

The Interaction of Genetics and Nutrition



Setting the stage

- I'm a geneticist, not a nutritionist
- Goal for today is three-fold:
 - Share how the pig is changing over time
 - Focus on the traits and the biology, to provide an expectation
 - Demonstrate the speed of this change
- Objectives:
 - Using examples, demonstrate change is occurring
 - Stimulate thought and ideas

Conclusions

- The rate of genetic change today, due to genomic selection, is 25-40% higher than it was 5 years ago
- This higher rate of genetic gain means that the management and nutrition program must change at a rate faster than we've ever done
- The nutrition of the sow is the hardest to research, and the area most lacking
- Grow-finish recommendations should be updated every 3 years



How is the sow changing?



14

PIGS

14

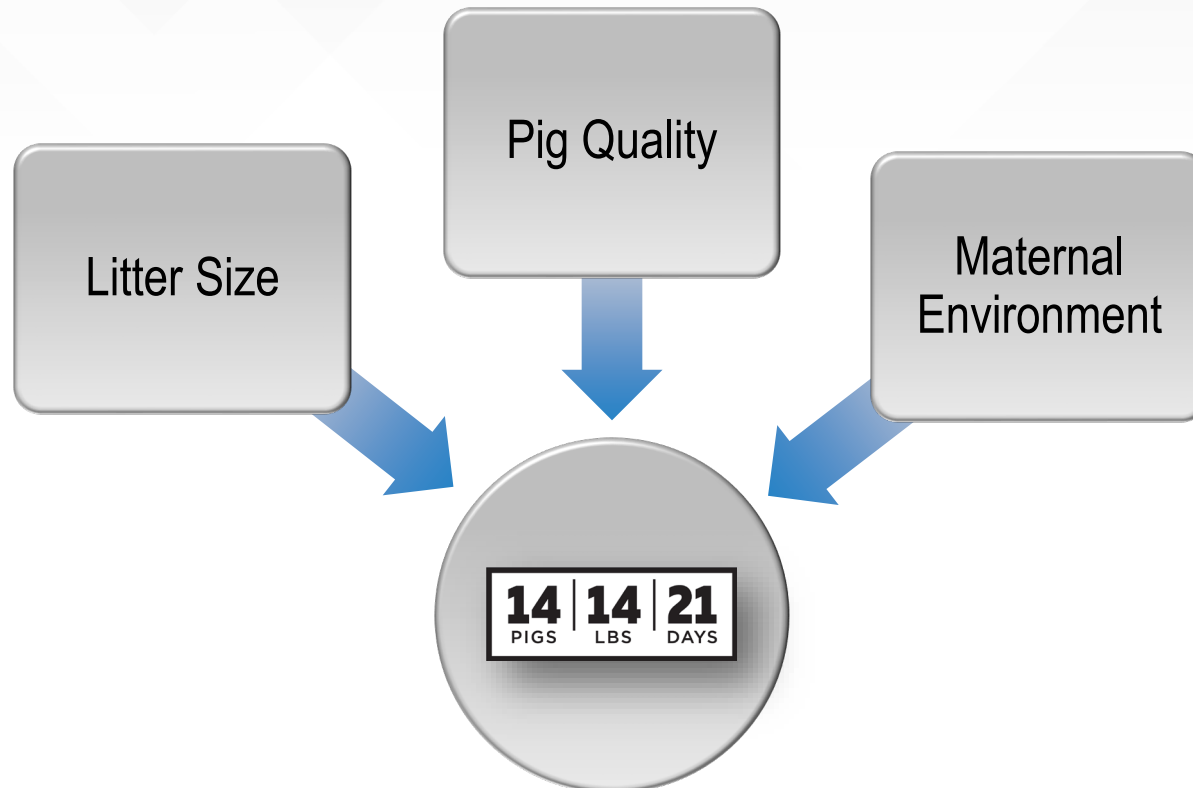
LBS

21

DAYS

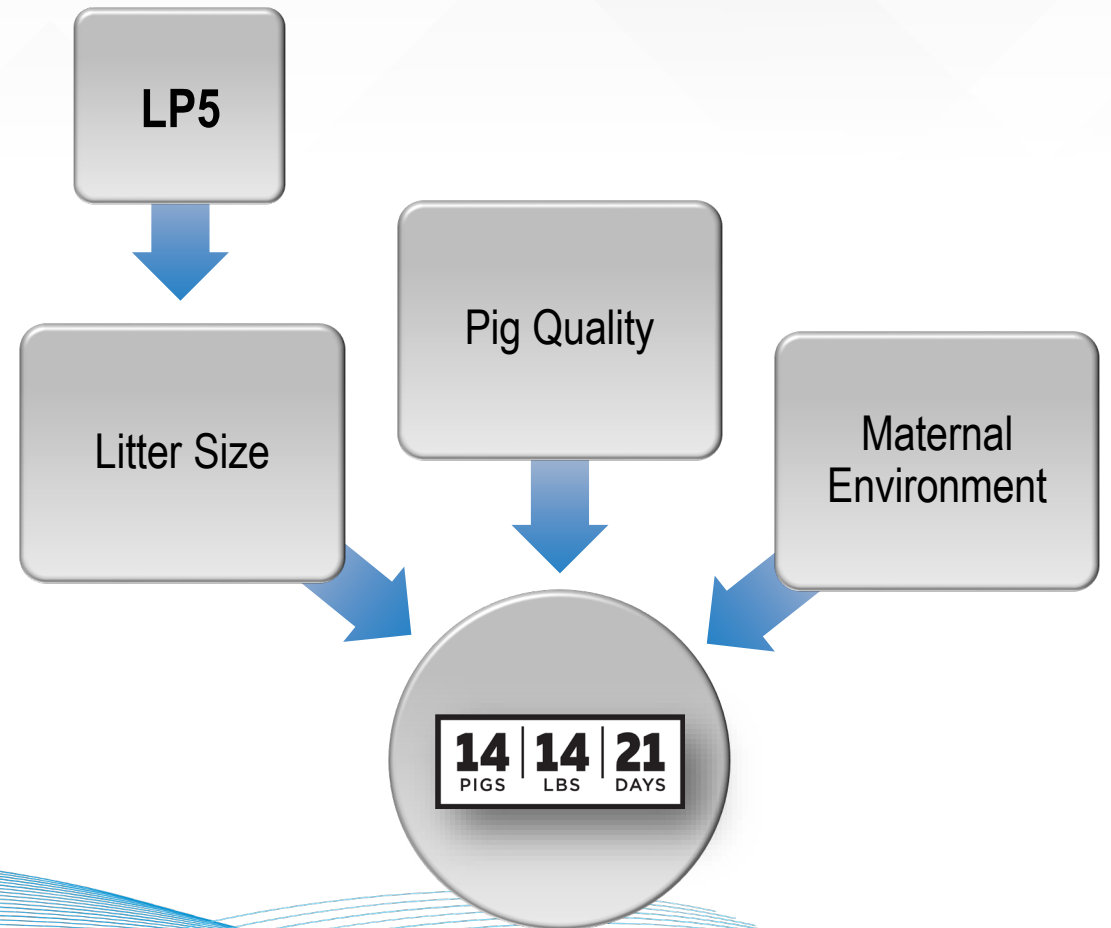
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Biological Model



