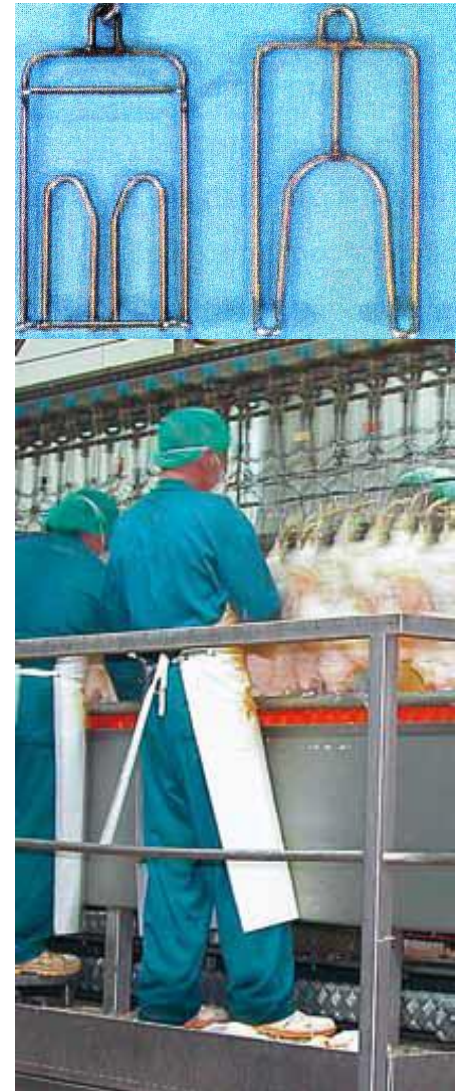
Pre-slaughter handling  
**Pigs**



# Slaughter process – critical points

- Collection
- Transport conditions
- Shackling
  - Risk of induce or increase pain/ shackling of live birds cause them to struggle, flap their wings and vocalise
  - Condition and size of shackles
  - Suspended birds should not hang conscious for more than one minute
- Stunning methods
- Head cutting/debleeding
  - Correct manual or automatic cutting of neck veins
  - Automatic cutting has to be followed by inspection

Technology combined with management can improve animal welfare and quality



Pre-slaughter handling  
**Poultry**

# From farm to slaughter

## Transportation

- Climate
  - Ventilation
  - CO<sub>2</sub>-concentration
  - Temperature
  - Humidity
- Duration
- Boxes - design, number of birds
- Delivery to slaughterhouse



Pre-slaughter handling  
**Poultry**

# Stunning methods

- Commonly used stunning methods at commercial chicken slaughterhouses
  - Electrical stunning in water bath
  - Controlled Atmosphere Stunning (CAS)
- Other methods
  - Head only Stunning System™
  - Low atmospheric pressure stunning (LAPS)
- Loss of consciousness before killing



# Electrical stunning in water bath

## System

- Head to body electrical stunning

## Comments

- Shackling of living birds
- Actual current received by each bird depends on its resistance that varies
- Electro-immobilization instead of loss of consciousness
- Risk of pre-stun shock



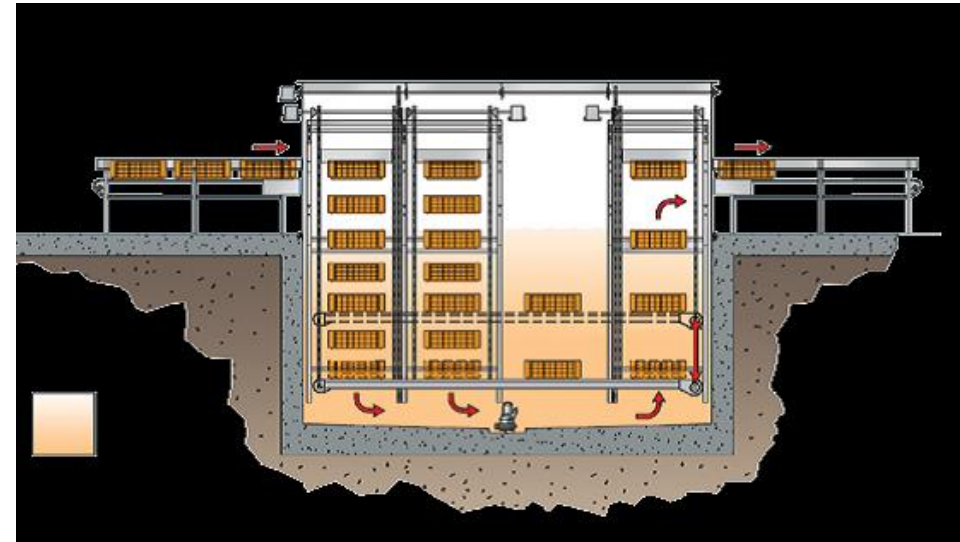
# Controlled Atmosphere Stunning (CAS)

