Prolificacy, sow lifetime productivity and efficiency of pork production: convergent or divergent trends?

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EAAP, 2013
"Sow nutrition to cope with increased reproductive potential"

Swine Research & Technology Centre

Outline

1. Introduction
2. Impact of genetic selection on gilt performance and management
3. Impact of genetic selection on sow performance and management
4. Impacts of increased prolificacy on litter quality and implications for management

1. Introduction

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General observations on sow productivity

- Gilts are growing faster, with no apparent change in age at puberty
- Total litter size born has increased steadily over the last 20 years
- In prolific sow populations, quality pigs born live and weaned has not kept pace with total born
- Sow feed intake and milk production has increased
- Negative effects of increased productivity on sow fertility are increasingly less obvious but probably affect litter quality

Impacts of all these changes on measures of lifetime sow productivity are needed …….. concepts like Total Feed Efficiency can drive this discussion.

Progress in Pigs

TOPIGS

Phenotypic and genetic applications for total nutritional efficiency in pigs

L.M.G. Verschuren, H.A. Mulder, R. Bergsma, E.F. Knol

28 August 2013

2. Impact of genetic selection on gilt performance and management

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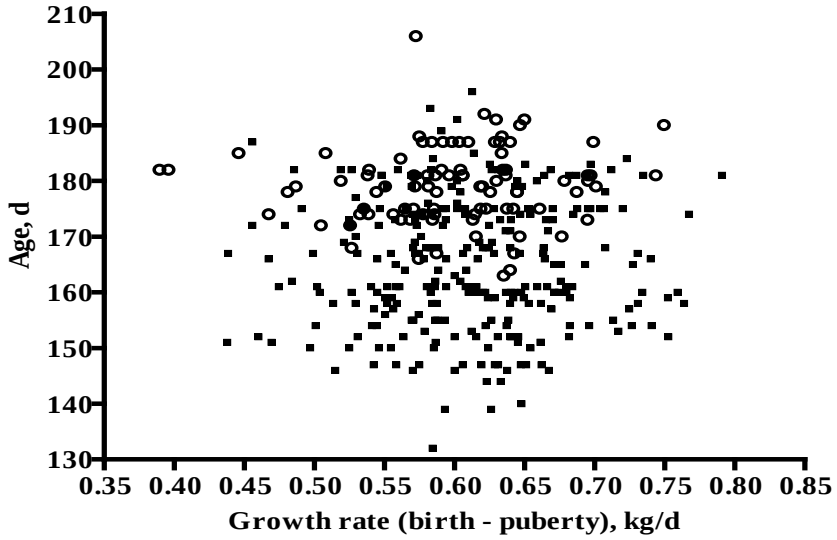
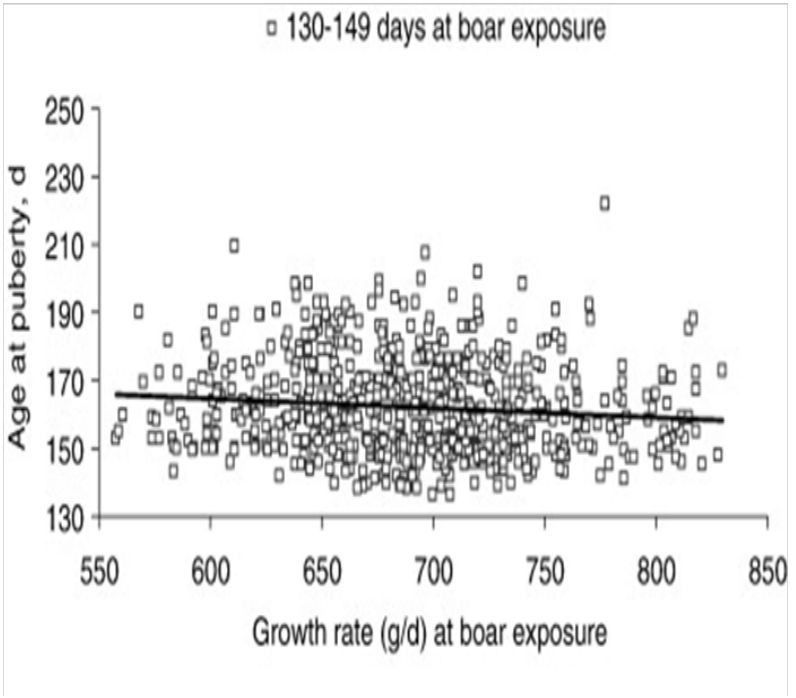
Growth rate and sexual maturity

Lack of an association between age at puberty and growth rate

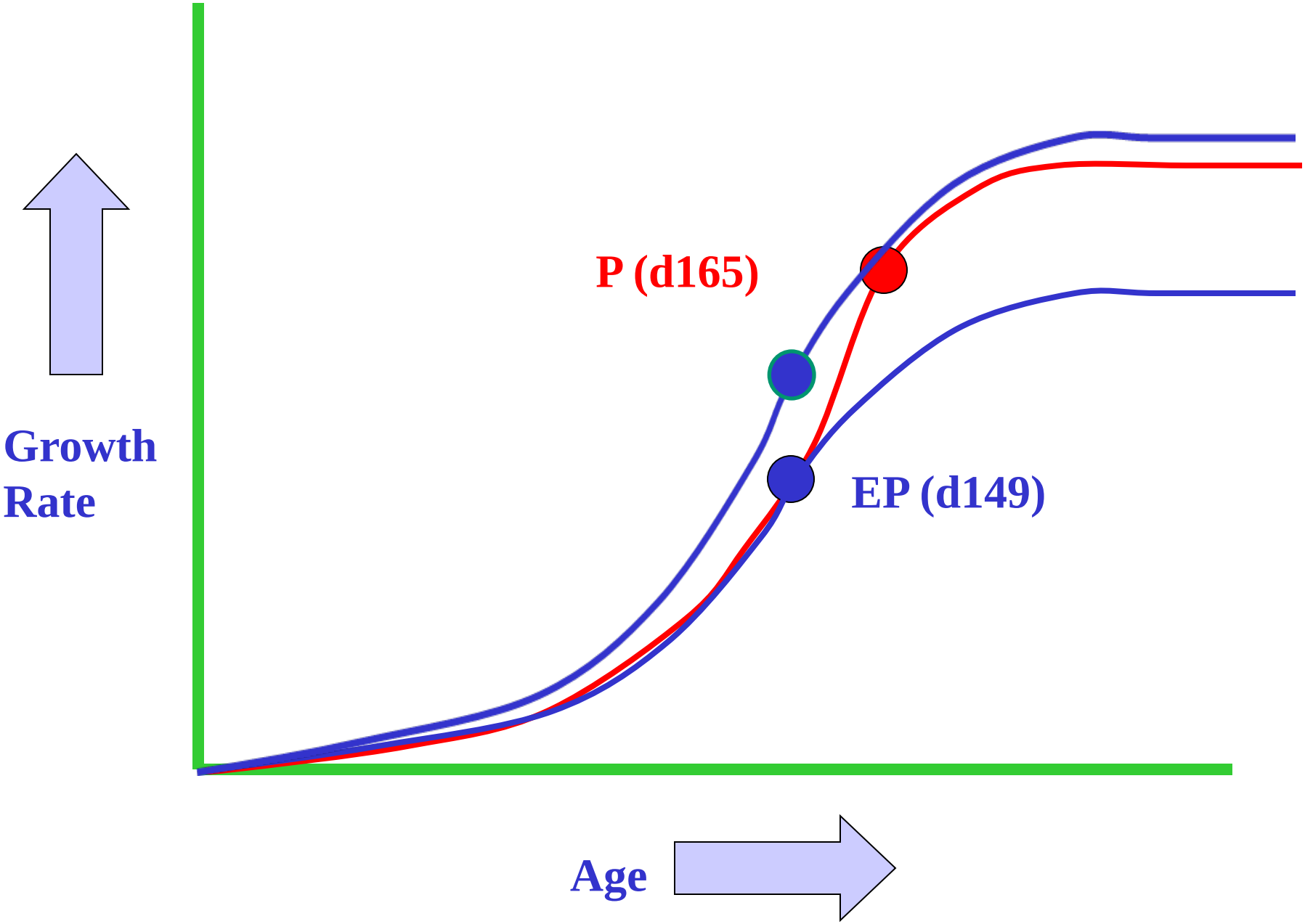
Patterson et al., (2010)