Biological Model – Litter Size

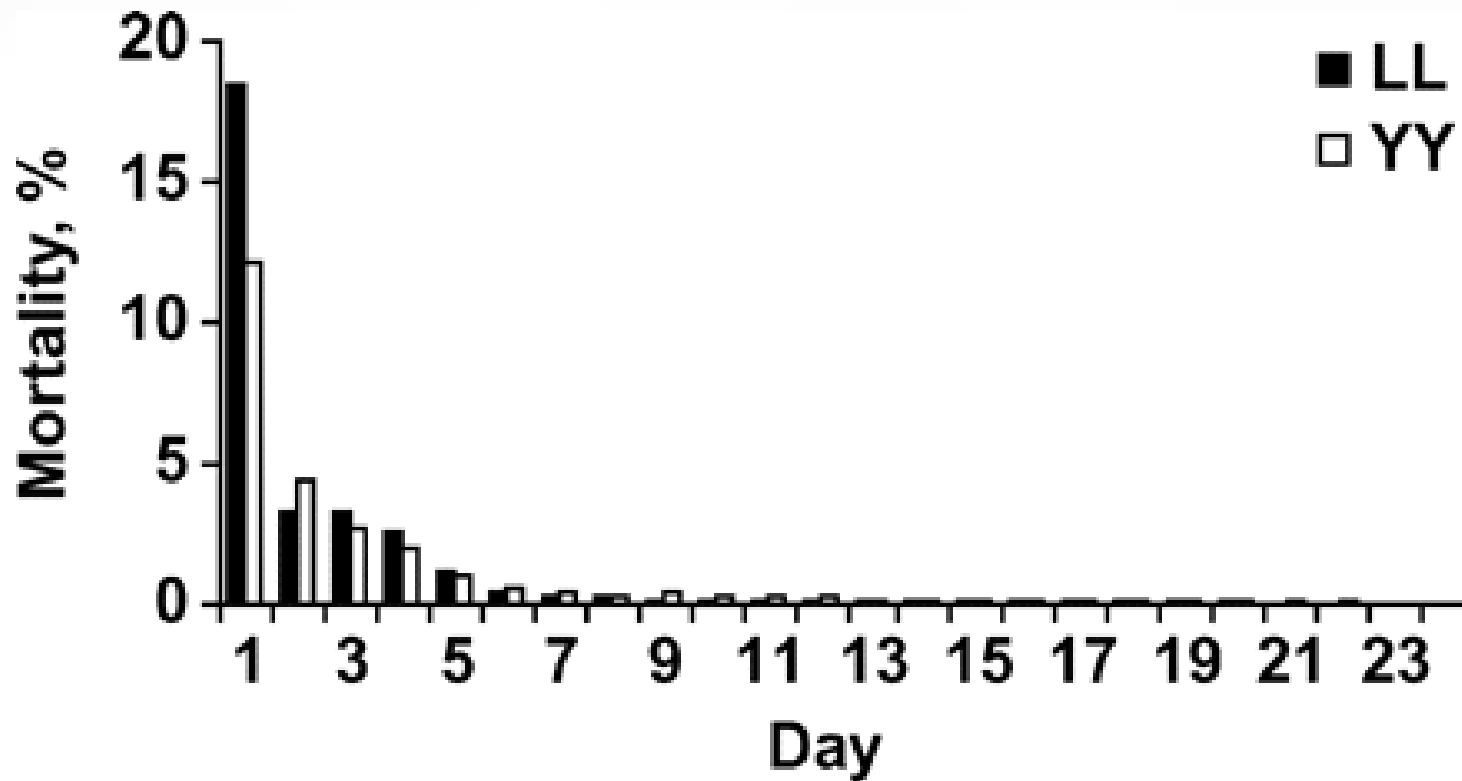
- Live Pigs at Day 5:
 - Began in 2004
 - Increases litter size
 - Eliminates sows of high total born with poor survival
 - Reduces stillborn rate
 - 0.98 correlation to number weaned



Su et al. (2007, JAS)

- Developed the concept of LP5
 - 7519 Landrace sows, 9310 litters, 22 farms
 - 5569 Yorkshire sows, 6861 litters, 21 farms
- Response to a decade of selection for total number born
 - +3 pig improvement in total born
 - Increasing pre-weaning mortality
 - Decreasing pig birth weight
 - Decreasing response in number weaned
- Objective to define an improved trait for number weaned

When do pigs die? Su et al. (2007)



Why LP5? (Su et al. 2007)

Landrace					Yorkshire				
Trait	TNB	NBA	LP5	NW	Trait	TNB	NBA	LP5	NW
TNB	0.07	0.6	0.34	0.29	TNB	0.05	0.7	0.58	0.53
NBA		0.08	0.75	0.72	NBA		0.05	0.89	0.87
LP5			0.09	0.99	LP5			0.07	0.99
NW				0.09	NW				0.07

Heritabilities along diagonal, genetic correlation between traits off-diagonal

LP5 and pre-weaning survival (Su et al. 2007)

Breed	Trait	TNB	NBA	LP5	NW
Landrace	Surv. at Birth	-0.28	0.61	0.56	0.58
	Surv. at day 5	-0.26	-0.54	0.58	0.61
	Surv. at Wean	-0.43	0.03	0.32	0.40
Yorkshire	Surv. at Birth	-0.38	0.41	0.43	0.46
	Surv. at day 5	-0.07	0.35	0.71	0.76
	Surv. at Wean	-0.52	-0.36	-0.08	-0.03

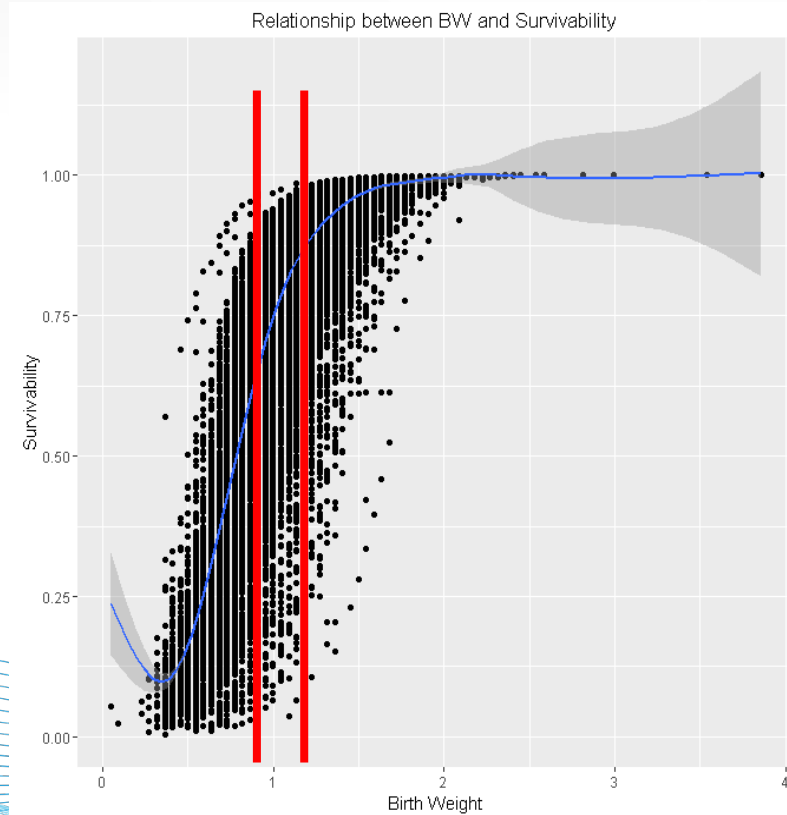
Biological Model – Pig Quality

- Pig Birth Weight:
 - Is a trait of the sow, not of the pig
 - Is increased by selecting sows that produce heavier pigs at birth
 - Is not increased by selecting pigs with high birthweight
 - Selection initiated July 2017, MBW
- Relation to LP5:
 - Favors sows with above average birth weight

