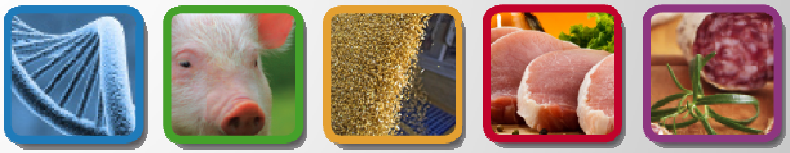
CT & Automatic Imaging Systems for a Value-Based Marketing System in Pig

Gérard Daumas



Co-authors

- Tamas Donko, Kaposvar University, Hungary
- Maria Font-i-Furnols & Marina Gispert, IRTA Monells, Spain
- Mathieu Monziols, IFIP Le Rheu, France
- Eli Olsen, DMRI Roskilde, Denmark

Introduction: FAIM framework

- FAIM session
- WG1: Body/Carcass Composition
- To review and develop robust references
- To agree on strategies for defining references
- To review and develop harmonised procedures for *iv, pm* and on-line imaging methods of predicting compositional traits

Introduction: Pig grading framework

- FAIM session: IMAGING
- Pig Grading: EU regulation under discussion
- WG1: Carcass Composition
- To review and develop robust references: CT
- To review and develop harmonised procedures for *pm* and on-line imaging methods of predicting compositional traits: LMP (Lean Meat %)

3 compulsory constraints

- LMP is assessed by means of authorised grading methods
- Only statistically proven assessment methods may be authorised
- Authorisation is subject to compliance with a maximum tolerance for statistical error

EU requirements for calibrating pig classification instruments

- Reference = dissected LMP
- Prediction by using objective anatomical traits
- Representative sample
- N > 120 or n1 > 50 if Double Regression
- A proven statistical procedure
- RMSEP < 2.5

LMP definitions

- 2006: dissected LMP in the 4 main joints
- + 2008: dissected LMP in the carcass
- + 2008: “The dissection may also be replaced by assessing the LMP by means of total dissection with a CT on the condition that satisfactory comparative dissection results are provided”.

  (EC Regulation No 1249/2008)
- Consensus between national experts

NATIONAL CT STRATEGIES

- Reference = Manual Dissection / Knife
  - CT has to be calibrated against dissection
  - DE, DK, ES, HU
- Reference = Virtual Dissection / CT
  - No manual dissection
  - FR

DE, ES & HU procedures

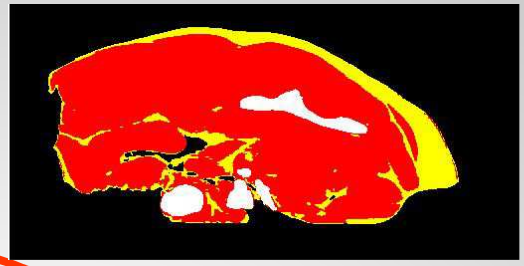
- Scan of the left side (« total dissection with CT »)
- Knife Dissection:
  - DE: the whole side
  - ES & HU: the 4 main joints
- PLS on the HU spectra
  - DE: +10 / + 95
  - ES: - 100 / + 120
  - HU: -100 / + 100
- RMSEP
  - DE: 0.7 (Judas *et al*, 2007)
  - ES: 0.8 (Font i Furnols *et al*, 2009)
  - HU: 1.4 (Donko & Komlosi, 2011)

Danish procedure

- Scan of the carcass (« total dissection with CT »)
- Knife Dissection: the 4 main joints
- Carcass weight model
- Densities estimated on a subsample (n=29) with carcass dissection
- Contextual classification into 3 tissues: meat, fat & bone
- RMSEP = 0.5 (Vester-Christensen *et al*, 2009)

DANISH MEAT
RESEARCH INSTITUTE

Weight and virtual LMP



$$W = V_{fat} \cdot \beta_{fat} + V_{meat} \cdot \beta_{meat} + V_{bone} \cdot \beta_{bone}$$

W : Estimated weight of ½ carcass

V : Volume (estimated from images)