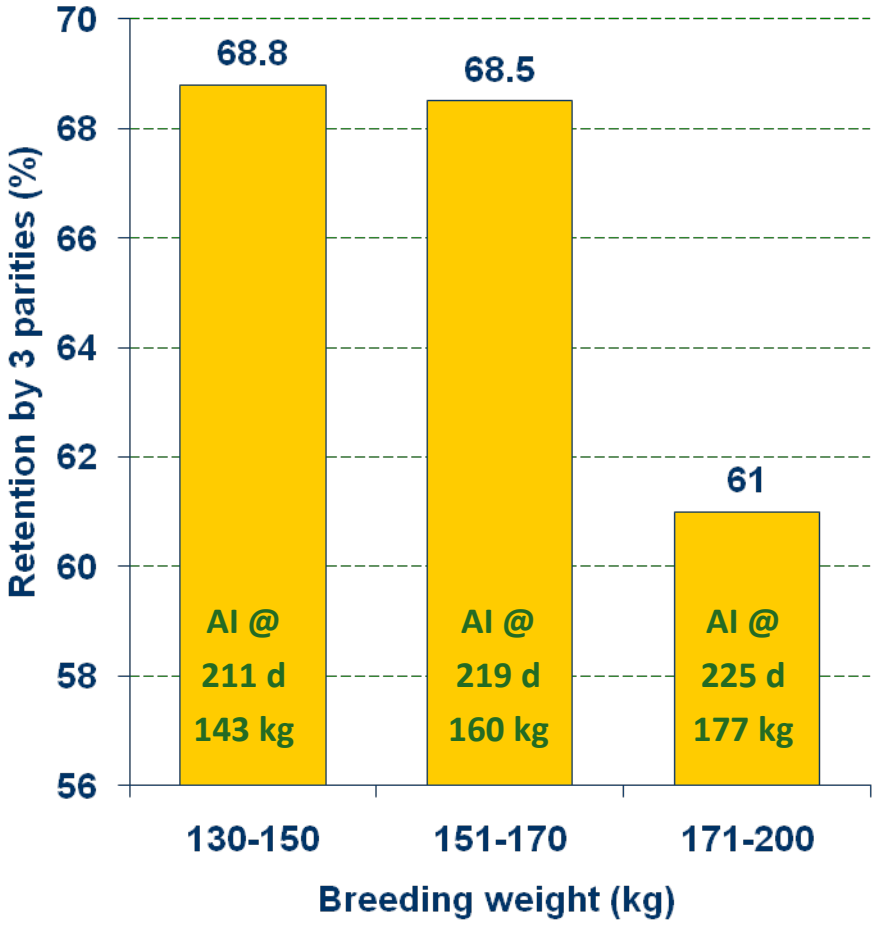


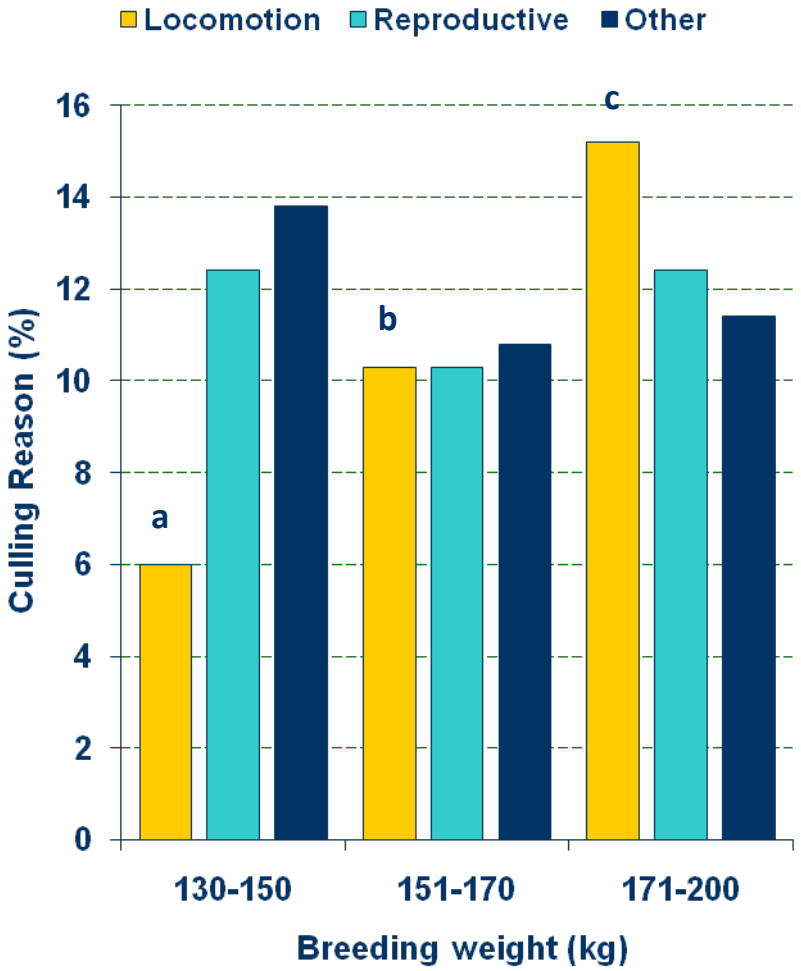
In gilts that were younger at 1st boar exposure (130–149 d), puberty was attained earlier in those with a higher growth rate

Amaral Filha et al., (2009)


Growth Rate
P (d165)
EP (d149)
Age

Effect of Breeding Weight on Retention Rate to 3rd Parity





Source: Amaral Filha, 2008)

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada



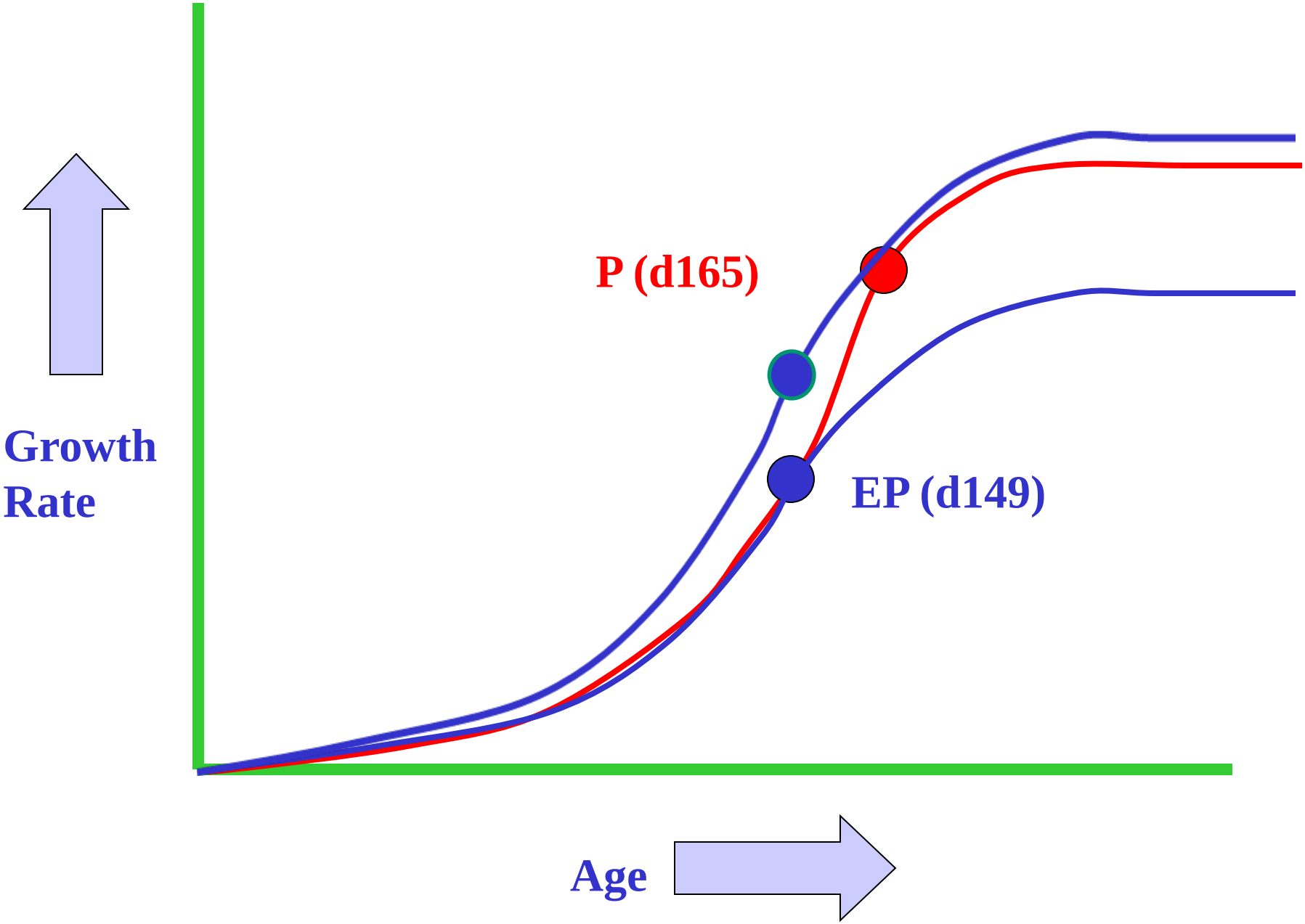
Compensatory feeding of gestating gilts: effects on mammary gland development and lactation

Farmer C[1], Palin M-F[1], Martel-Kennes Y[2]