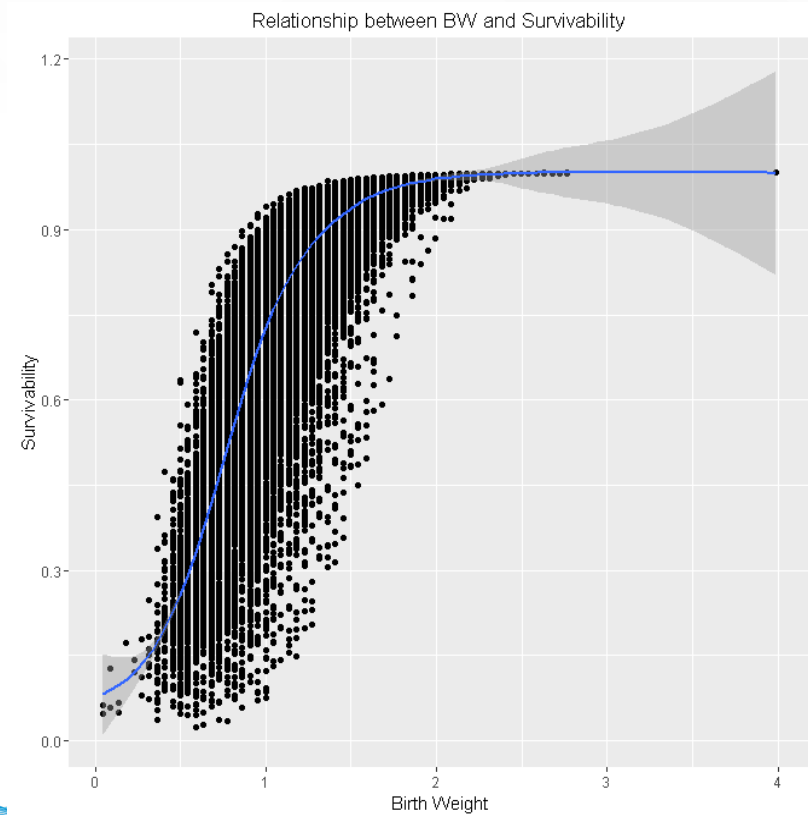


Why Birth Weight?

Yorkshire



Landrace



Move mean birth weight by 0.1 kg (0.2 lb) = ~5% improvement in PWM

More about birth weight

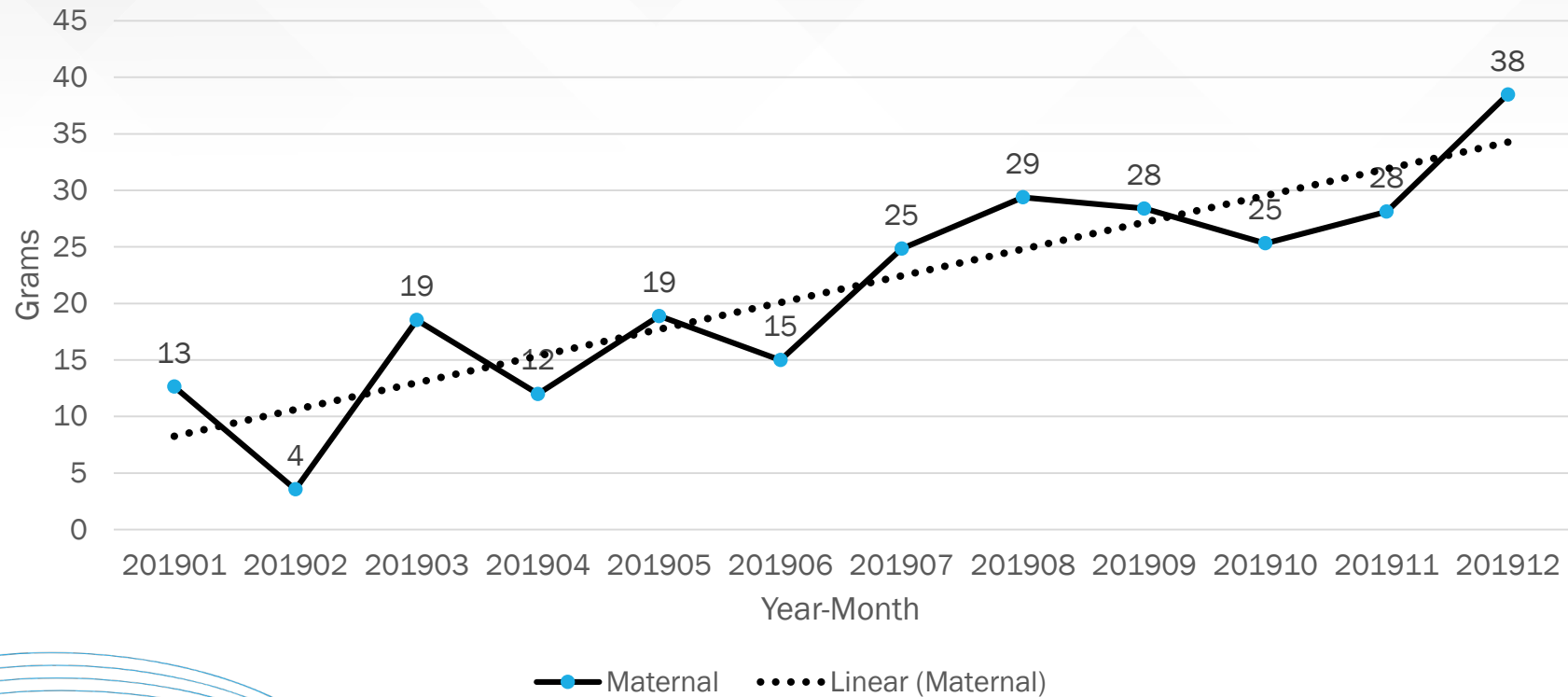
	Yorkshire	Landrace
Total Born	-0.028 (0.001)	-0.027 (0.001)
NBA	-0.026 (0.001)	-0.024 (0.001)
Stillborn	-0.030 (0.002)	-0.021 (0.001)
Live Pigs Day 5	-0.007 (0.001)	-0.010 (0.001)

Each additional total born reduces birth weight by 28/27 grams, LP5 by 7/10 grams.

