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Accuracy of Core Sampling in Cartons of Beef: A Simulation Study

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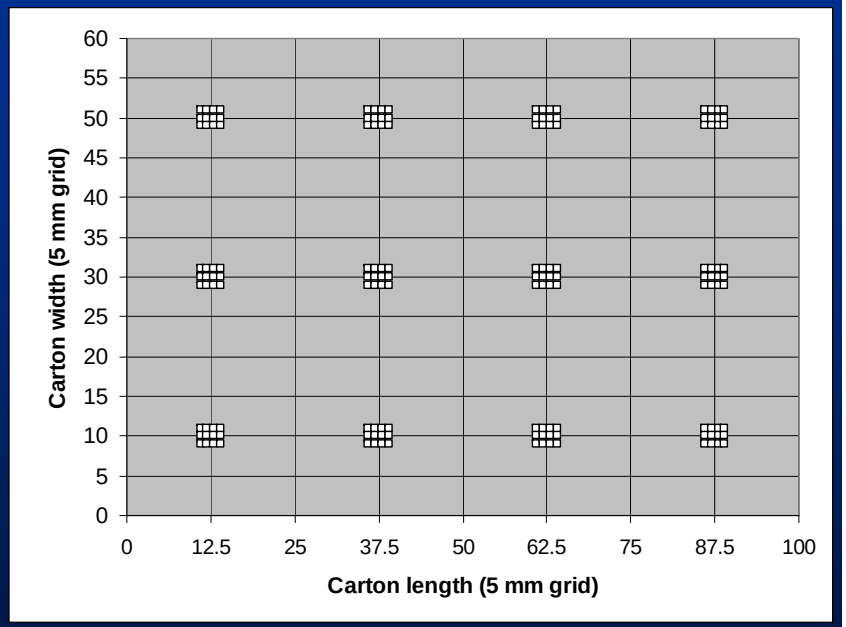
Te Kunenga ki Pūrehuroa

The basic carton model

- In plan view the carton is a 100 x 60 grid with each cell 5 x 5 mm to give dimensions of 50 cm x 30 cm.
- Height = 20 cm with 8 x 25 mm layers.
- Thus, the volume (50 x 30 x 20) was 30,000 cm^3, or 30 kg if SG = 1.
- Their are 6,000 elements of 5 x 5 x 25 mm in a layer, and 48,000 elements /carton.
- 12 cores of 3 x 4 elements are as shown. (each = a core of 19.5 mm dia. (~3/4")).
- With cores passing all the way through the carton, the total core sample is 2.4% of the total volume.
- The MICA coring protocol requires that samples are at least 1 lb from a 60 lb carton or 1.67%.



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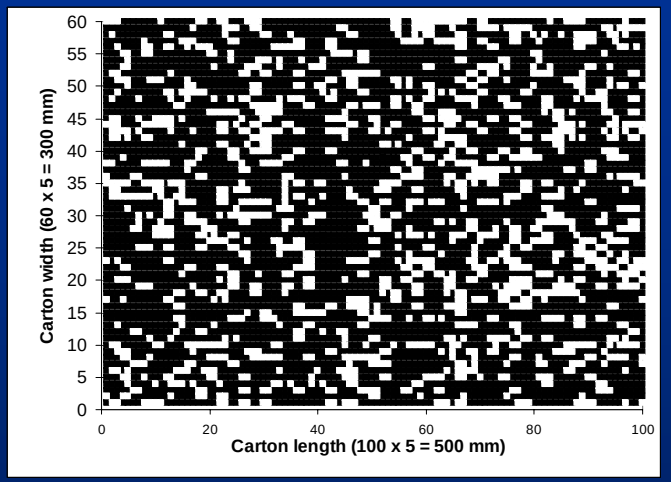
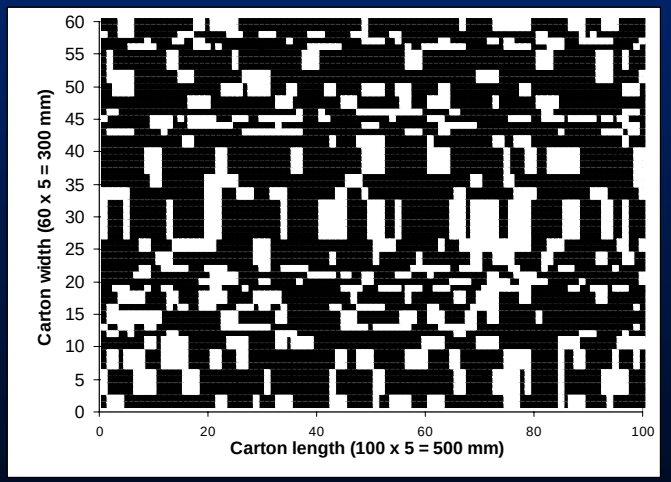
Allocating varying levels of meat% and piece size