[1]AAFC, Sherbrooke, QC,

[2]La COOP Fédérée, QC, Canada

Canada


Growth Rate
P (d165)
EP (d149)
Age

3. Impact of genetic selection on sow performance and management

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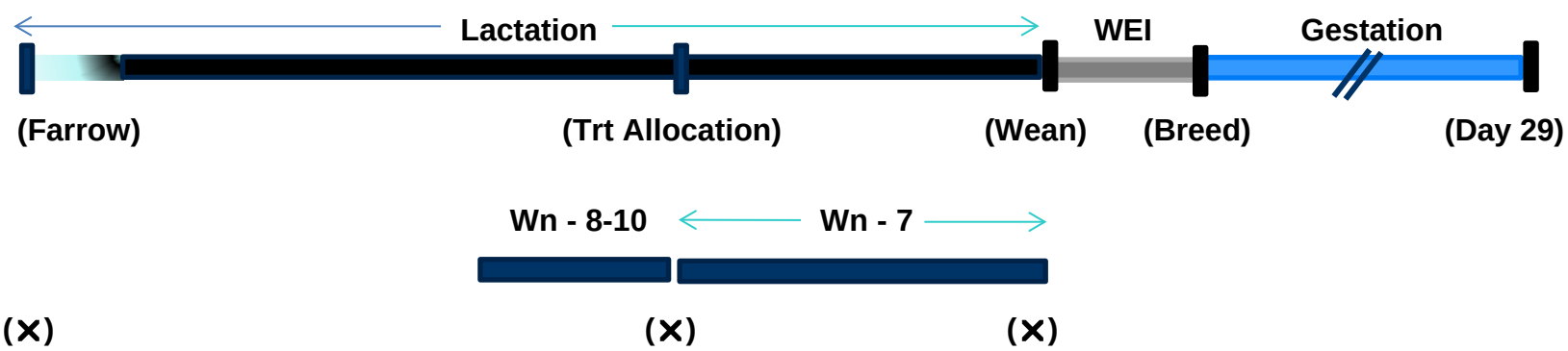
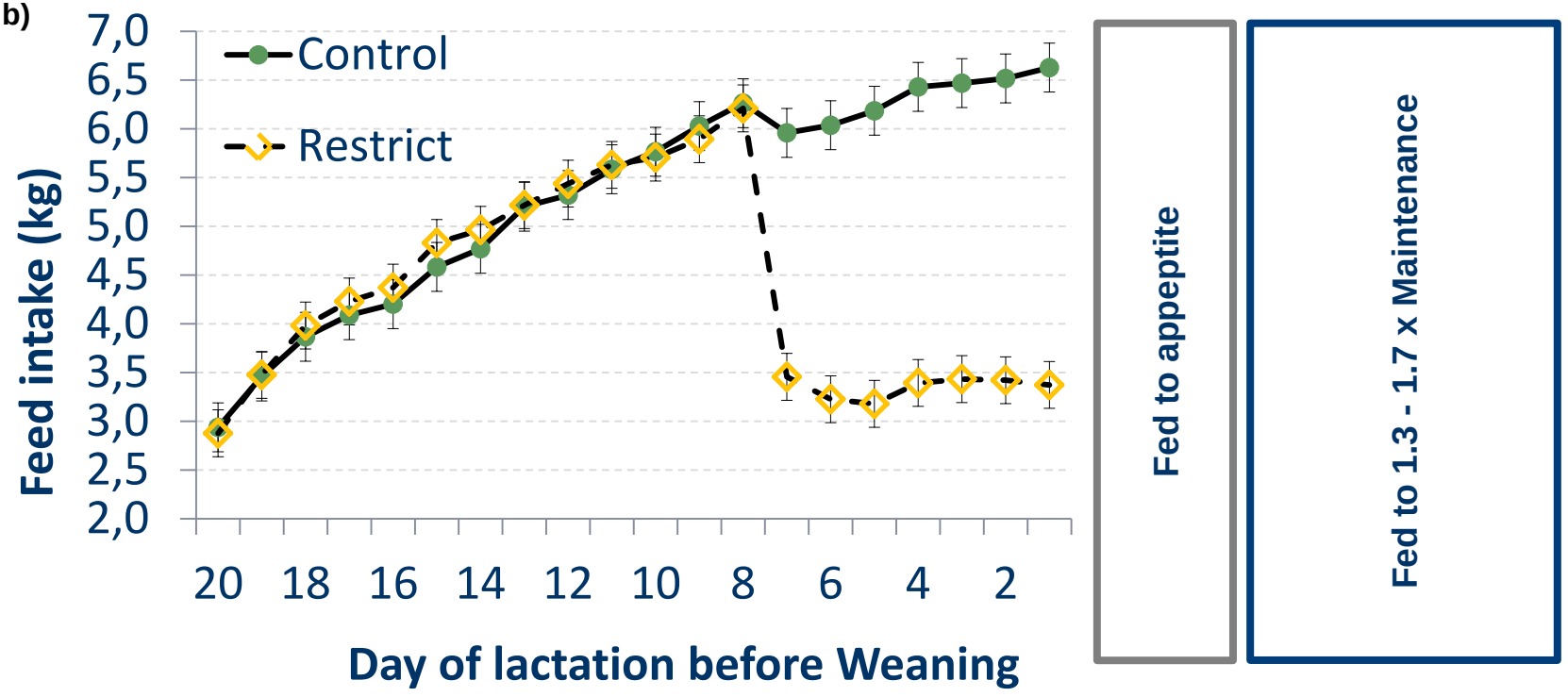
Experimental Design

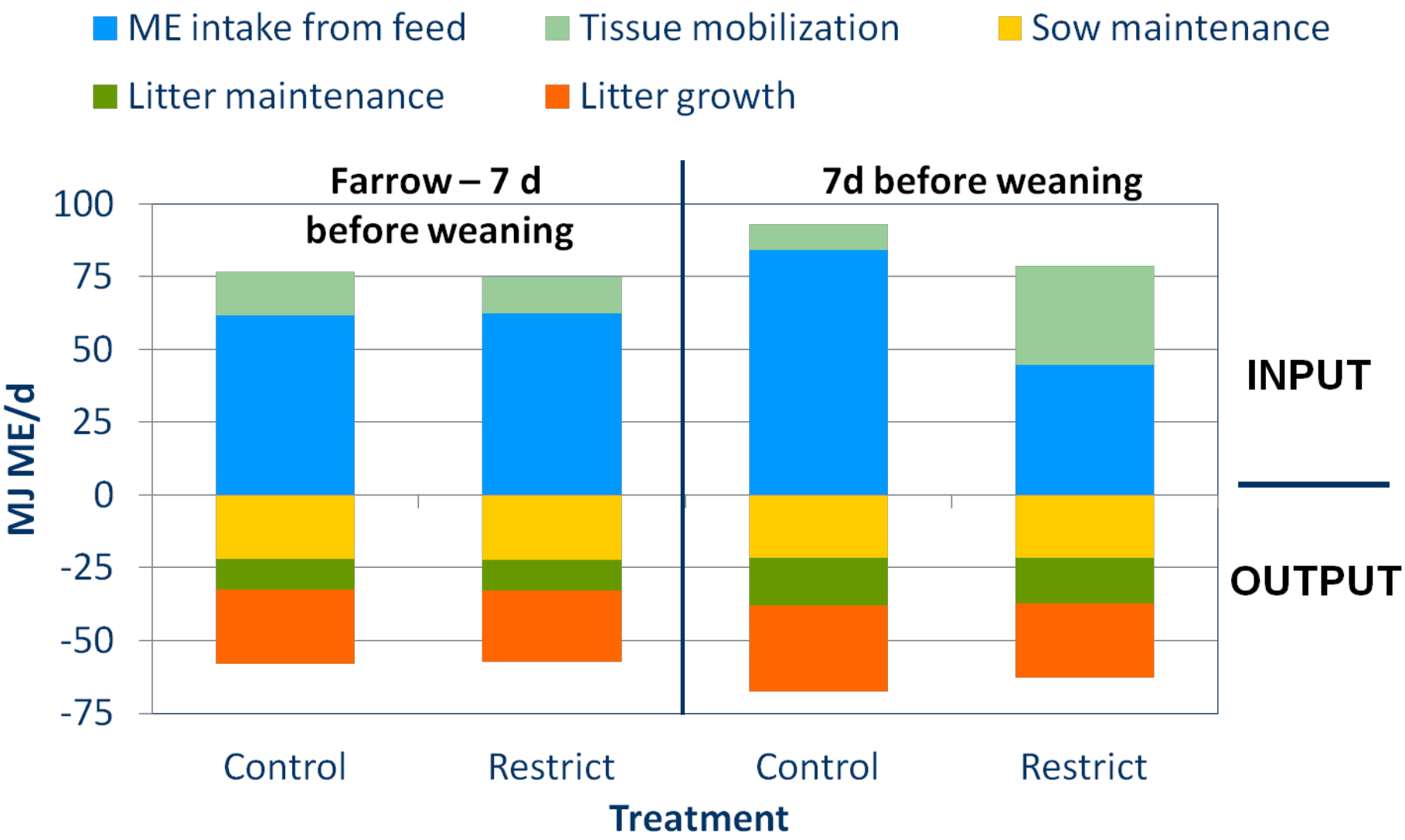
a)



b)