## System

- CO<sub>2</sub> - multiphase systems using O<sub>2</sub> and CO<sub>2</sub>. 1<sup>st</sup> phase, low concentrations of CO<sub>2</sub> (max. 40 %) are induced to reduce aversiveness, 2<sup>nd</sup> phase, CO<sub>2</sub> concentrations are increased (80 %)

## Comments

- Less damage (bone fractures, bruises and haemorrhages) compared with electrical stunning (Gigaud et al., 2010)
- Withdrawal reaction -> more damages
- Admixture of oxygen -> less damages
- Possible to stun in transport modules
- Sorting out 'dead' bodies – thermography?



Pre-slaughter handling  
**Poultry**

## Stunning quality

### Behaviour indicators

- No rhythmic respiration
- No cornea reflex
- No wing flapping/no conscious movements
- No vocalisation

### Key parameters to be controlled

#### Electrical stunning

- Minimum current, voltage
- Maximum frequency
- Minimum time of exposure

#### Gas stunning

- CO<sub>2</sub> concentration
- Duration
- Gas quality
- Gas temperature

#### Stun-to-stick/kill interval

## Stunning – welfare advantages and challenges

	Electrical stunning	Controlled Atmosphere Stunning
Industrial use	80 %	20 %
Advantages	Rapid onset of unconsciousness Limited operation cost	Stunning in transport modules Shackling post-stun Fewer haemorrhages
Challenges	Shackling Potential for prestun shock Electro-immobilization vs. unconscious	Operation cost Unconsciousness is not rapid Detection of bodies that died during transport Consciousness at loss of posture

Ref. Buhr (2009)

# Surveillance of animal welfare

## **Why?**

- Internal inspection and product responsibility
- Feedback to staff, haulier, farmer etc.
- Demands from market and authorities

## ***How?***

- Behavioural studies
- Ethical audits
- Continuous monitoring of animal welfare - possibilities:
  - Video recording/Vision systems
  - Sound recording - vocalization by the animals
  - Temperature measurements
  - Blood analysis
  - Etc.



# Surveillance of animal welfare

## Behavior/clinical measures



## Indirect measures



- **Simple**
  - **Meaningful**
    - **Valid**
      - **(Cheap)**

Surveillance of animal welfare

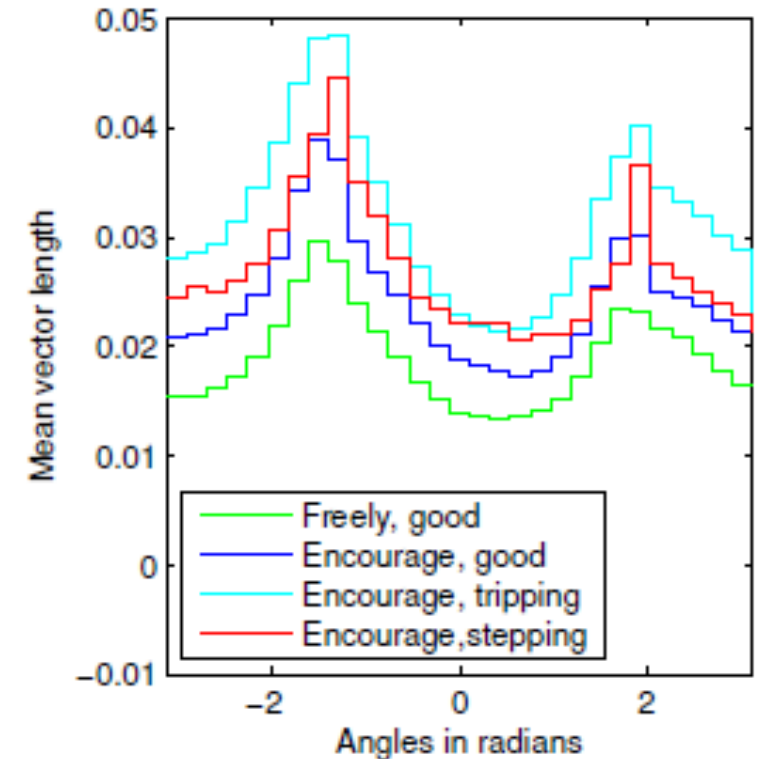
# Monitoring motion of pigs – Vision for animal welfare



Movement analysis can give information about the health and welfare of farm animals.

Motion of animals is estimated using optical flow (OF).

A modified angular histogram (MAH) is used to summarize the length of the vectors within a small range of angles.