- The model is run in MS Excel with Visual Basic.
- Each of the 48,000 elements is randomly set to be meat or fat, with meat% and fat % determined by specific parameters.
- Graph 1 = a layer with 73% meat and small piece sizes (lean = black).
- It is also possible to vary piece size by varying:
  - the proportion of elements that are the same as the previous element in the row,
  - the proportion of rows that are the same as the previous row.
- Graph 2 = larger piece sizes, but still 73% meat.
- Piece size can also be changed by varying the number of layers in the 200 mm depth.





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Objectives of the initial studies

- The model has been used it to address the following objectives:
  1. To determine the accuracy of core samples when the lean% varied over the range from about 60% ➔ 95%.
  2. To determine the effect of piece size in the carton on the accuracy of core sampling.
  3. To determine the effect of increasing core size on the accuracy of core sampling.
- The general approach was to simulate from 30 to 50 cartons under a prescribed set of conditions and then to determine the level and variability in measures of accuracy.
- What measures of accuracy are appropriate?

An output example showing measures of accuracy

- The basic output for each simulated carton is the meat % of the whole carton and the meat % of the core samples taken.
- The average for these 10 cartons was very similar for the carton and the cores (ie minimal bias).
- But the SD was more than 6 times larger for the cores (1.33 vs 0.21).
- The main measure of accuracy used has been the SD of the carton/core difference (RSD or SEE).

	Meat %		
Carton No	Whole carton	Core only	Diff
1	64.68	64.31	0.37
2	64.70	65.49	-0.79
3	64.83	63.40	1.42
4	64.64	67.19	-2.54
5	64.50	62.47	2.04
6	64.73	65.21	-0.48
7	64.53	65.38	-0.85
8	64.26	63.85	0.40
9	64.36	64.24	0.12
10	64.93	65.45	-0.52
Average	64.62	64.70	-0.08
Min	64.26	62.47	-2.54
Max	64.93	67.19	2.04
StDev	0.21	1.33	1.28