Energy Balance



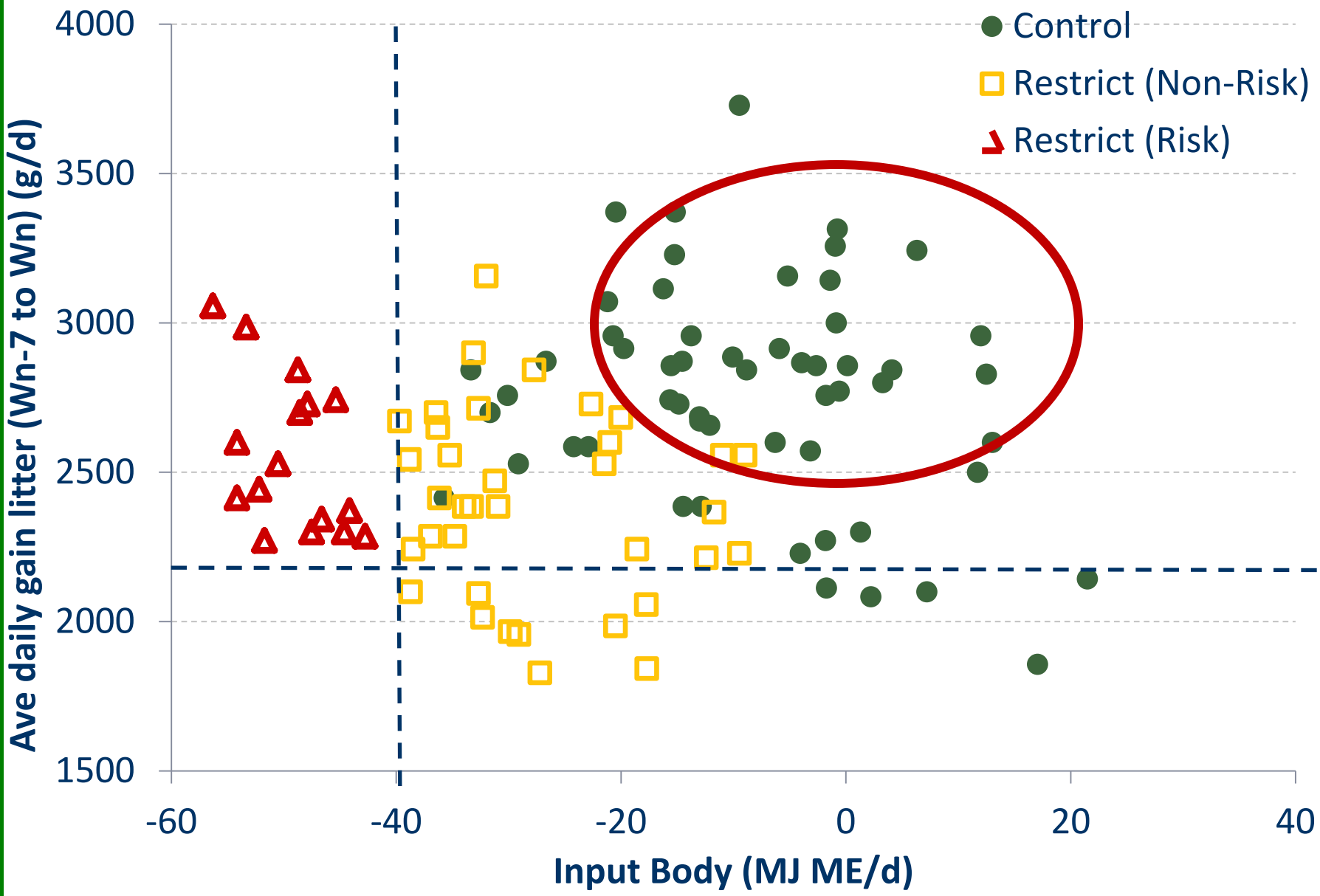
Changing responses to catabolism in late lactation

	Zak *et al*. 1997	Vinksy *et al*. 2006	Patterson *et al*. 2011
WEI	Yes	No	No
Ovulation rate	Yes	No	No
Number of live embryos	Yes	Yes	No
Embryonic survival (%)	Yes	Yes	No
Embryonic weight	N/A	Yes	Yes
Sex ratio	N/A	Yes	Partial

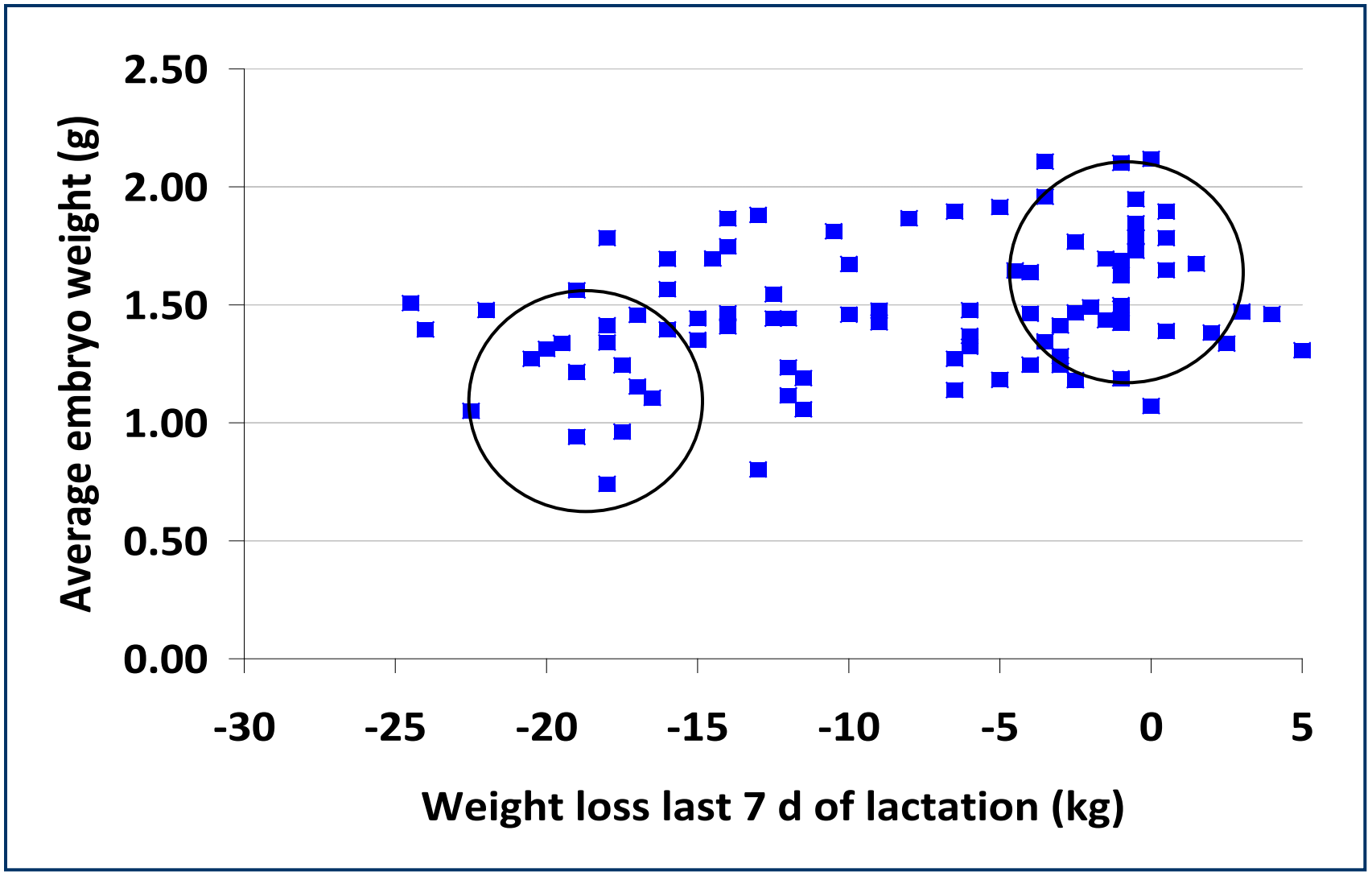
Why have things changed?

