Using X-ray computed tomography to predict beef carcass composition

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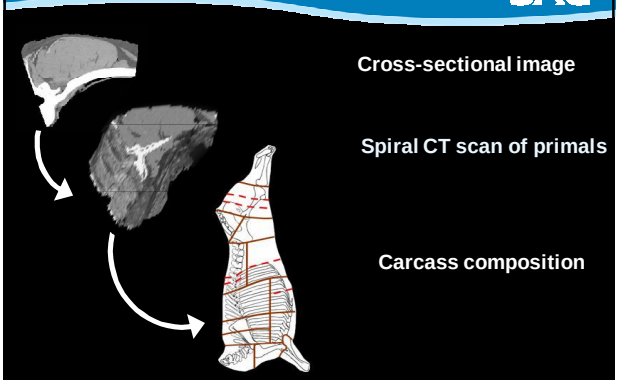
Carcass composition

- Carcass value is related to its composition
- Dissection: reference method for assessing composition
  - costly and time consuming
- X-ray computed tomography (CT) provides very accurate *in vivo* and postmortem information on carcass composition in sheep and pigs
- Scanning of beef cattle is restricted by size of the scanner gantry. However, beef primal cuts are small enough to be scanned

CT scanning beef primals



Full & Partial "virtual dissection"

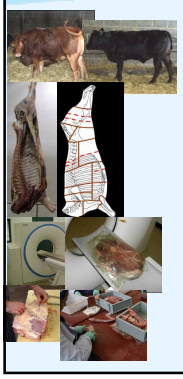
- **Full "virtual dissection" by CT**

  Carcass composition = Σ composition of primals

- **Partial "virtual dissection" by CT**
  - use of the composition of a sample joint as predictor of carcass composition
  - one of the first alternative methods to reduce costs and increase the number of carcasses to be evaluated

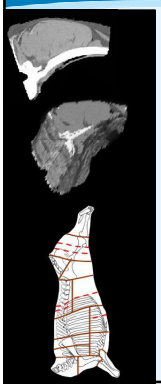
Tissues weight of one primal → carcass tissue weights

Beef cattle trials



- Primal and carcass composition
  - Pilot trial: 880 primal cuts of 44 Limousin (LIMx) & A. Angus (AAx) crosses slaughtered in 2006
  - Development and validation
- Partial dissection
  - Added 28 LIMx and AAx crossbred carcasses
- Left side of carcasses split into 20 primal cuts (vacuum packed)
- Primal cuts
  - transported to CT Unit and CT scanned
  - spiral CT scans collected for each cut
  - dissected into lean, fat and bone, and the tissues weighed

CT image analysis



- **PRIMAL CUT COMPOSITION**
  - Tissue areas in the slices
  - VOLUME: Σ Tissue area x Thickness of slices
  - WEIGHT: Volume x Tissue Density

    Tissue density = (Density HU x 0.00106) + 1.0062 (g/cm^3) (Fullerton, 1980)
- **CARCASS COMPOSITION**
  - Σ primal composition

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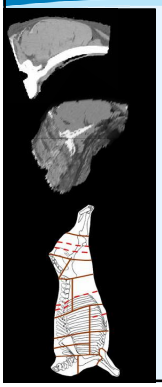
CT image analysis



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⇨ Estimation of tissue thresholds

- 240 cuts of 22 animals balanced by breed and batch
- Histograms of pixel values (>-256 HU) vs. dissection data
- Minimisation of prediction errors of tissue weights

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Statistical analysis

- Accuracy by linear regression analysis: $y = \beta x$
  - Intercept zero
  - y= dissection wt; x= CT wt
- Partial "virtual dissection"
  - Simple regression: $y = \alpha + \beta x$
    - i.e. y = carcass muscle wt
      x = forerib muscle wt
  - Multiple regression
    - Other predictors included: carcass wt, forerib wt, wt of fat, muscle & bone in forerib breed, sex

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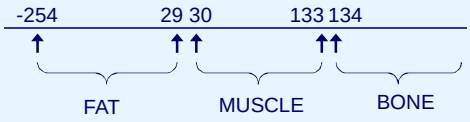
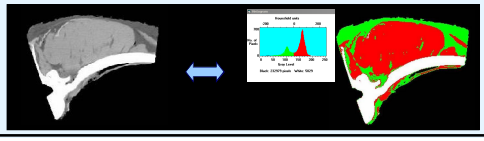
Tissue thresholds

- Tissue thresholds (HU):





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Primal composition

Tissue	Estimated slope (±s.e.)	R^2
Estimation		
Fat	0.987 ± 0.006	0.89
Muscle	0.990 ± 0.002	0.99
Bone	0.996 ± 0.004	0.95
Validation		
Fat	0.964 ± 0.006	0.92
Muscle	1.003 ± 0.002	0.99
Bone	0.993 ± 0.004	0.97

- High R^2 values
- Regression slope close to 1

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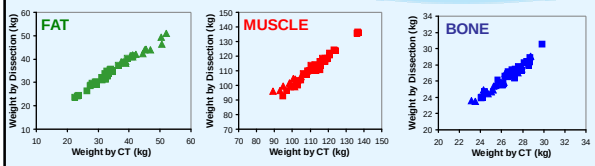
Carcass composition



- Regression slope close to 1
- High R^2 values: 0.95 – 0.96
- Similar or better accuracies than:
  - CT in other species
  - Other indirect methods for beef carcasses

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Partial "virtual dissection"

- Only forerib composition by CT as predictor:

  Fat ..... R^2 = 0.79
  Muscle ..... R^2 = 0.60
  Bone ..... R^2 = 0.52

- Adding other predictors (carcass wt, forerib wt, breed, sex)

  Fat ..... R^2 = 0.92
  Muscle ..... R^2 = 0.96
  Bone ..... R^2 = 0.77

- High accuracy and similar to those obtained by partial "conventional" dissection

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Final comments

- Assessment of beef carcass composition based on the CT scanning of primal cuts:

Accurate	→	high quality information
Automatic analysis of CT images	→	fast delivery high repeatability reduced costs
Minimum depreciation	→	maintain returns

- Alternative useful method:
  - research studies with large number of animals: i.e. calibrations/validation
  - genetic improvement: traditional breeding programmes, MAS or genomic selection

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