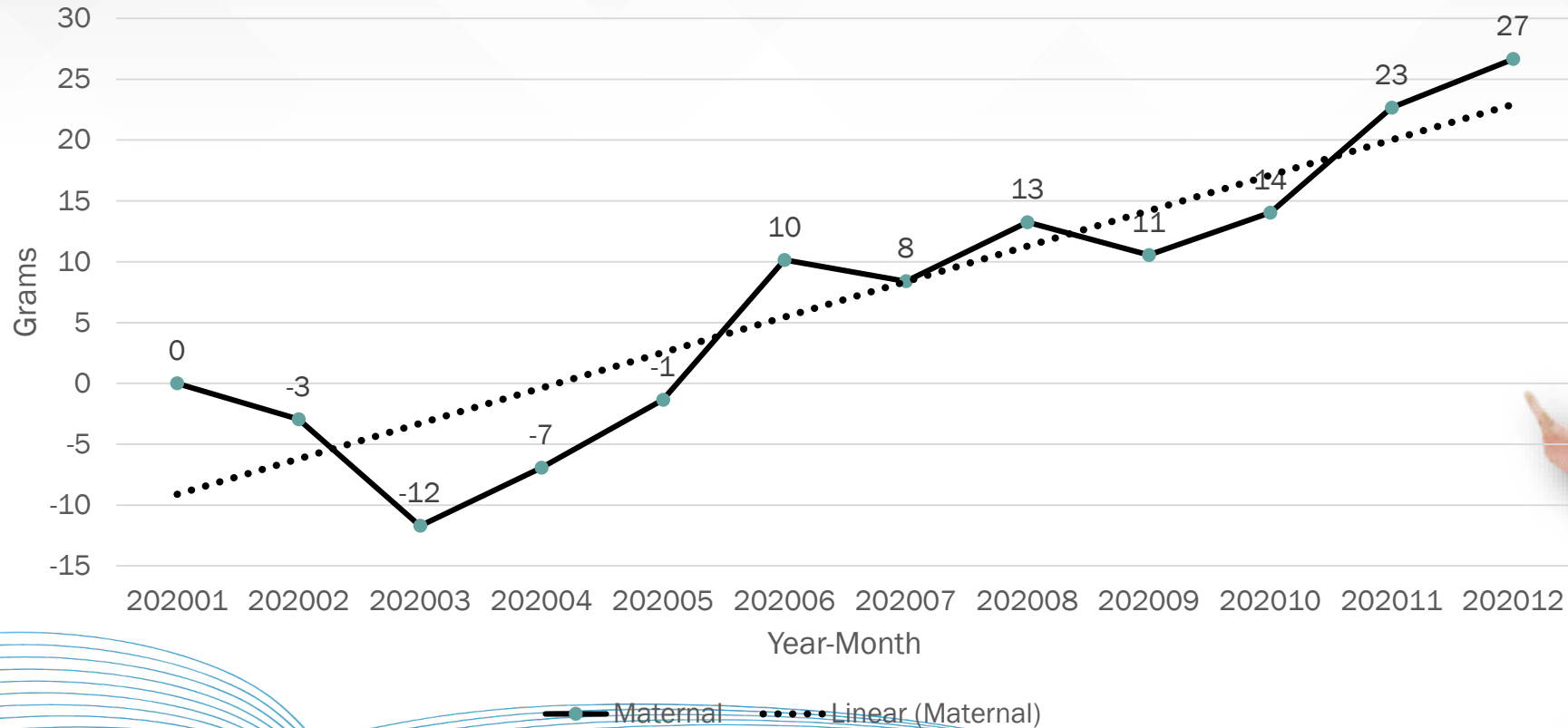
Impact of birth weight on growth

	Yorkshire		Landrace		Duroc	
	Estimate	SE	Estimate	SE	Estimate	SE
On-Test Weight	8.51	0.12	8.86	0.10	7.17	0.09
Off-Test Weight	15.64	0.36	18.31	0.27	15.20	0.27
ADGn	110.05	1.66	113.14	1.31	93.34	1.24
ADGf	83.17	3.29	111.12	2.54	96.83	2.59

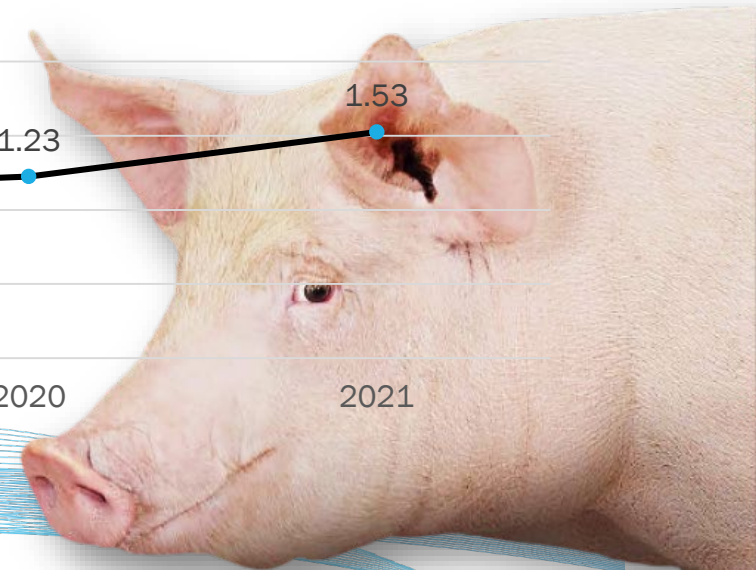
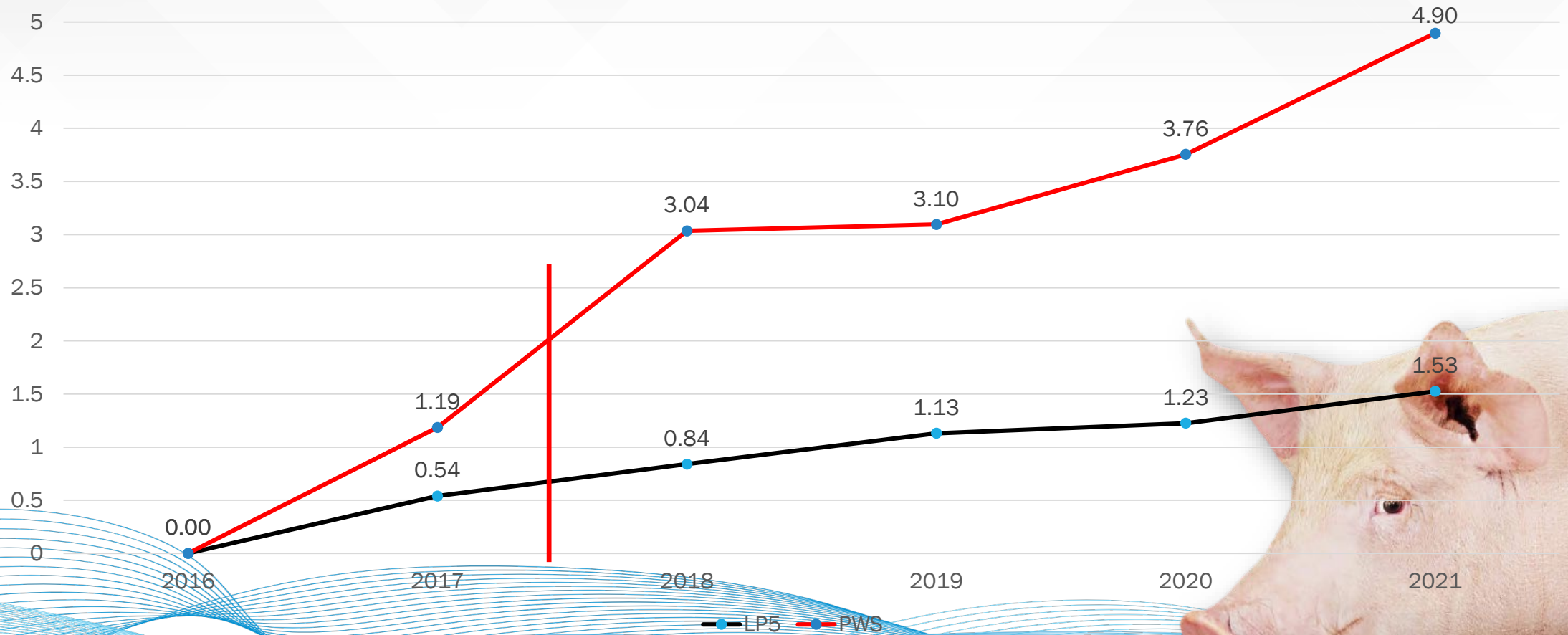
2019 Trend for Maternal Birth Weight