β : Estimated average density

$$LMP = \frac{V_{meat} \cdot \beta_{meat}}{W} \times 100\%$$

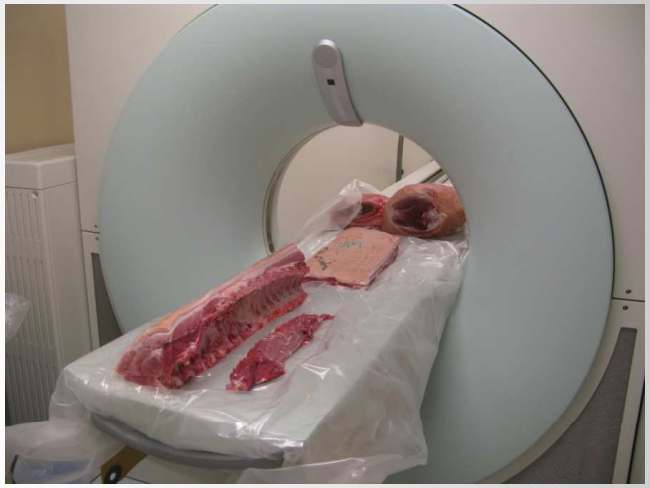
Reference = « CT Dissection »

IFIP - FRANCE

- Concept
  - CT scanners are physical instruments designed for measuring volumes and densities
  - LMP = 100 x Muscle Weight / Entity Weight
  - Muscle Weight = Muscle Volume x Muscle Density
- Implementation
  - Muscle Density = Constant = 1.04 (ICRU, 1989)
  - Muscle Volume = Thresholds 0 – 120
- Daumas & Monziols, 2011, ICoMST

Adaptation of the FR strategy

- Scan of the 4 main joints
- Dissection of the 4 main joints
- Same entity
- RMSEP = 0.5 by thresholding
- RMSEP = 0.3 + math. Morphology (rind)



CT accuracy

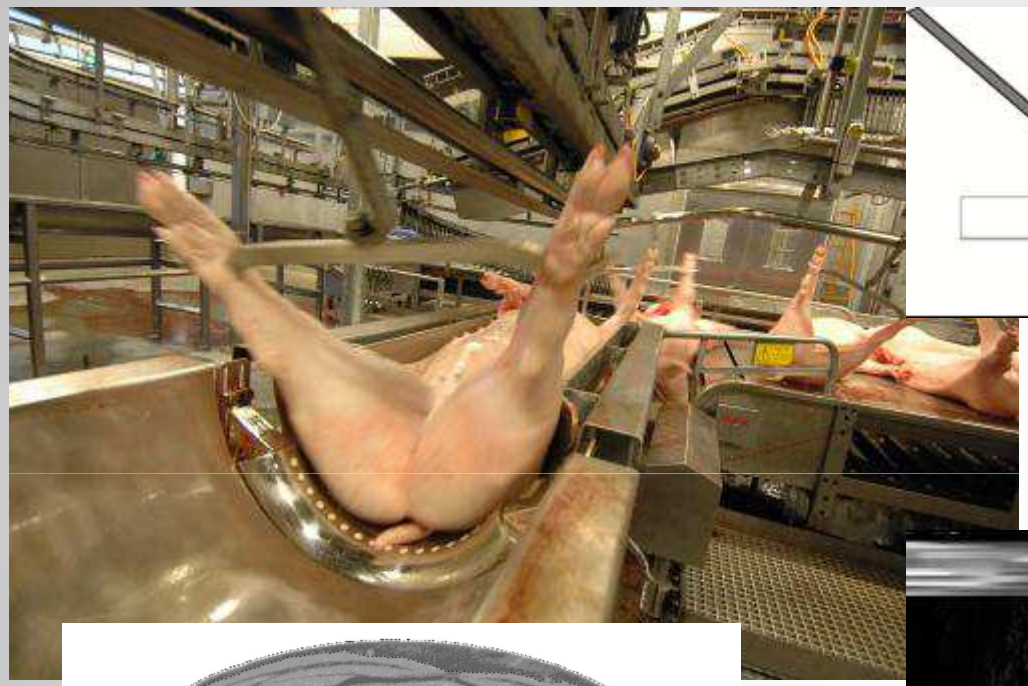
Industrial implementation (pig grading)					
RMSEP	**Country**	**Year**	**LMPdis**	**CT scan**	**Method**
0,5	DK	2005	4 joints	carcass	contextual & math. Morphology & carcass weight model
0,5	FR	2012	4 joints	4 joints	thresholding
0,7	DE	2011	carcass	carcass	spectral