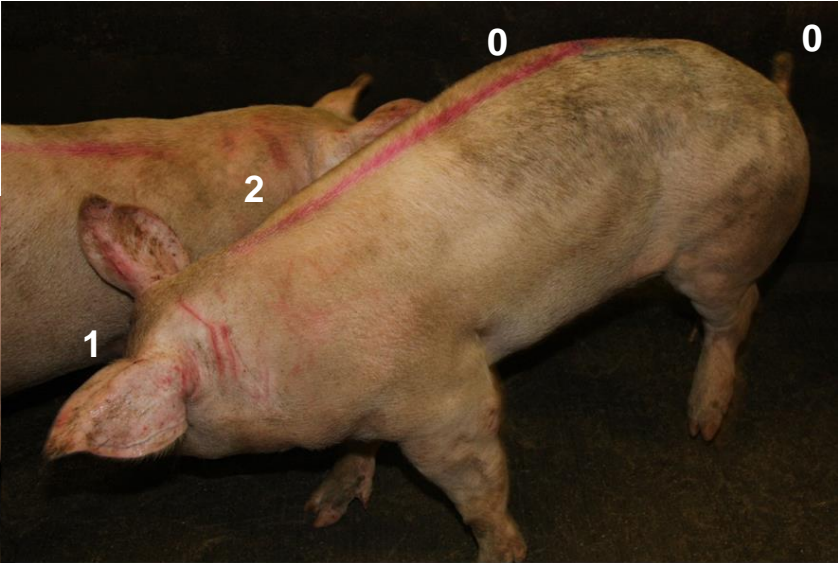


Modified from Gronskyte (2014)

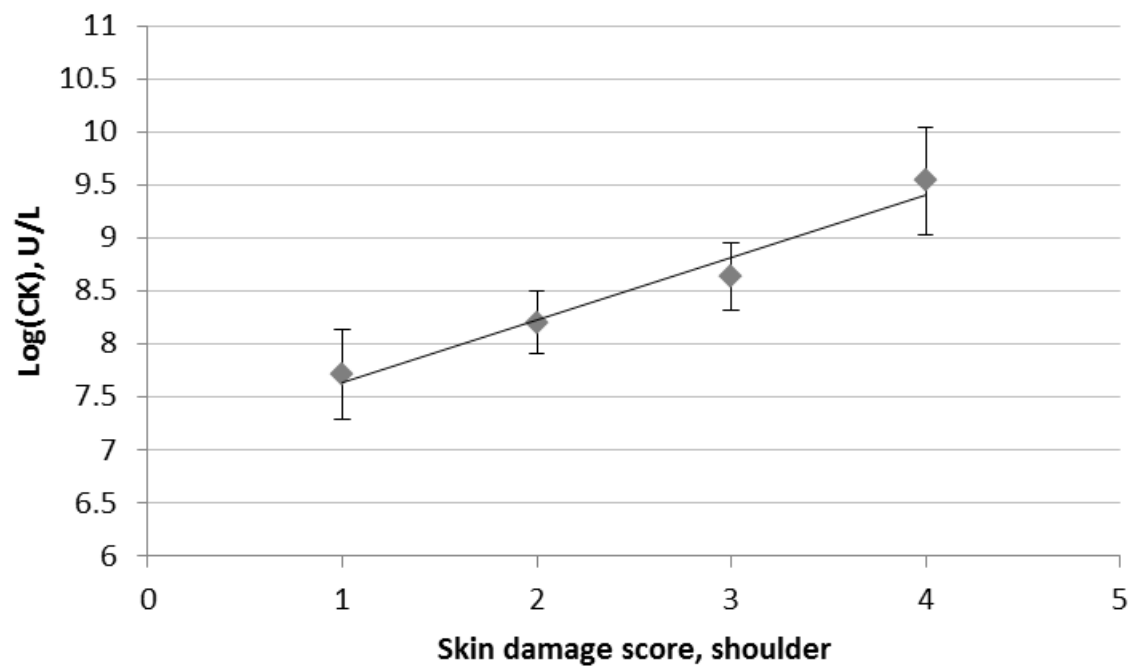
Surveillance of animal welfare  
**Pigs**