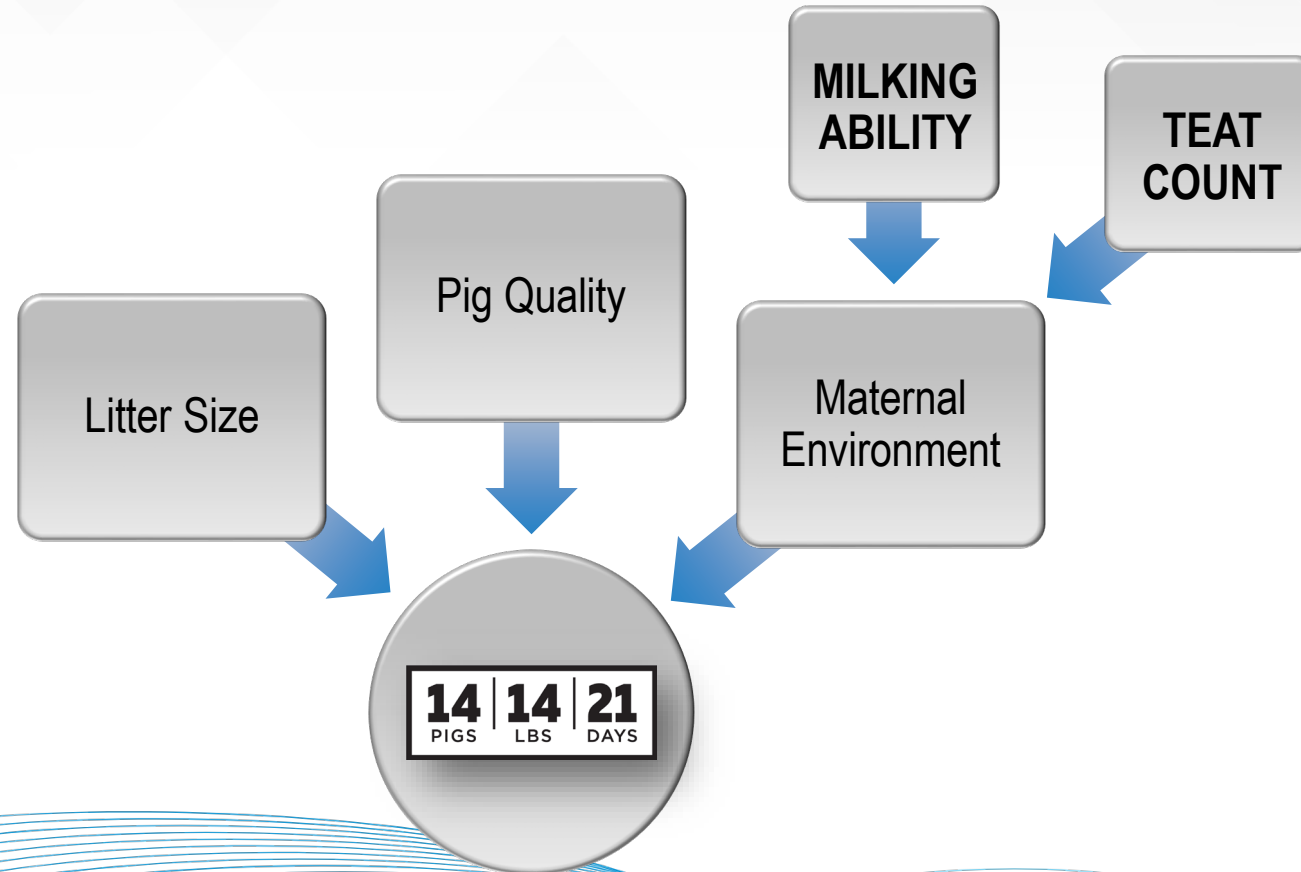
2020 Trend for Maternal Birth Weight



Phenotypic Trend in LP5 and PWS

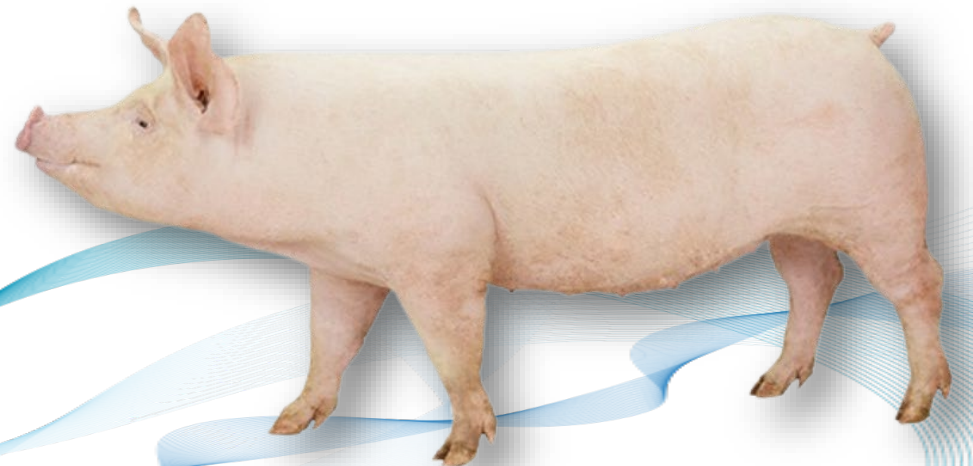


Biological Model – Maternal Environment



Milking Ability

- We had to identify a trait that predicts a sow's ability to add weaning weight
- Data collection began in 2015:
 - Birth weight (began in 2014)
 - Foster date, from/to sow, foster weight
 - Mortality date and weight
 - Protocol to load sows to functional teat count + 1 pig
- Allowed calculation of pre-weaning growth rate for pigs a sow nursed