- genetic improvements over 15 years
- selection against effects of catabolism (WEI)

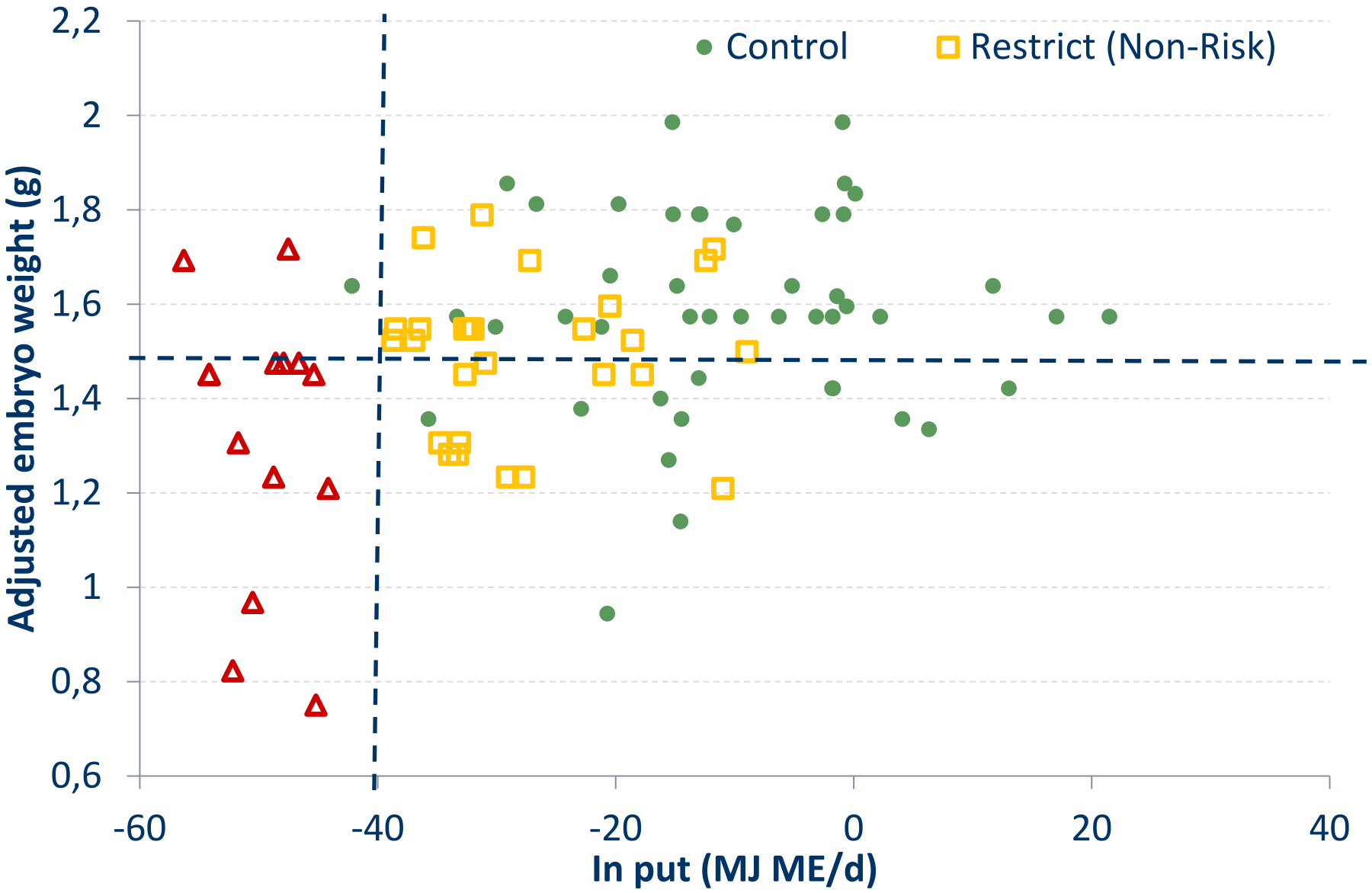
Selection for a prompt return to estrus after weaning appears to have changed the relationship between metabolic state of the sow and reproductive performance ……. the subsequent litter may carry a metabolic "imprint" that contributes to phenotypic plasticity of the litter and impacts Total Feed Efficiency.


Control
Restrict (Non-Risk)
Restrict (Risk)
Ave daily gain litter (Wn-7 to Wn) (g/d)
4000
3500
3000
2500
2000
1500
-60
-40
-20
0
20
40
Input Body (MJ ME/d)

Changing biology of the weaned sow

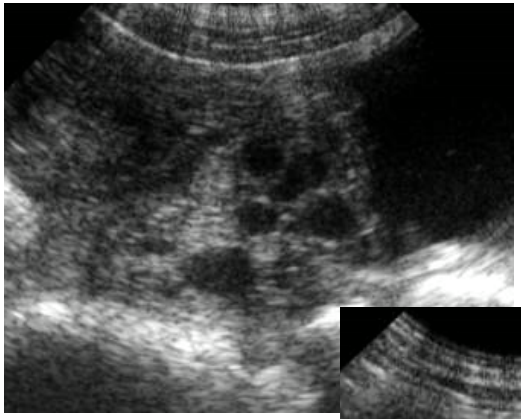


(Swine Reproduction & Development Program, U of A, unpublished data)

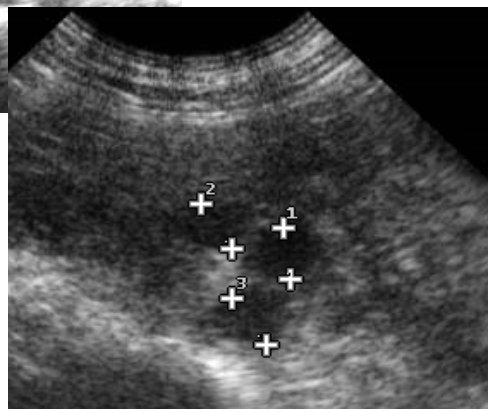

Control
Restrict (Non-Risk)
Adjusted embryo weight (g)
2,2
2
1,8
1,6
1,4
1,2
1
0,8
0,6
-60
-40
-20
0
20
40
In put (MJ ME/d)

Follicular dynamics at ovulation

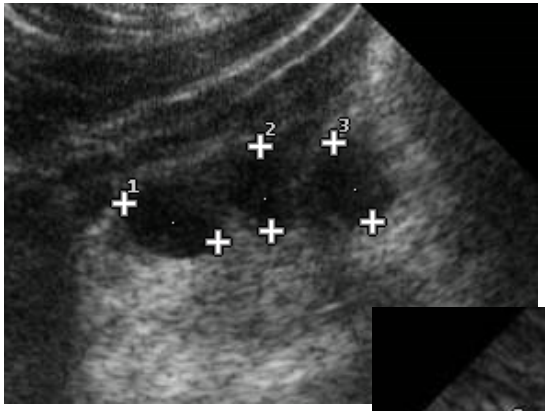
- Emerging pre-ovulatory follicles are smaller
- Skip-a-heat breeding partly corrects this trend
- Effect on embryo quality remains to be determined

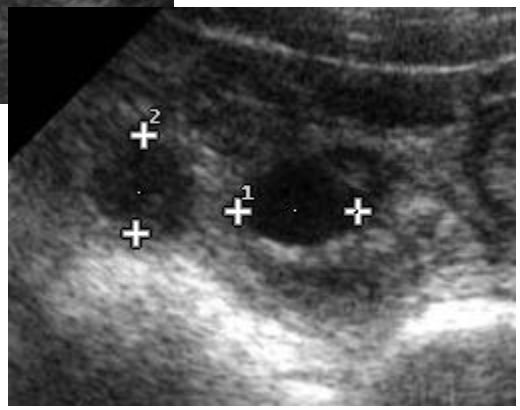


4.5 mm



6.1 mm





7.8 mm

Outstanding questions for sow biology

- What is the most efficient way to develop sows in the future?
- Selection for increased voluntary feed intake seems to address problems with subsequent litter quality
- However, there may then be problems with lactational oestrus ….. or is this an opportunity to breed in lactation?

4. Impacts of increased prolificacy on litter quality and implications for management

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Evidence for induced “litter phenotypes” in commercial sow populations.