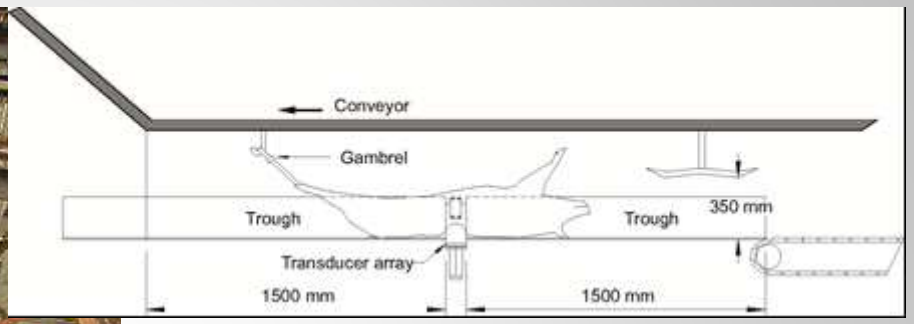
Research					
RMSEP	**Country**	**Year**	**LMPdis**	**CT scan**	**Method**
0,3	FR	2012	4 joints	4 joints	thresholding & math. Morphology
0,8	ES	2009	4 joints	carcass	spectral
1,4	HU	2011	4 joints	carcass	spectral

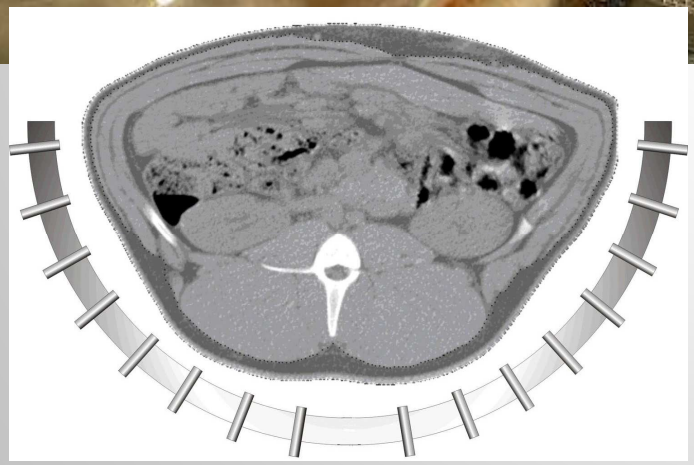
3 automatic imaging systems

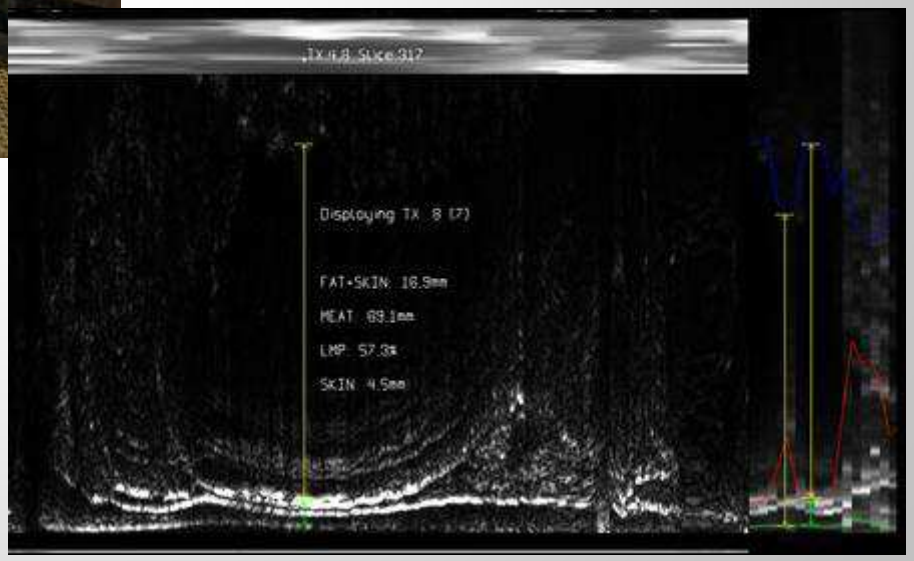
- AutoFom:
  - Ultra-sounds on non eviscerated pig
  - DK company Carometec
  - 2 versions: I & III
- Image-Meater
  - 1 camera for the splitline
  - DE company CSB
- VCS 2000
  - 3 cameras for the splitline
  - DE company E+V

Autofom




Conveyor
Gambrel
Trough
Trough
350 mm
Transducer array
1500 mm
1500 mm




Displaying TX 8 (7)
FAT+SKIN 16.9mm
MEAT 69.1mm
LMP 57.3%
SKIN 4.5mm

AutoFom™

National Approvals

Country, year of approval and the number of slaughterhouses using AutoFom I / AutoFom III:

- Belgium (2012), 2 slaughterhouses slaughtering 2 million pigs annually
- Denmark (2012), 9 slaughterhouses slaughtering 18 million pigs annually
- Finland (2008), 2 slaughterhouses slaughtering 3 million pigs annually
- France (2007), 2 slaughterhouses slaughtering 2,5 million pigs annually
- Germany (2011), 28 slaughterhouses slaughtering 43 million pigs annually
- Poland (2011), 3 slaughterhouses slaughtering 3,1 million pigs annually
- Spain (2012), 16 slaughterhouses slaughtering 22 million pigs annually
- Sweden (1997), 2 slaughterhouses slaughtering 1,5 million pigs annually
- Switzerland (1998), 6 slaughterhouses slaughtering 3 million pigs annually
- UK (2004), 2 slaughterhouses slaughtering 1,5 million pigs annually
- USA (1995), 2 slaughterhouse slaughtering 5 million pigs annually

Total number of carcasses measured by AutoFom™: 105 million per year in 74 slaughter sites in 11 countries

Carometec
FOOD TECHNOLOGY

Accuracy of Autofom

AUTOFOM I

RMSEP	Country	Year	LMP
1,6	A	2008	4 joints
1,8	B	2007	4 joints
1,9	C	2011	carcass
2,0	D	2008	4 joints
2,0	E	2007	4 joints
2,2	F	2011	4 joints