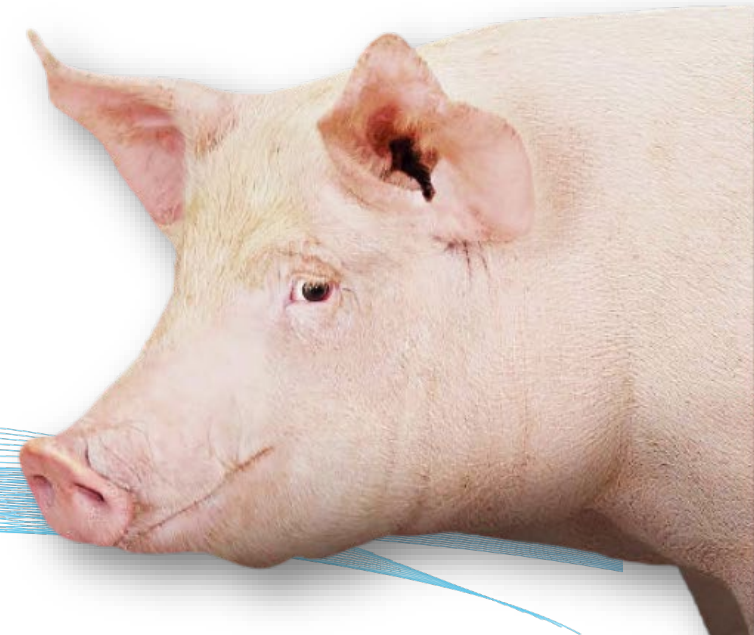
Average Daily Gain Birth to Weaning

- Like birth weight, the important genetic component is the sow, not the growth potential of the pig
- Selection is for sows producing a higher daily gain to weaning for the pigs she is allowed to nurse

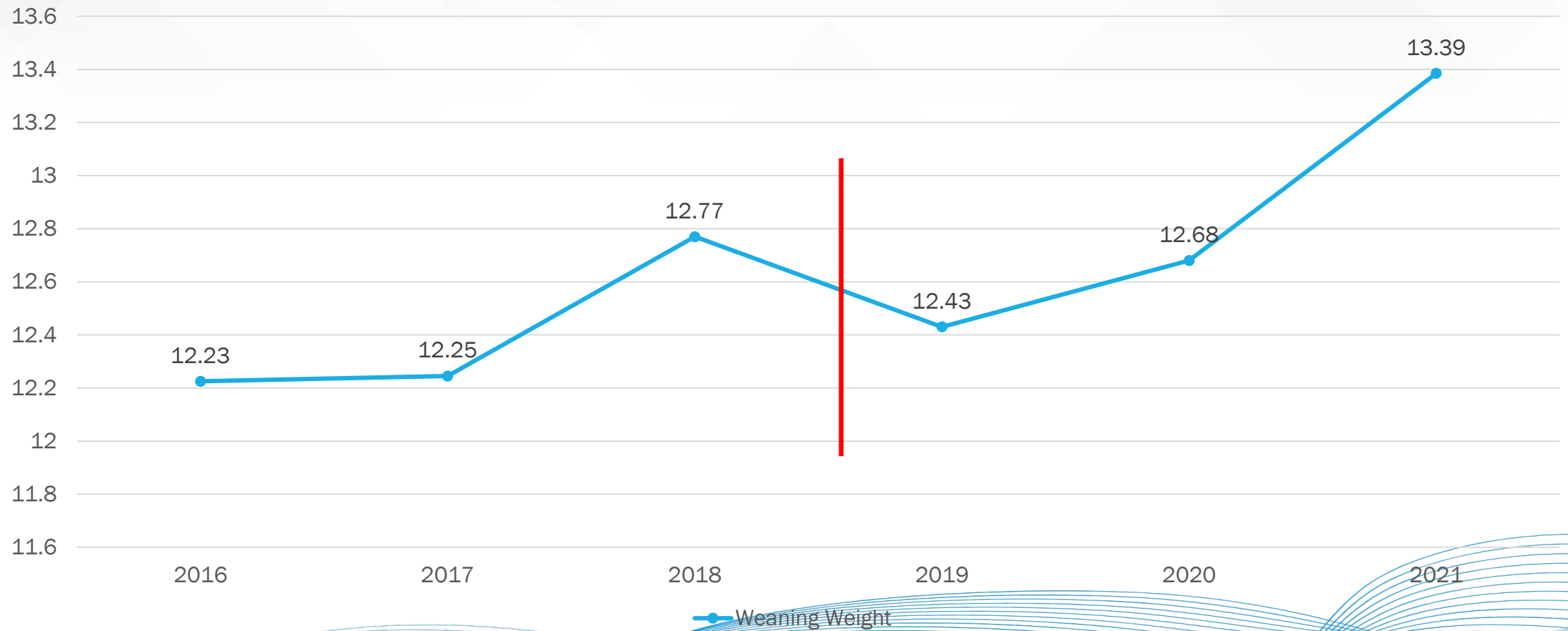


Average Daily Gain Birth to Weaning

- Genetic change:
 - From 2019 to 2020 = +4 grams
 - From 2020 to 2021 = +5 grams
 - Change of +9 grams per day
- Over a 21-day lactation = +0.42 lb. wean weight



Wean Weight Phenotypic Trends



Commercial Trendline

Trends:

- TNB = 0.25 pigs per year
- NBA = 0.21 pigs per year
- PWM = -0.55% per year
- GT/Sow Farrowed = 0.25 pigs per year
- Total wean weight = +36 lb. per sow per year

Sows have maintained weaning weight for an additional 1.5 pigs weaned

Implications for Sow Nutrition

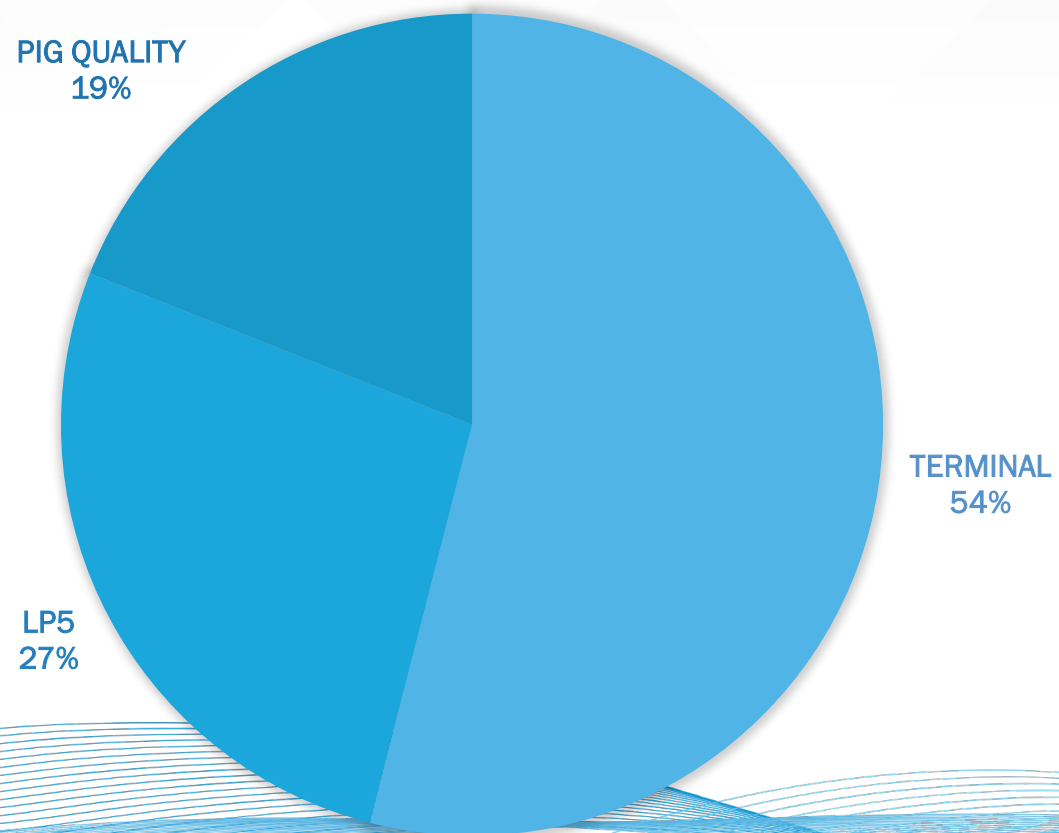
- 1.5 additional pigs
 - Feeding for increased uterine capacity
 - Gestation requirements
 - Maintenance of body condition, while feeding the developing fetus
- Sows weaning (lactating) an additional 36 lbs. (16.3) kg per year
 - 6.8 kg per litter (2.4 litters per year)
 - Energy and protein requirements, feed intake
- Difficult to do research on sows with very few facilities available
- A robust, heavy and healthy pig is the starting point for success