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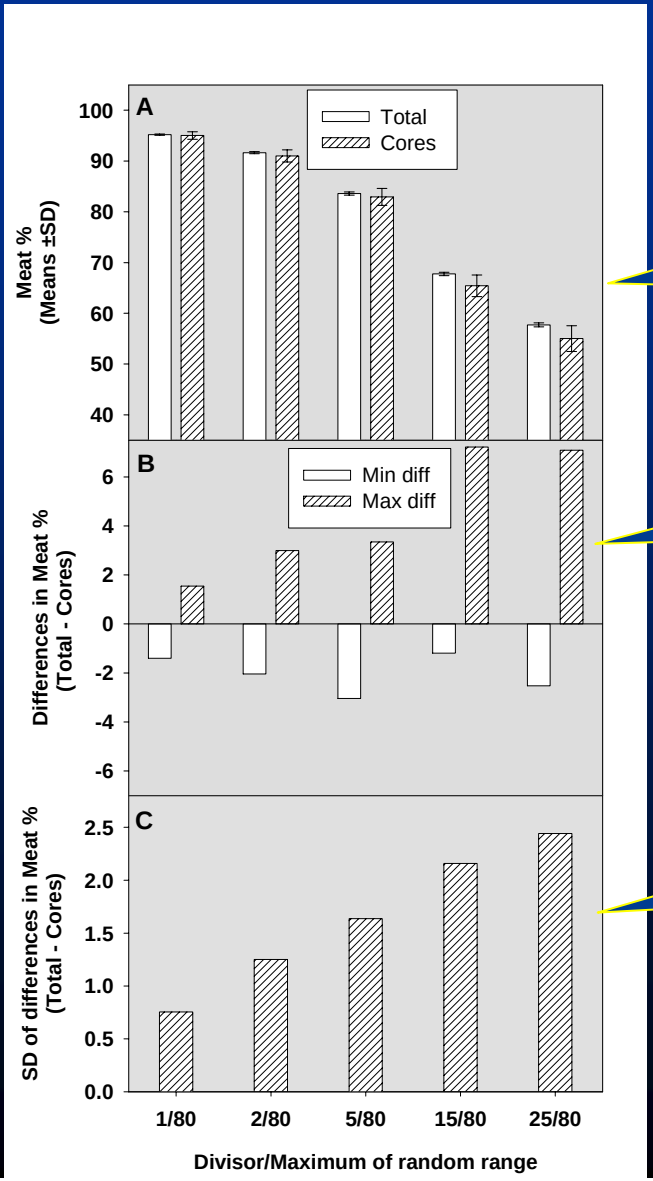
Effects of different meat% levels



The top panel shows the average (±SD) meat% for whole cartons and in the corresponding core samples. At each level 30 cartons were simulated. Note the greater variability for the core values.

The middle panel shows the maximum and minimum differences between the whole carton and the core sample for the 30 cartons within each level.

Panel C shows that the SD of the difference (the main measure of accuracy) increased from <1 to >2 as the meat% decreased.

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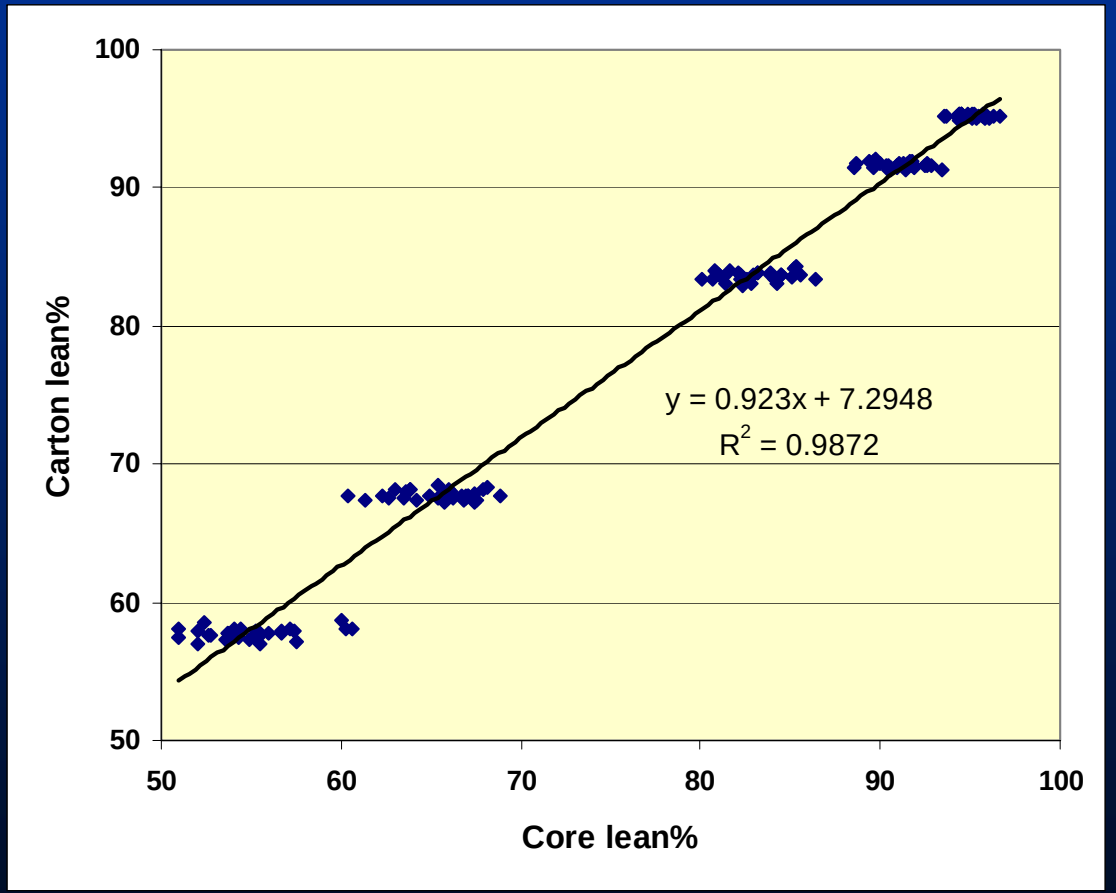
The overall regression relationship