1.6 < RMSEP < 2.2

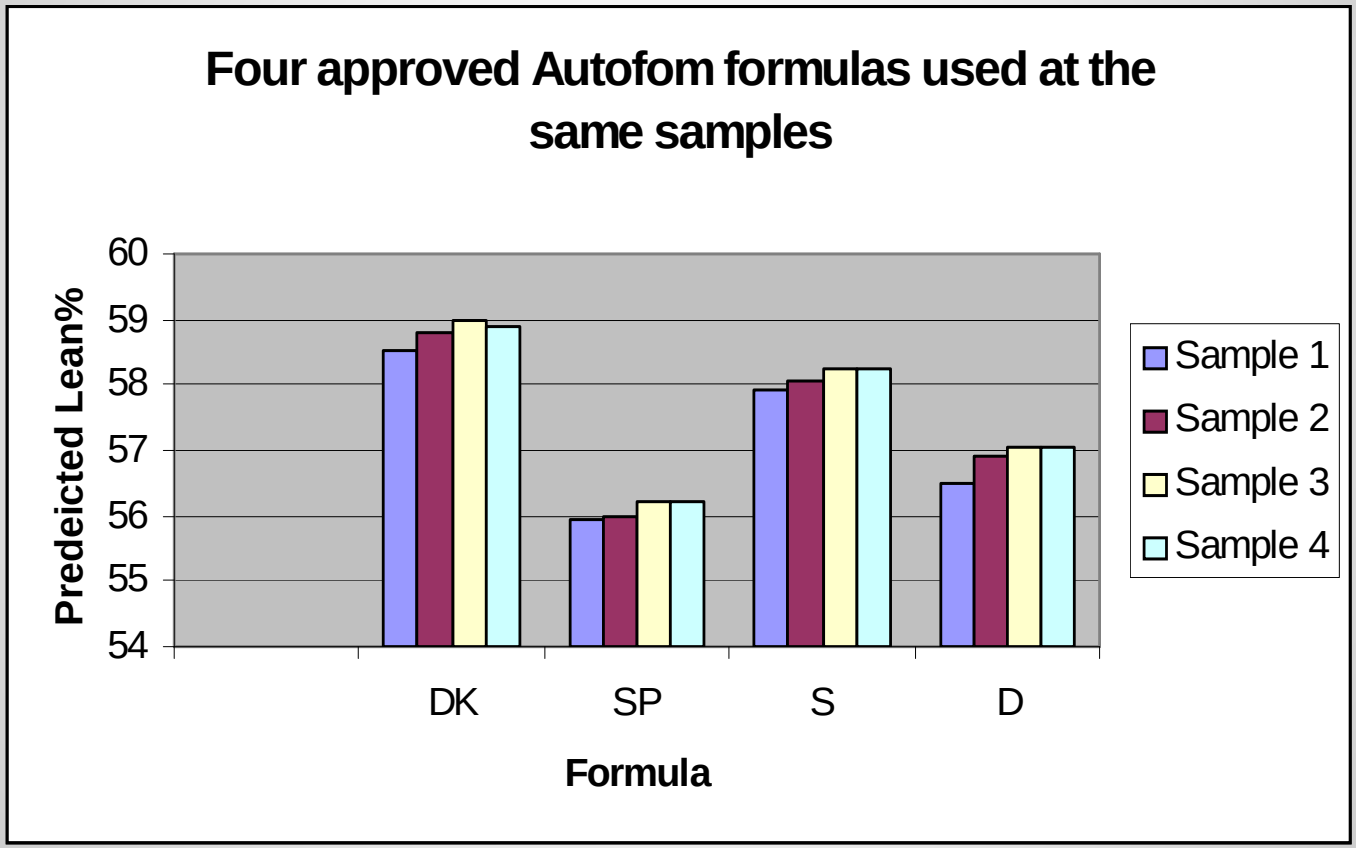
AUTOFOM III

RMSEP	Country	Year	LMP
1,1	G	2012	4 joints
1,2	H	2012	4 joints
1,3	I	2012	4 joints
1,4	J	2011	4 joints
1,6	K	2008	4 joints
1,8	L	2011	carcass

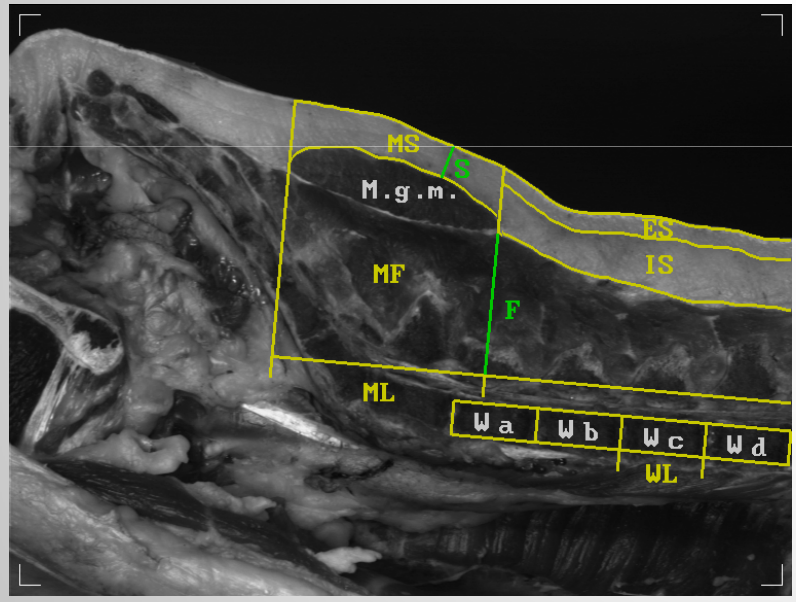
1.1 < RMSEP < 1.8

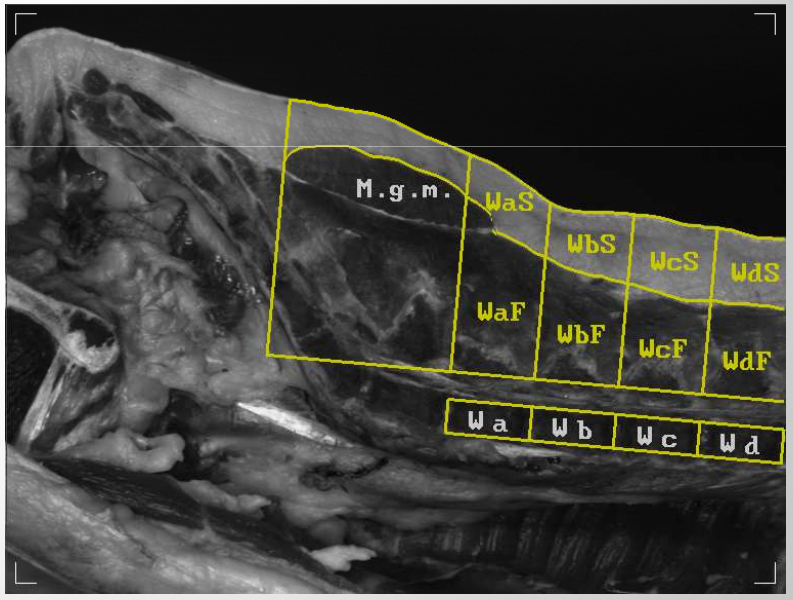
DANISH MEAT
RESEARCH INSTITUTE

The calibrations are probably more different than the pig populations



The16 variables of Image-Meater
8 fat + 6 muscle depths + 2 lengths





VCS 2000

Accuracy of VIA

Image-Meater

RMSEP	Country	Year	LMP
2,0	M	2011	4 joints
2,2	N	2008	4 joints
2,3	O	2011	4 joints
2,3	P	2012	4 joints
2,3	Q	2012	4 joints
2,5	R	2011	carcass