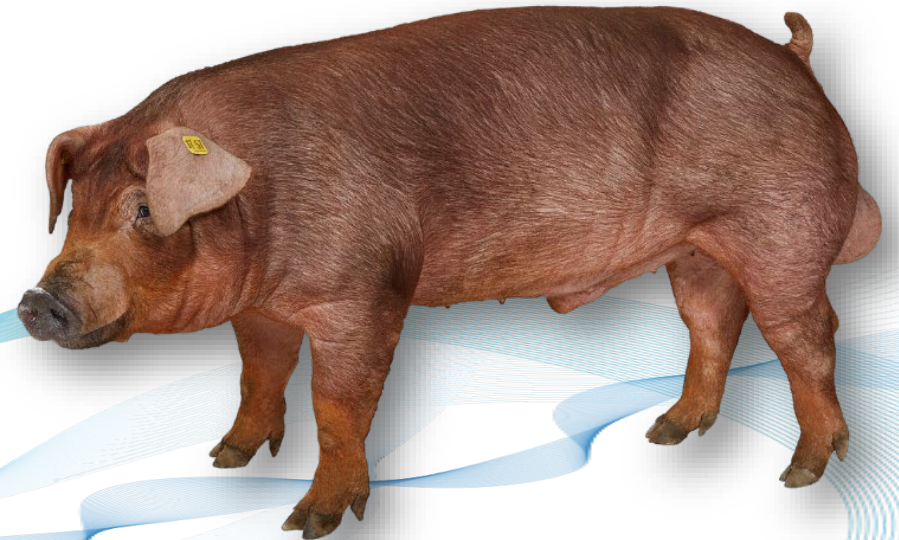
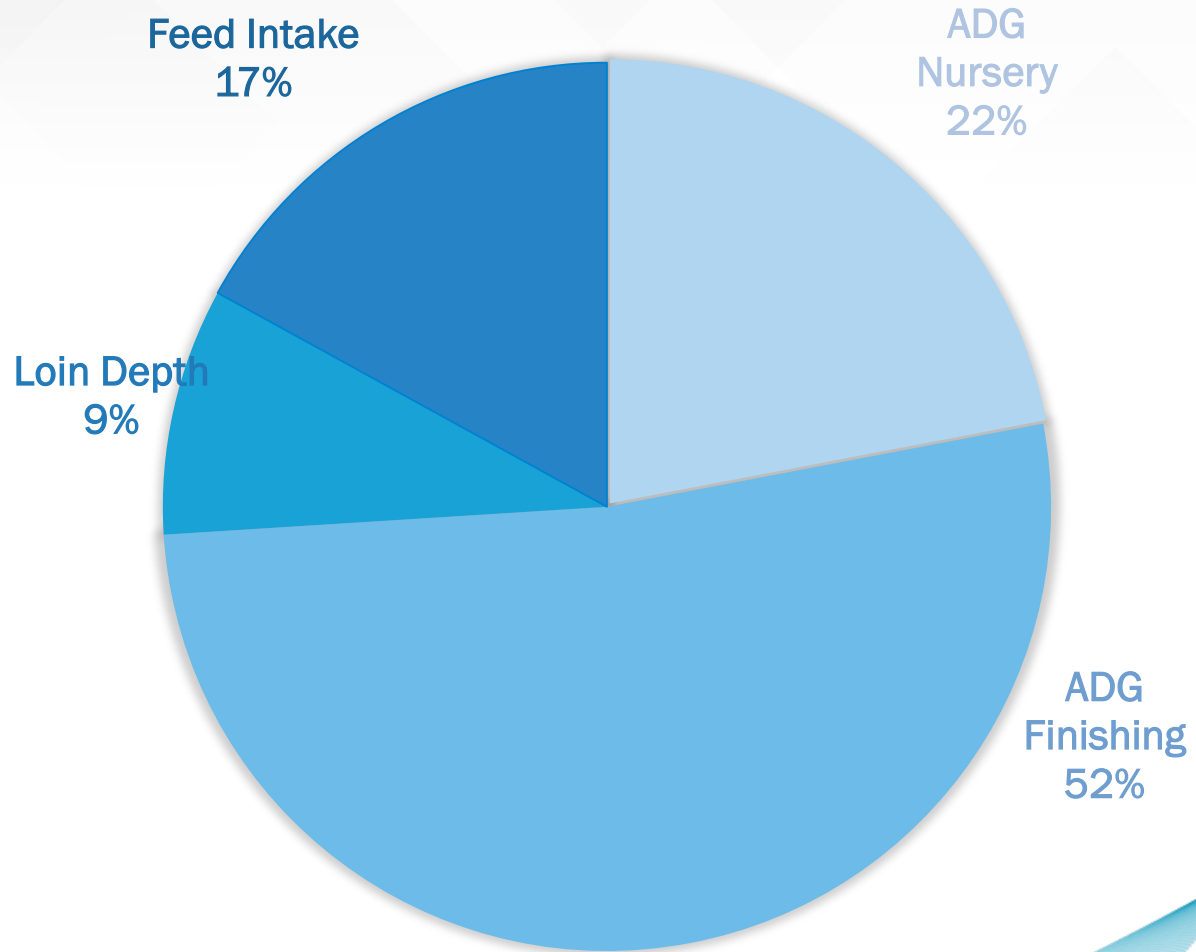
Growth and Efficiency