# Skin damage

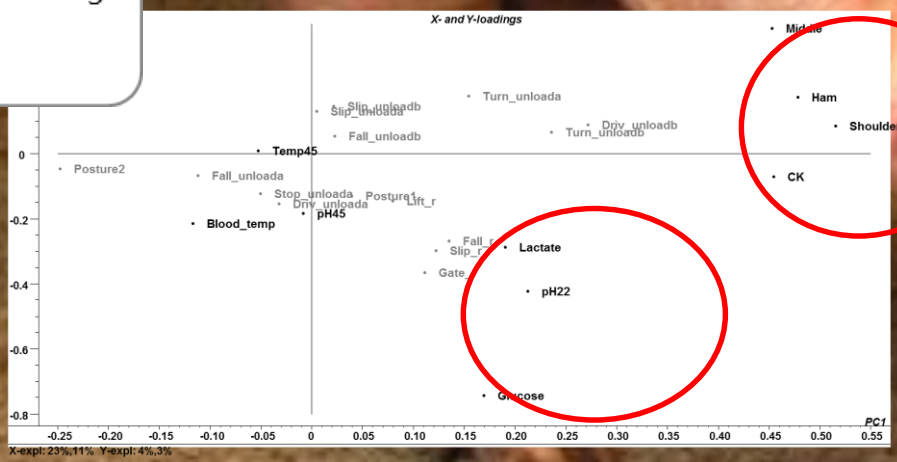
- 0 None or a little superficial damage
- 1 Some superficial damage
- 2 Clear deep and/or long damage
- 3 Much deep damage



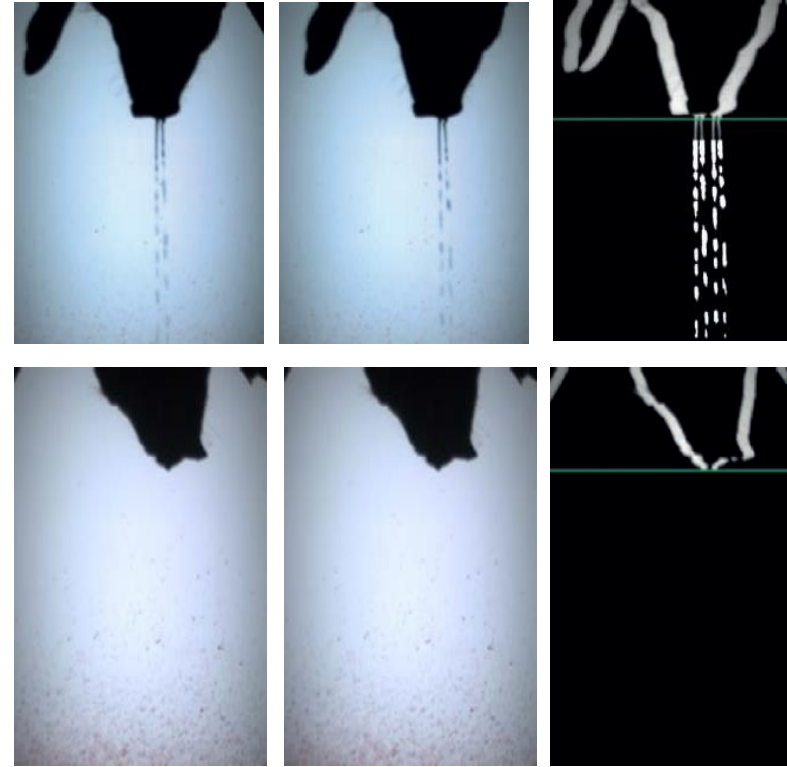
# Automated blood analyses of lactate and creatine kinase (CK)



Brandt, P., Rousing, T., Herskin M. S., Aaslyng, M. D., 2013. Identification of *post-mortem* indicators of welfare of finishing pigs on the day of slaughter. *Livestock Science* 157, 535-544.



# VisStick – monitoring the sticking procedure



Detection range: 98 to 100 %  
False positive: 0 to 0.064 %  
(Borggaard et al, 2011)

# Footpad dermatitis – an indicator of welfare problems

- Danish broilers have been checked for footpad dermatitis since 2002
- Inspected Danish flocks with a low score:

2003: 30 %

2013: 75 %

(Danish Veterinary and Food Administration)



Surveillance of animal welfare  
**Poultry**

# Footpad lesions – automatic measurement



Surveillance of animal welfare  
**Poultry**

# Improved value of slaughter pigs at commercial slaughterhouses

Improvement of pre-slaughter handling incl. optimization of the stunning systems – change from electrical to CO<sub>2</sub> stunning.

⇒ Less PSE

⇒ Lower drip loss

⇒ Fewer haemorrhages

⇒ Increased value of the cuts and more products acceptable for high price markets.

~ **\$ 4,600,000** for a slaughterhouse killing 4,000,000 pigs a year



Improved value of livestock



## Improved value of broilers

Demand for high-quality paws  
Chicken paw prices have escalated in the US  
Paws accounting for approx. \$ 280 million a year

US Poultry & Egg Export Council, 2009



Improved value of livestock



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[www.animalwelfare.dk](http://www.animalwelfare.dk)



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*Thank you for your attention!*

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