2.0 < RMSEP < 2.5

VCS 2000

RMSEP	Country	Year	LMP
2,0	S	2012	4 joints
2,0	T	2008	4 joints
2,0	U	2007	4 joints
2,2	V	2008	4 joints

2.0 < RMSEP < 2.2

Comparison of error/accuracy

Prediction Error

- Autofom III 1.1 < RMSEP < 1.8 (1.7)
- Autofom I 1.6 < RMSEP < 2.2
- VCS 2000 2.0 < RMSEP < 2.2
- Image-Meater 2.0 < RMSEP < 2.5 (2.4)

Accuracy

- AFOM III > AFOM I > VCS > Image-Meater
- Greater variability with Autofom
- Trial effect: national population, year, reference, predictors, sampling, statistical analysis, …

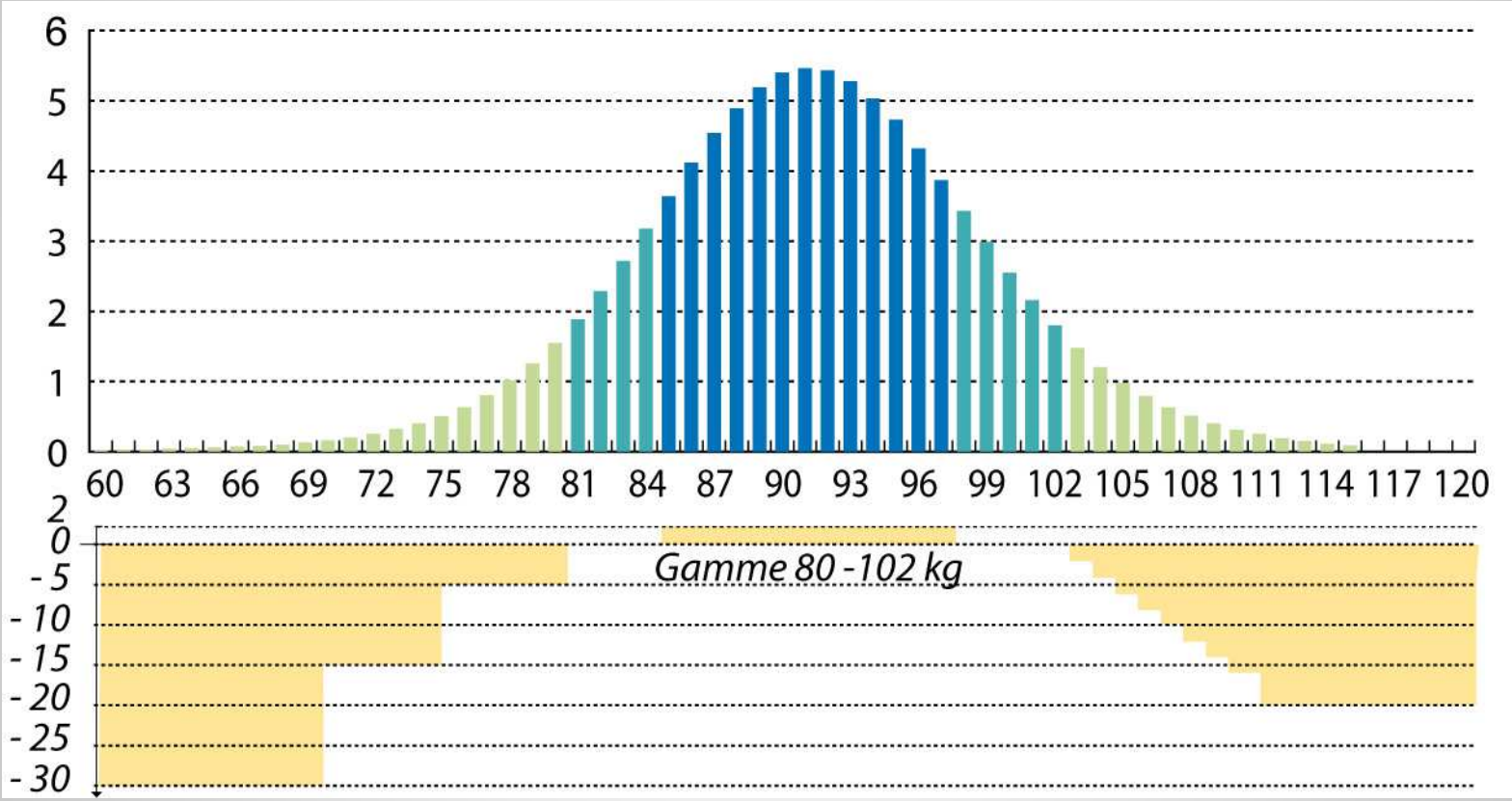
Grading for PAYMENT

Million of pigs classified and paid by automatic imaging systems in the main countries:

- DK: Autofom = 13 Mio
- DE: Autofom = 30 Mio
- FR: Image-Meater = 18 Mio

France: Weight payment

% of pigs



Premium or Penalty

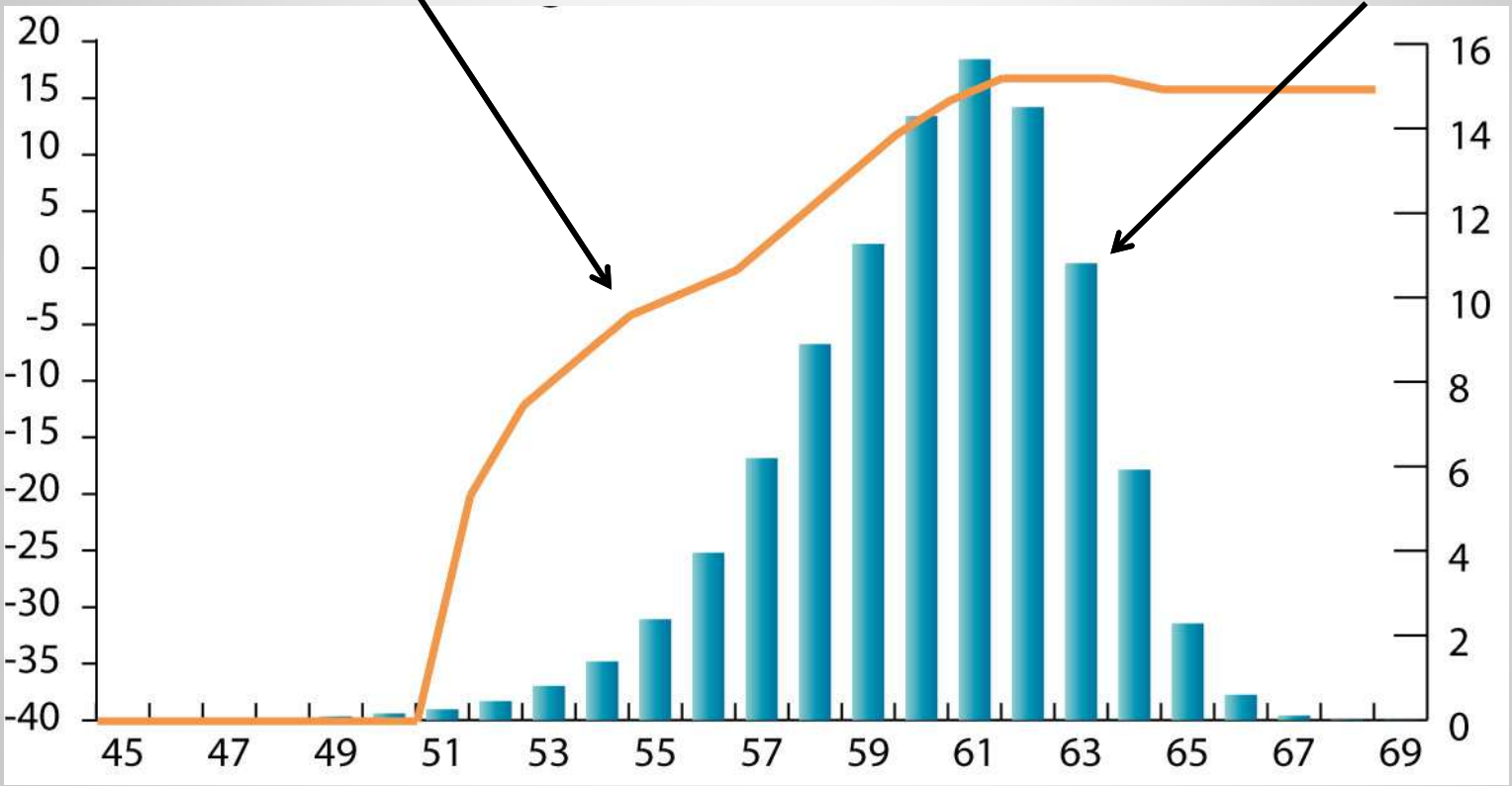
Cent € / kg

France: LMP payment

Premium or Penalty

Cent € / kg

% of pigs



LMP

Last change in LMP payment scheme (since 04/06/2007)