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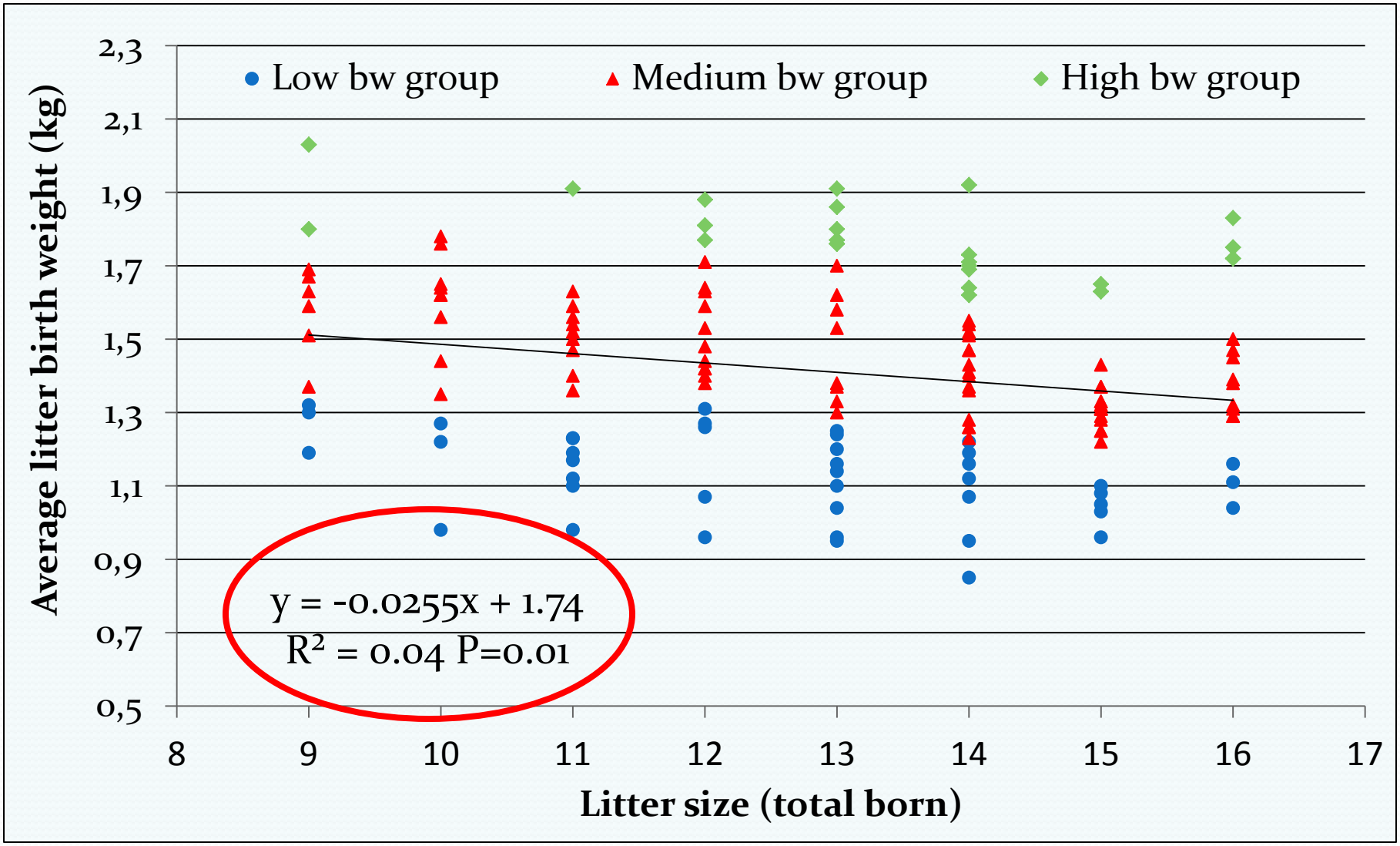
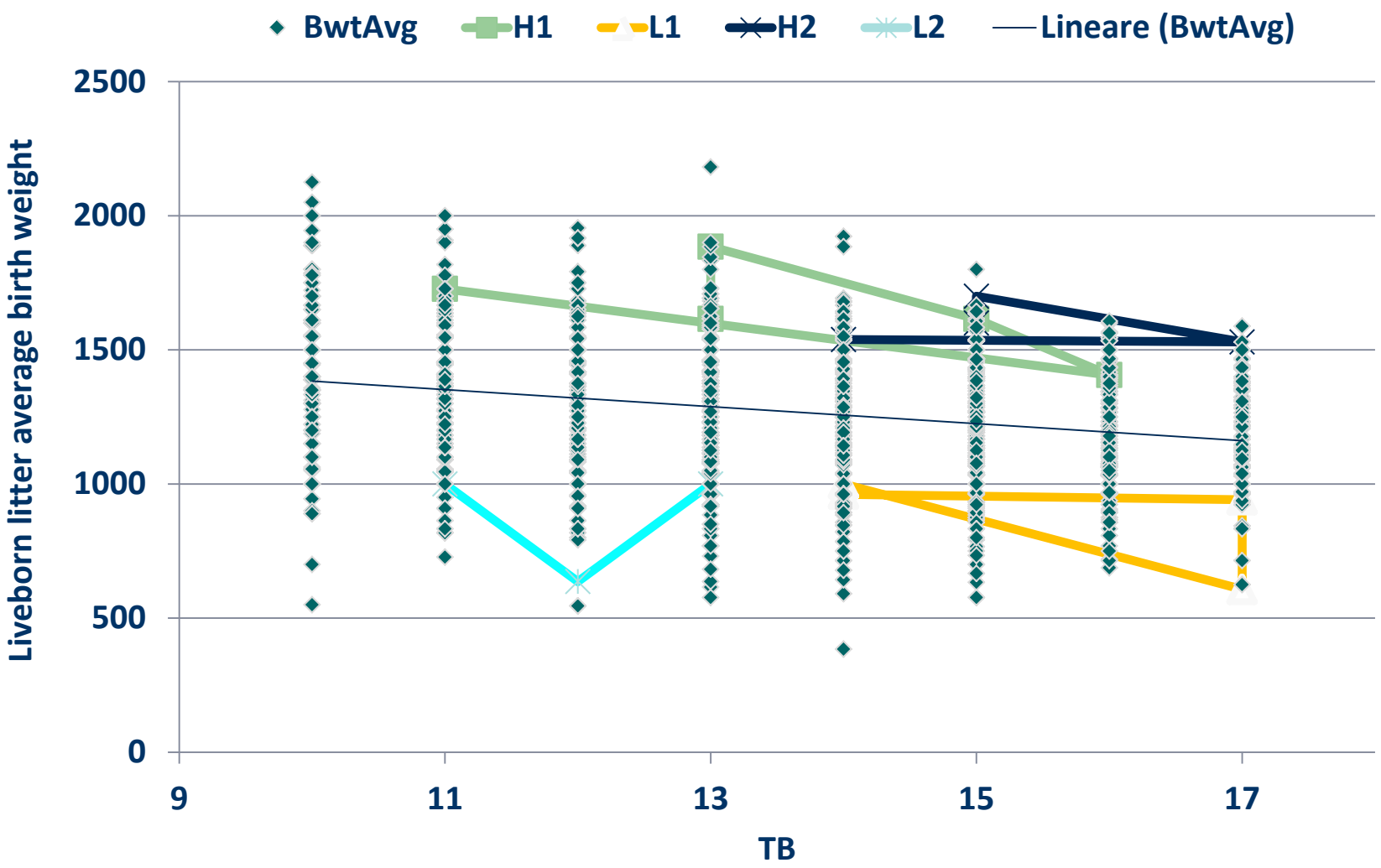
Litter birth weight phenotype



Usask / UofA / C-Pig study, 2010, preliminary data

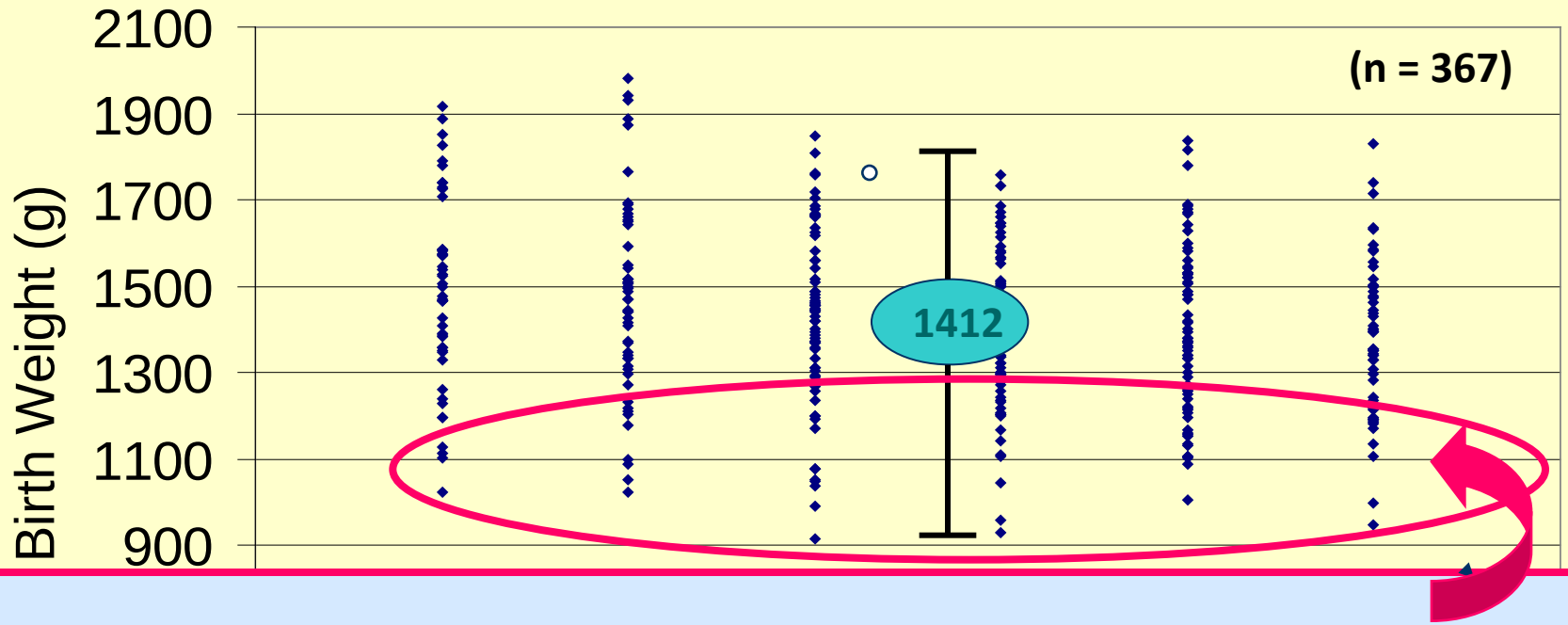


In some sows, selecting for increased prolificacy in the sow has indirectly created an imbalance between the number of ovulations and the number of developing embryos *in utero* …… a better balance is needed with functional uterine capacity to support the optimal development of fetuses to term.

