Feed-a-Gene

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

Evaluation of pen-allocation strategies to homogenise weights in finishing pigs

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Problem

- Variation in the performance of finishing pigs
- significant economic losses to producers
  - delayed availability of pen space
  - deviation from market target, e.g.120kg

- Multiple causes, including
  - birth weight
  - growth rate
  - environmental and genetic components

Current approaches

Producers. Sort pigs in pens by weight, sex, or both, at start of finishing (~25kg)

- weights still differ at end of finishing (110-130kg) because growth rates differ
- no single variable able to predict end-weight
  - no agreement on how to reduce or manage variation

Breeding. Some of the variation in performance is heritable

- potential to select for low variation

Question

- What is the maximum potential benefit (i.e. reduction in economic losses) from increasing uniformity using pen sorting?

If the benefits were significant

- case to invest on approaches to uniformity
- Including pen sorting, other management, selective breeding

Approach

- To estimate the maximum potential benefit of pig uniformity at delivery:
  - 1. use retrospective data on individual weights
  - 2. predict each pig's age at 120 kg from it's predicted growth trajectory
  - 3. compare three alternative pen sorting strategies

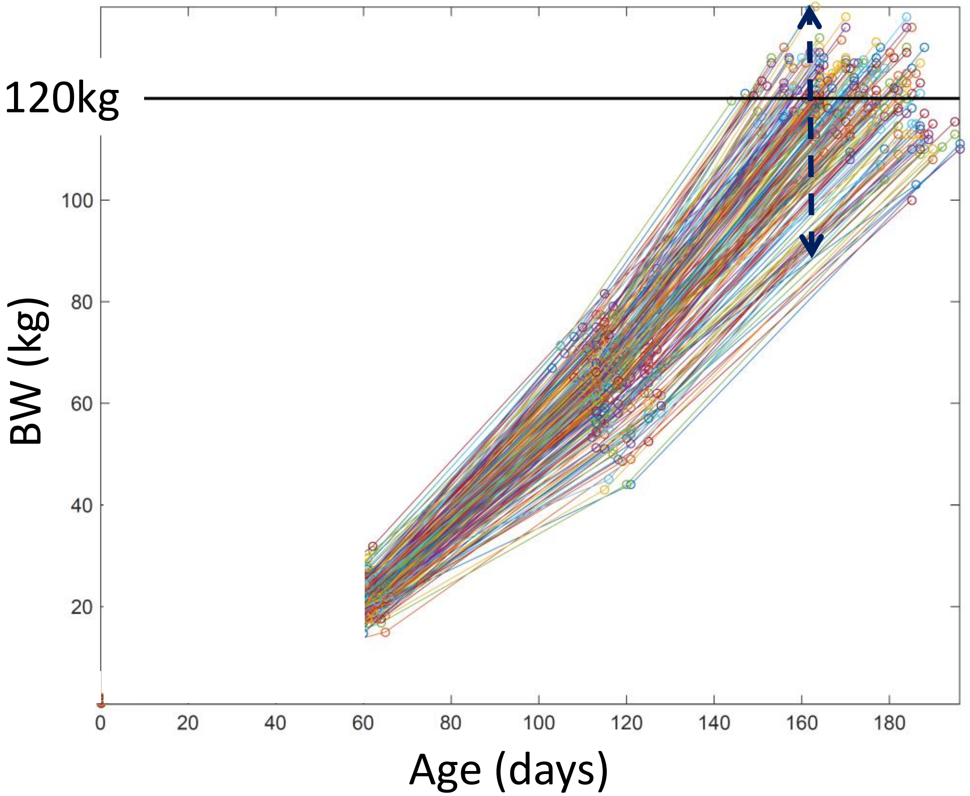
Dataset

- N=240 pigs from an experimental farm
  - 2 lines, 3 diets, gilts & boars
  - 6 groups of contemporaries (4 uniform, 2 mixed lines)

Group of contemporaries	Line and diet	no. pens	no. pigs	no. pigs/pen	Boars/ Gilts	Line A B
1	line A, diet x	4	25	7 8 5 5	13 12	25 0
2	line A, diet x	4	40	10 10 10 10	20 20	40 0
3	line B, diet x	4	39	10 10 9 10	19 20	0 39
4	line B, diet x	4	25	5 7 6 7	12 13	0 25
5	A, B, diet y	8	54	7 7 9 8 4 6 6 7	27 27	7 47
6	A, B, diet z	8	57	9 4 7 10 4 8 9 6	31 26	20 37
		32	**240**		**122 118**	**92 138**

BW-age measurements – start, middle & end of finishing

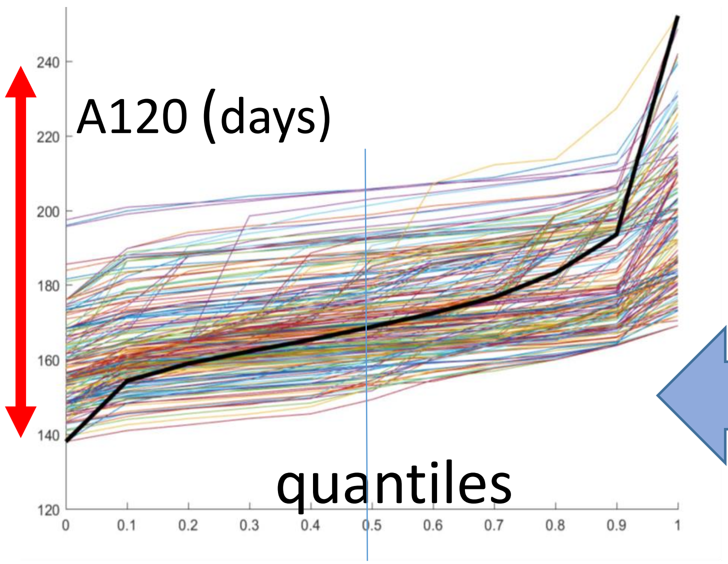
- Age range widens → so do weights at given age
- Lack of uniformity at delivery