Bonus & malus
From the base (56)
in ct/kg

LMP	Cumulative dif.	Dif. / point
≥64	16	-1
63	17	0
62	17	0
61	17	2
60	15	3
59	12	4
58	8	4
57	4	4
56	0	0
55	- 2	- 2
54	- 2	- 2
53	- 8	- 4
52	- 12	- 4
51	- 20	- 8
≤ 50	- 40	- 20

Payment example

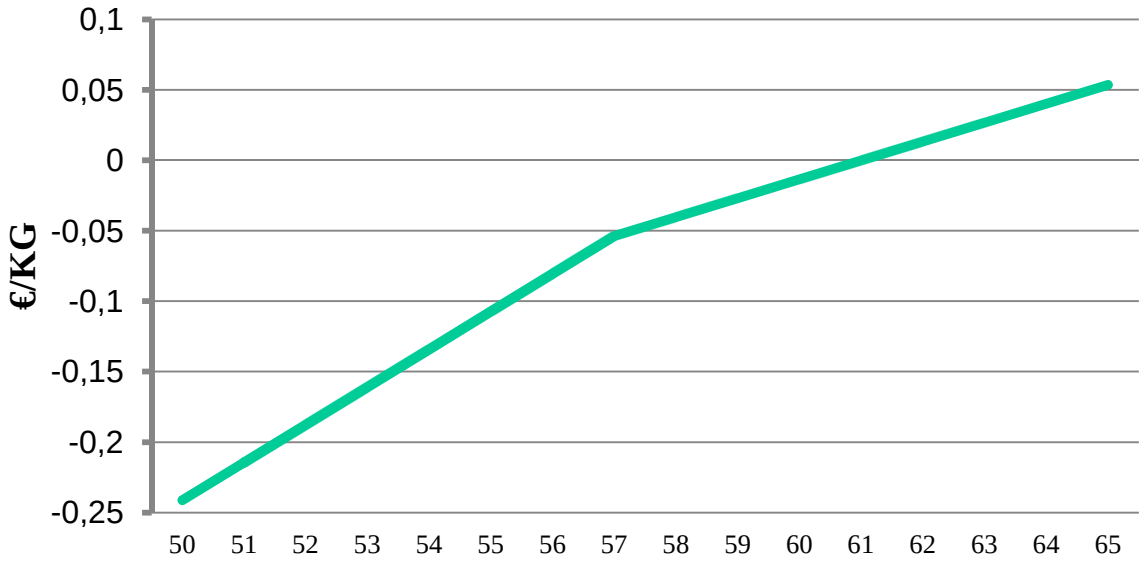
- Basis Price (56 LMP & 80-102 kg) = 1.50 €/kg
- Example: 91 kg & 61 LMP
- Weight premium = + 0.02 €/kg
- LMP premium = + 0.17 €/kg
- Total bonus = 0.02 €/kg + 0.17 €/kg = 0.19 €/kg
- Price per kg = 1.50 €/kg + 0.19 €/kg = 1.69 €/kg

- Hot weight = 91.0 kg
- Rebate (hot/cold & various) = 3 %
- Cold weight = 91.0 x (1 - 0.03) = 88.3 kg

PIG VALUE = 88.3 kg x 1.69 €/kg = 149.23 €

Denmark: LMP

- Base = 61 %
- 62 – 65 % = + 10 øre = + 1,3 ct € /%/kg
- 57 - 60 % = - 10 øre = - 1,3 ct € /%/kg
- 50 - 56 % = - 20 øre = - 2,7 ct € /%/kg



Conclusion

- CT nationally used as a 2ry reference:
  - Additional dissection costs
  - Additional errors
  - Biases between MS
- Automation & Imaging are increasing
- Accuracy:
  AFOM III > AFOM I > VCS > Image-Meater

But other criteria are more important for the choice

- 2 payment systems: LMP or Quality Joints Index

Merci de votre attention

www.ifip.asso.fr

Thanks to Inaporc for the financial support