- The regression line for the 150 cartons from the previous slide is shown here.
- The R^2 value was high (0.99), but the RSD (SEE) was higher than desired at 1.63.
- This is appreciably higher than the 1.00 that has been set by some as a reasonable target.
- The scatter was greater at the lower lean% values.



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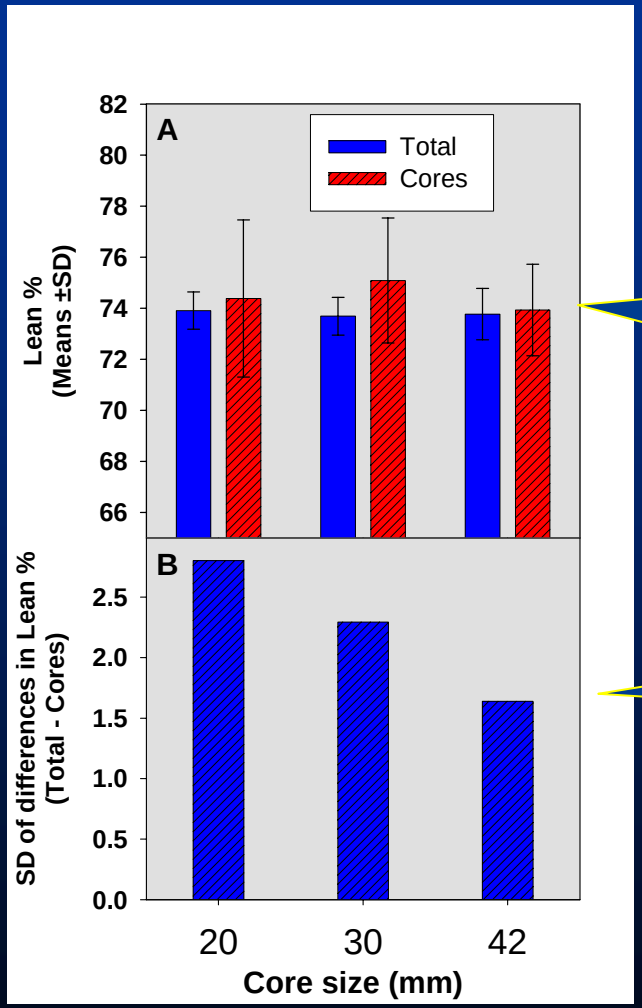
Effects of core size on accuracy



Core diameters of 20 mm (the control), 30 mm or 42 mm had little effect on the estimate of meat% (30 cartons per run, with medium piece size).