Maternal Line Selection Objective



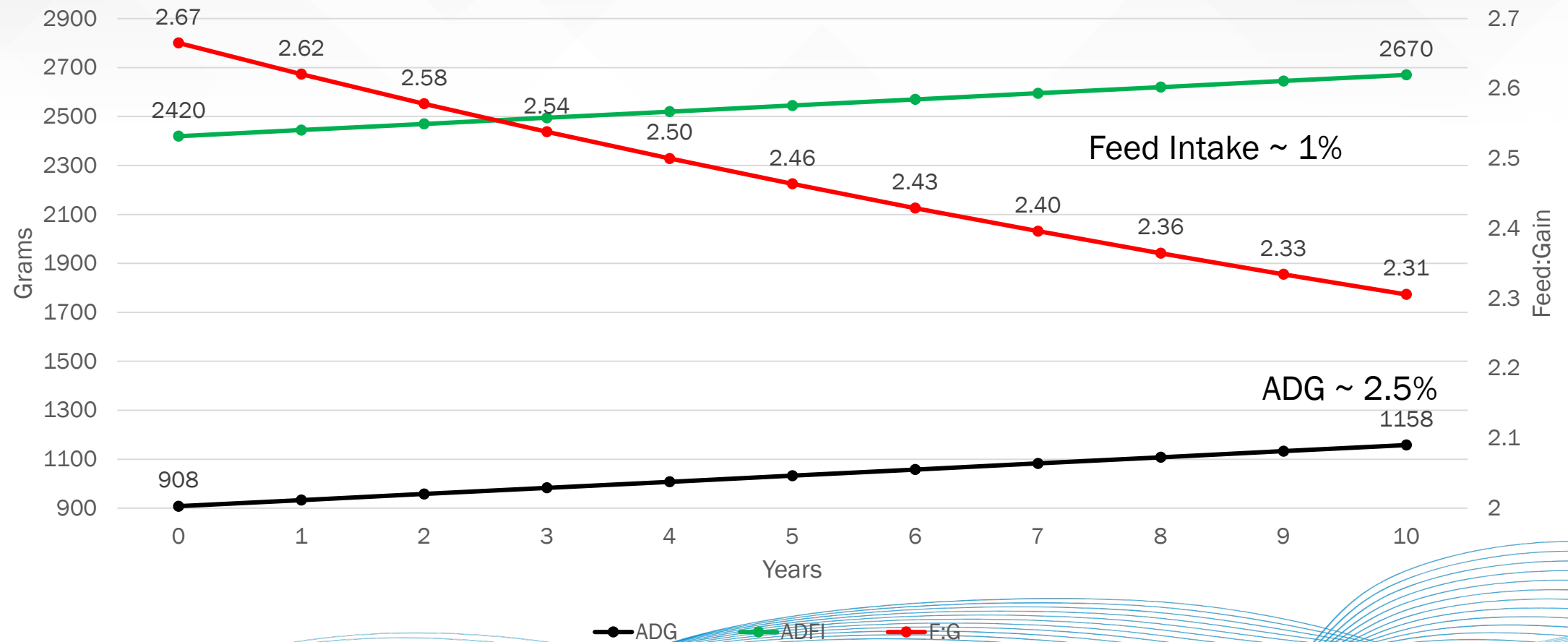
Duroc Selection Objective (prior to August 2021)



Predicted Response

- Market pigs will have:
 - Increasing finishing feed intake over time
 - Higher finishing and nursery growth rate
 - Increasing carcass muscling
 - Level to slightly increasing backfat measures
- Key relationships are between growth, feed intake and efficiency

Finisher Trend Over Time



Implications for Grow-Finish Nutrition

- Feed intake is increasing, but...
- At a proportionally slower rate than daily gain
- Feed efficiency will continue to improve at about 0.04 units
- Selection for a lean pig at a heavy market weight is:
 - Driving intake and efficiency in late finish
 - Likely pushing maturity further to the right...little decrease in daily gain
- There is approximately a 5% change in F:G and growth every 3-4 years



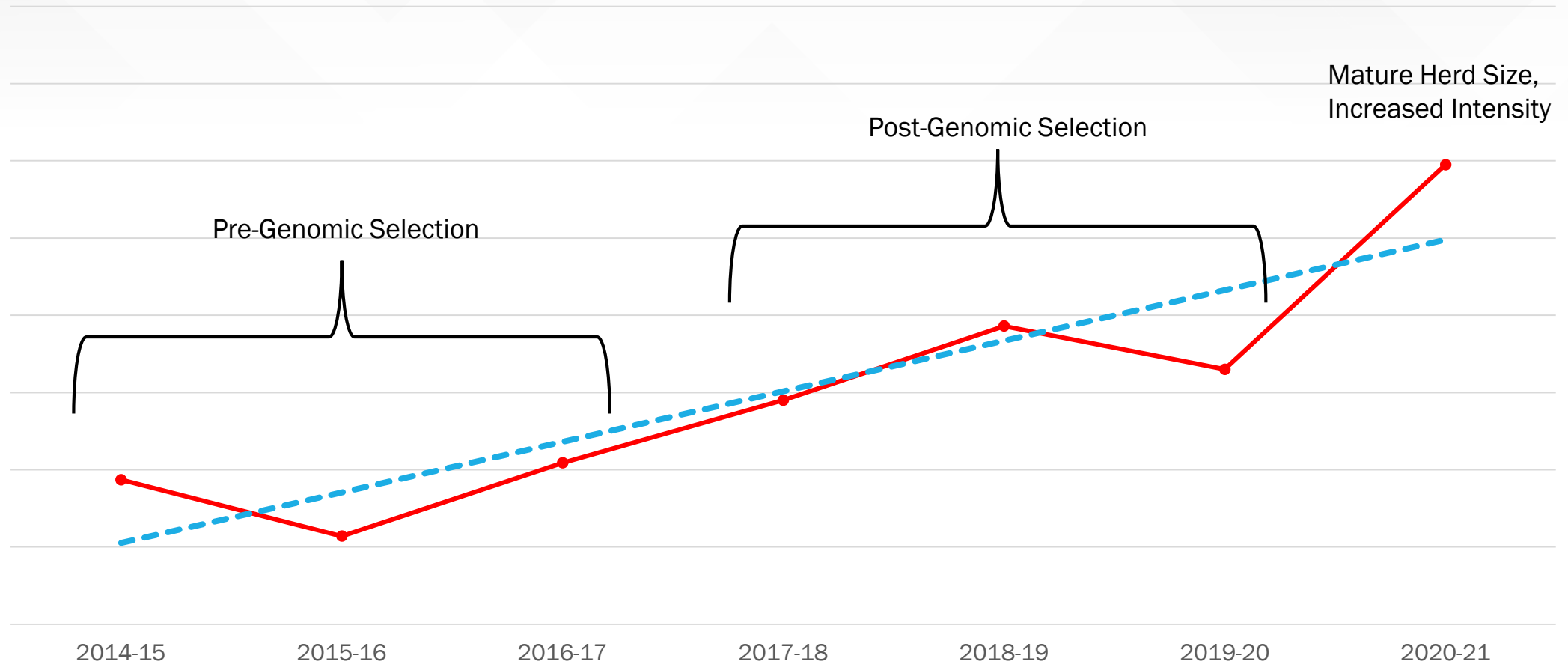
Acceleration of Change



What is Genomic Selection?

- An improvement in the accuracy of choosing the 'right' parents
- Its about the relationships:
 - Without genomics, all littermates assumed to be 50% related
 - With genomics, at the DNA level, an accurate relationship is calculated
 - Theoretical range of 0-100%
 - Most full-sib animals fall between 30 and 70% related
- Relationships at the DNA level are also calculated across families
- Higher accuracy = better decisions = more genetic change

Accelerating Trend (per market pig)



Implications of Genomic Selection

- The change in lowly-heritable and sex-limited traits can be up to 50% faster:
 - Live Pigs at Day 5
 - Maternal Birth Weight
 - Feed Intake
- The change in traits measured on all animals increases up to 25%
 - Growth Rate
 - Backfat
 - Loin Depth
- The pace of change must be equally met with changed in management and nutrition in order to extract the genetic potential

Conclusions

- The rate of genetic change today, due to genomic selection, is 25-50% higher than it was 5 years ago
- This higher rate of genetic gain means that the management and nutrition program must change at a rate faster than we've ever done
- The nutrition of the sow is the hardest to research, and the area most lacking
- Grow-finish recommendations should be updated every 3 years, corresponding to a ~5% change in the trait values

Questions?