Group (High=3 (+1SD mean), Medium = 2, Low=1 (-0.8 SD mean))

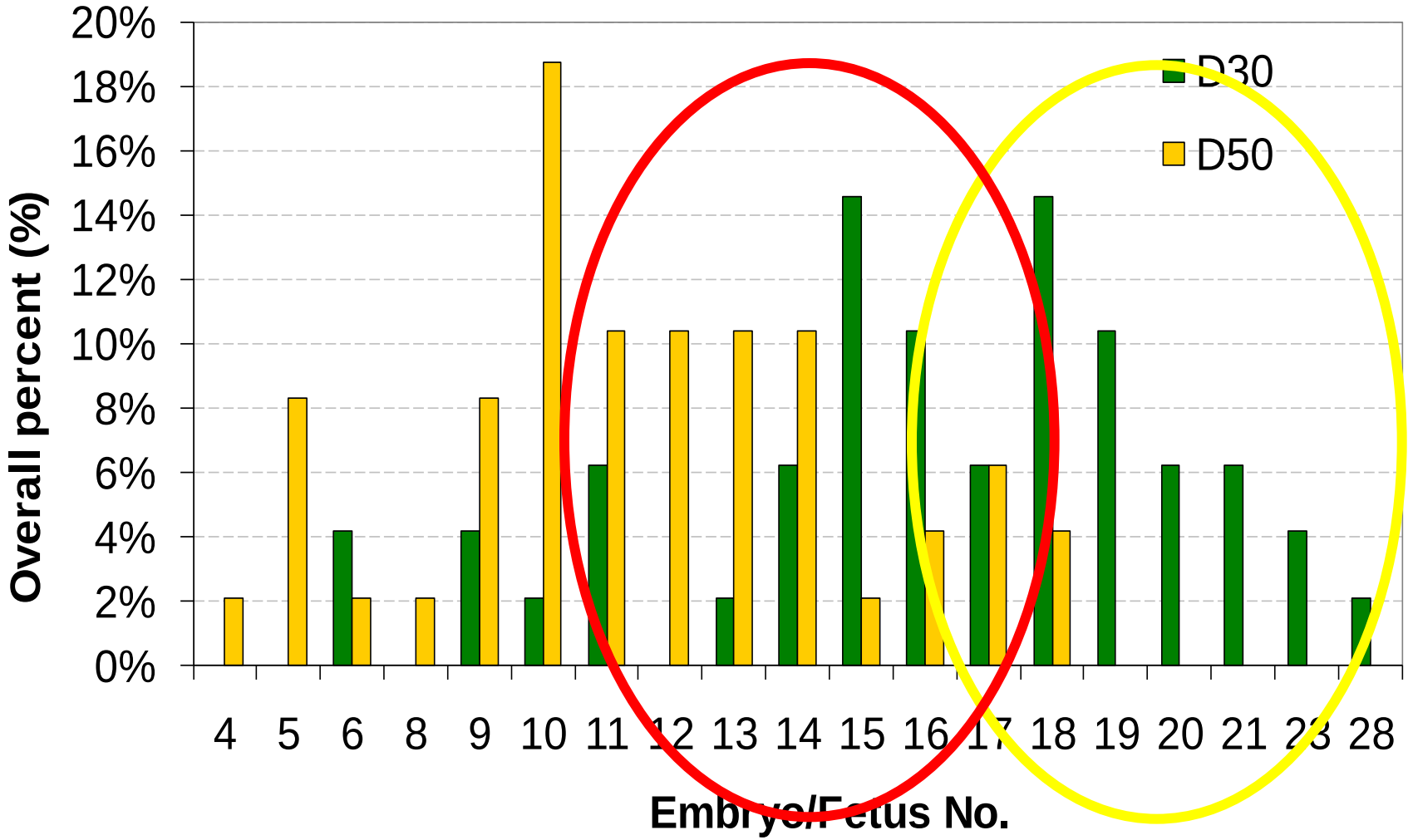
	Parity							ALL Parities		Ovulation
ID	1	2	3	4	5	6	7	Total Born	Ave Pig Wt	Rate
H1	2	2	2	2	3	3	3	12.9	1501.0	26
H2	1	3	2	3	3	3		13.1	1474.5	18
H3	3	3	3	3	3			12.5	1694.9	18
H4	3	3	3	3				12.8	1636.1	20
H5	2	3	2	3				15.6	1442.7	23
					Average:			13.4	1549.8	21
L1	1	1	1	1	1			12.2	942.5	21
L2	2	1	1	1	1			14.0	1033.7	27
L3	2	1	1	1	2			11.7	1207.8	29
L4	1	1	1	2				14.4	1075.4	25
L5	1	1	1					13.0	1003.4	28
					Average:			13.0	1052.6	26

Relationship between litter size (10-15) and birth weight



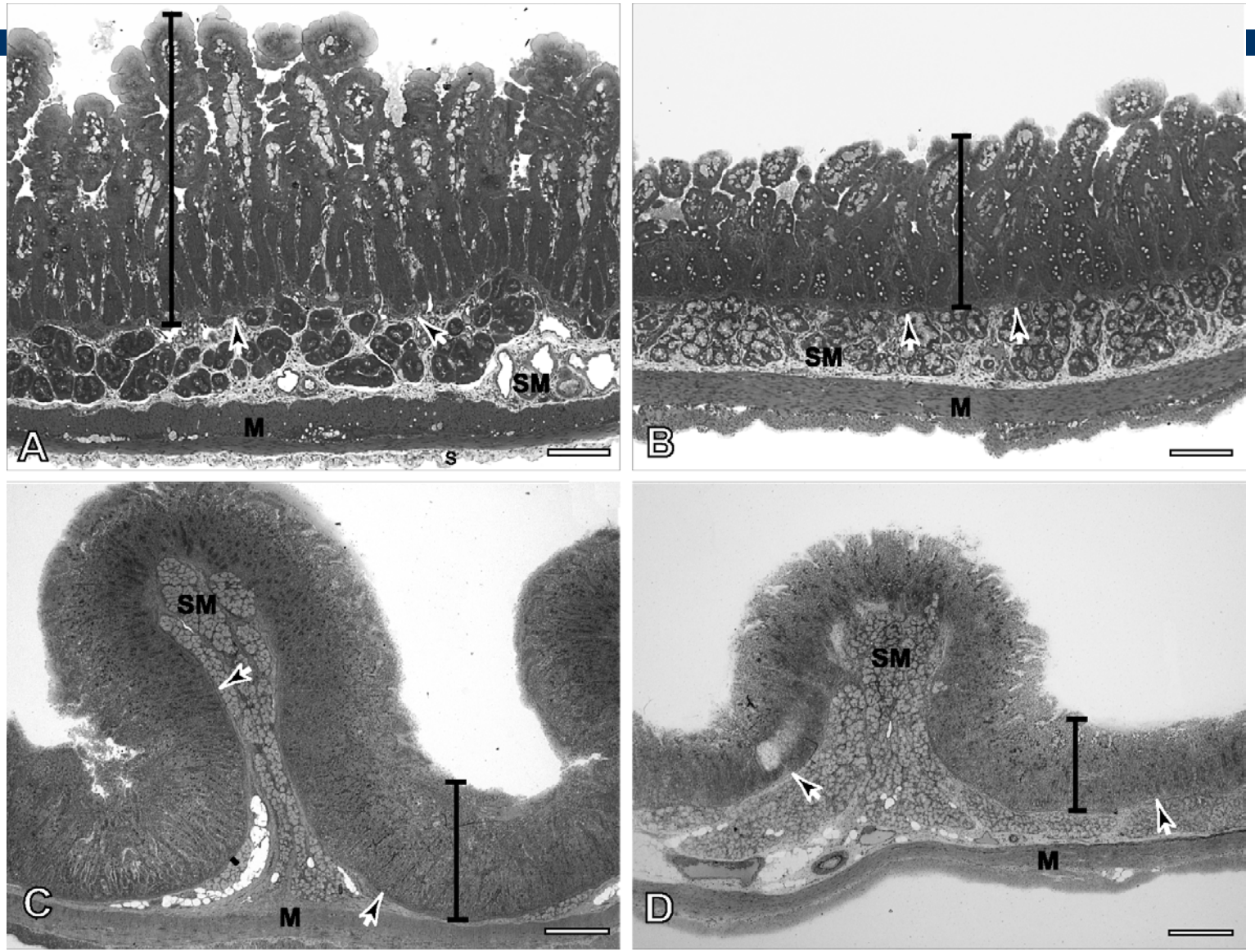
<u>Hypothesis</u>: Low average birth weight *<u>litters</u>* are a consequence of high ovulation rates, linked to early crowding of embryos *in utero* in early gestation and detrimental effects on placental development linked to IUGR later in gestation.