20 mm dia = 2.4% of total
30 mm dia = 6.0% of total
42 mm dia = 11.2% of total

Accuracy improved with increasing core size, but not dramatically.
Accuracy was also better with smaller piece size.

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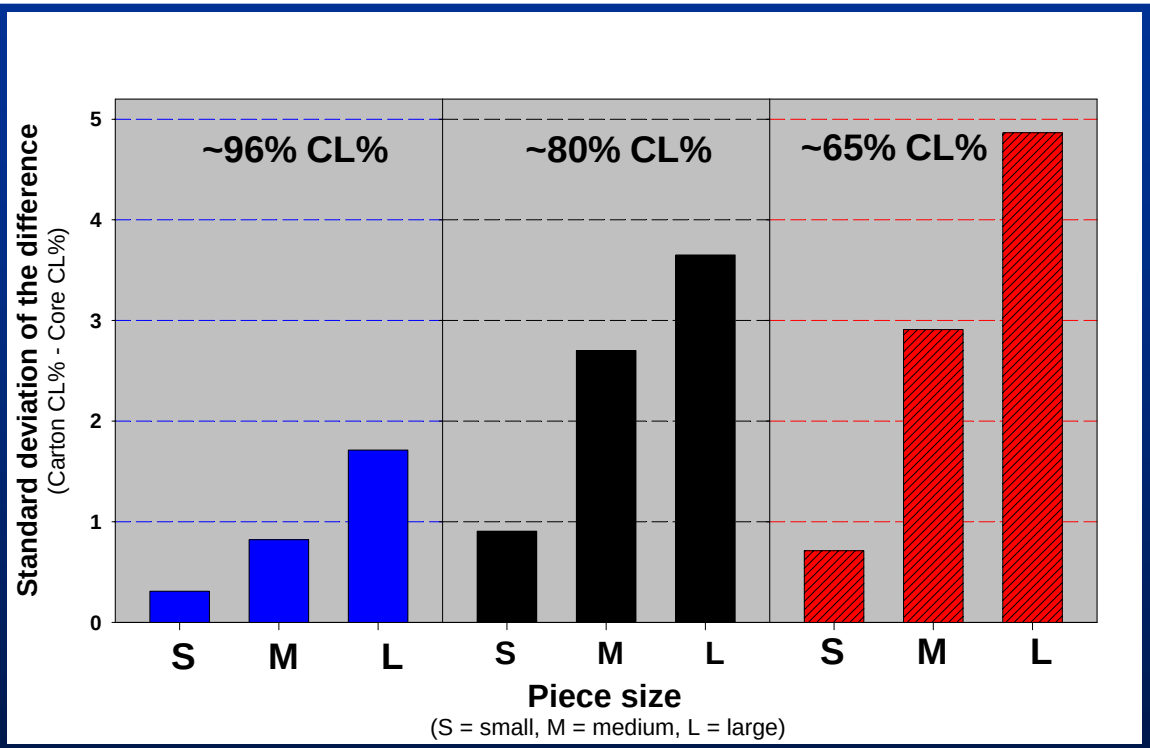
Effects of piece size and meat% on accuracy



- Key:
  - S = small pieces with 20 x 10 mm layers.
  - M = medium-sized pieces with 8 x 25 mm layers.
  - L = larger pieces with 4 x 50 mm layers.
- These results (50 cartons/run) show that accuracy decreased with:
  - lower meat% (CL%) and
  - with larger pieces.

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Summary & Conclusions

- An Excel model designed to simulate a carton of boneless beef containing meat and fat pieces has been described.
- The relationship between the meat and fat composition of the whole carton and of cores from the carton has been evaluated.
- Results suggest that accuracy in terms of the SD of the carton/core difference decreases :
  - With lower levels of meat%
  - With smaller cores (not a very large effect)
  - With larger piece sizes in the carton.
- The accuracy with which this model simulates the real-world situation is difficult to gauge.

Reference: *Computers & Electronics in Agriculture* (2007) **58**: 112-122.

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