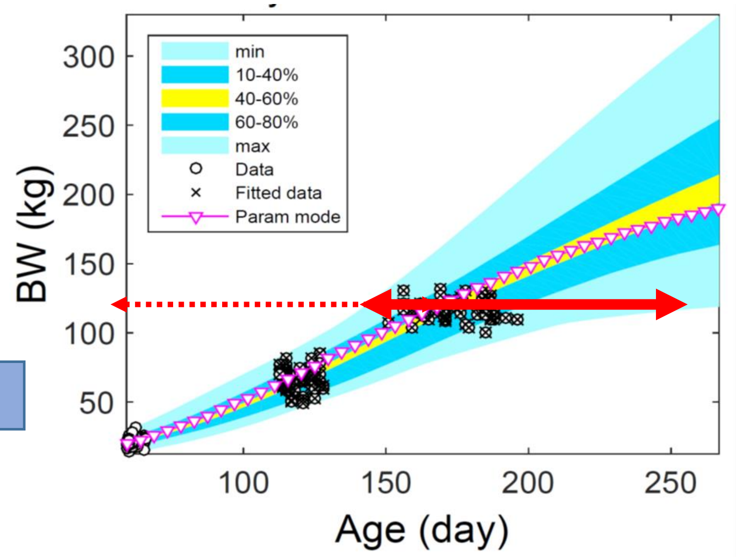


	Range (mean)		
Age (day)	53-66	103-128	144-194
CV ↑	**0.03**	**0.04**	**0.07**
BW (kg)	15-32 (22.0)	43-87 (65.3)	100-138 (120.3)
CV at diff. ages	**0.12**	**0.12**	**0.06**

Prediction of age at 120kg (A120)

- Predicted each pig's growth trajectory
  - Fitting Gompertz curves to the 3 weights - Bayesian methods
- age at 120kg - inverting each curve and taking the median
  - Curve was needed - end weights deviated from 120kg





Compared three sorting strategies

- **Producer's strategy** - actual used by producer
- **Optimised strategy** - pens filled with pigs of similar predicted A120 (in fact T120 = A120 + birthdate, but BDs very close)
- **Random strategy** - pens filled at random.

- Only same-group contemporary pigs were mixed in pens
  - avoid phenotype incompatibilities
  - sorting could have happened - meaningful to compare with actual
- Optimised & Random - simulated 1000's times

Assumptions

- **Predicted pig growth (**based on the actual allocation) is unchanged in hypothetical allocation to other pens.

- **Pen emptying**: removing pigs weekly, starting with the earliest A120 in the pen.
  - In each visit, pigs reaching A120 within ½ week were removed.
  - Emptying occurred after full removal, or a fixed number of visits.

- **Economic gain** = Difference in loss at emptying compared to the Producer, at current market values.
  - Loss = (Cumulative empty spaces in each pen until empty)
    + (Deviation of each pig from 120kg 1d after removal)

Assumptions

- Market costs and revenues

Revenues	Costs	Value (€)
Pig finishing with 120kg		150 €
	Investment in piglet 25kg	30 €
	Feed	80% of finishing value
Net finishing value		(150-30)*0.2 = 24 €
Net finishing value /kg		24/(120-25) = 0.25 €/kg
	Pen empty space per day	(Net finishing value /kg) x ADG = 0.25 €/day

Result summary

Optimised strategy

- up to 28% gain in profit/pig (group av. 15% [3.5%, 28.4%])
- gain 28500 €/year in a farm of 4000 pigs (gr. av. € 15000)

Random strategy

- more often economic loss than profit compared to Producer's strategy (group av. -2% [-18%, 5%])

Producer's strategy

- clearly better than random, but can be improved
- improvement requires a proxy of A120 at sorting

Results

Which measurable proxy at sorting?

- A120 correlated with birth BW and start BW
  - across all pigs: -0.27 and -0.35
  - within groups: -0.02 to   -0.42 - +variable because pens small

- Possibility of combining weight and temporal traits
  - start weight and rate of growth (affected by different factors)

Implications

Given the theoretical potential to reduce losses, based on the current data and assumptions,

how could uniformity be implemented in future systems?

- **Management** – optimised sorting could
  - allow pen-based precision feeding and health treatments
  - be applied to growing & finishing pens
  - Experimentation needed to identify proxies for sorting
- **Breeding** – potential for more uniformity, across/within pens
  - selecting for low variation in growth rate
  - or for A120, as a new trait

Pig behaviour

- Would pigs in optimised pens change feeding behaviour and reduce uniformity?
  - possible - more study needed

  - But, Optimised strategy <u>does not strictly create uniformity</u>
    - growth trajectories converge at 120kg - size differences and hierarchy remain

  - Possibility of preventing variation after sorting, by reducing competitive feeding
    - e.g. selecting for low aggressiveness?
    - offering subdominant pigs a second meal after the first meal?

Thank you for listening!

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Datasets

- The dataset used is small compared to usual practice
  - Future work will use larger datasets
    - More factor affecting growth trajectories
  - Variation in market conditions
    - some studies suggest may be less dominant than animal variation

- Benefit of demonstrating with this dataset
  - Able to study strategies for small groups
  - Able to predict growth from small sparse samples, by using non-parametric Bayesian estimation