Evidence for early intra-uterine crowding and a wave of fetal losses by day 50



(From Patterson et al., 2008)

Effects of birth weight on duodenal mucosal height



150 days

birth

High BW

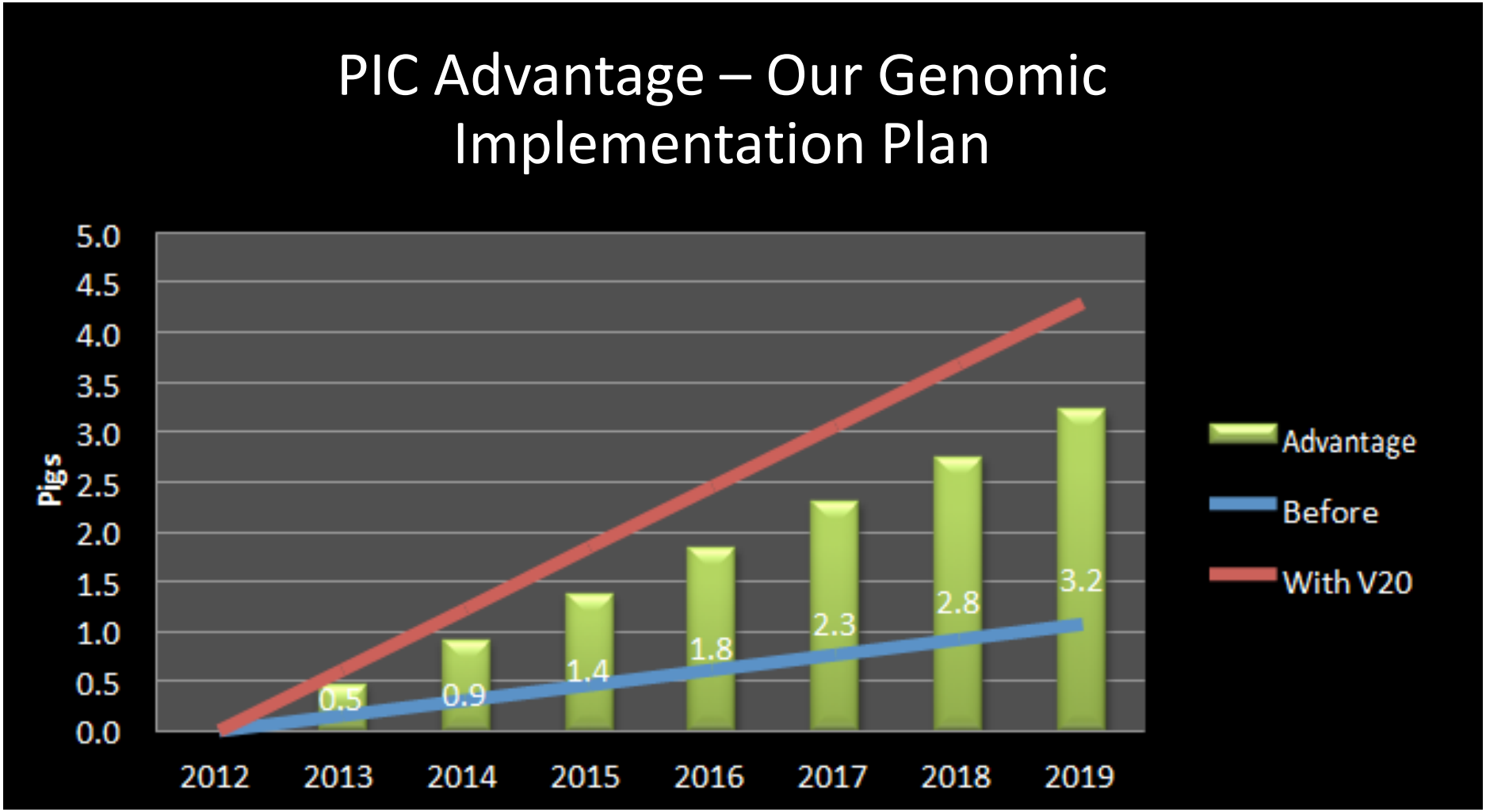
Low BW

(Alvarenga et al., 2012)

Complex G x E interactions affecting plasticity of litter phenotype will have an ongoing impact on variation in Total Feed Efficiency and need to be better understood.

Accelerating PIC Genetic Progress

Strategic Use of Genomics



(PIC newsletter, August 7, 2013)

Genetic trends

Trait	Genetic trend
Total number born #	0,380
Still born #	-0,190
Lactation litter mortality %	-1,340
Gestation length d	-0,090
Number of teats #	0,920
Birth weight kg	-0,060

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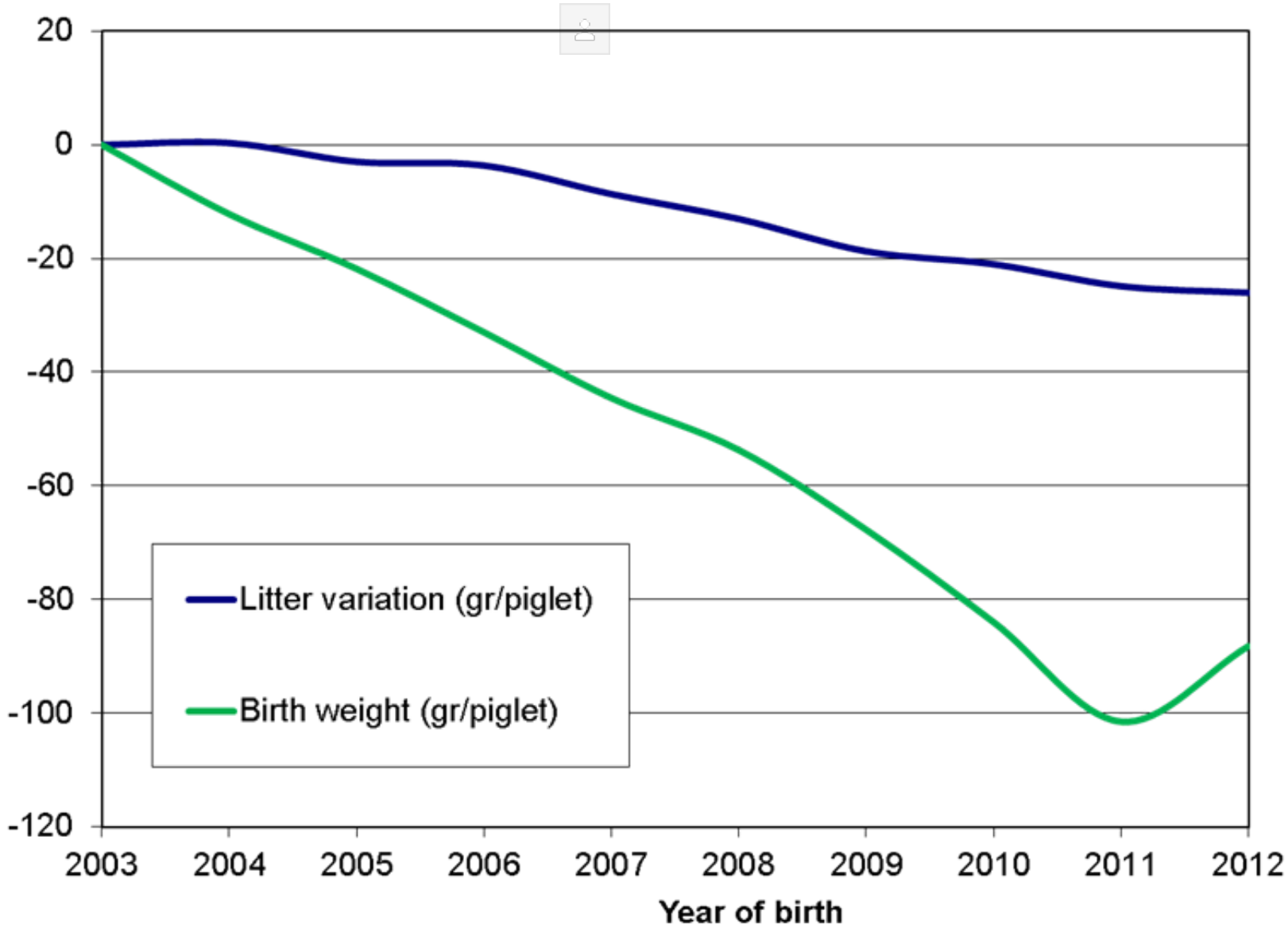
More recently, selection pressure has focussed more on measures of piglet quality *(live pigs born and survivability to weaning)* …..

…… interpreted as a better balance between selection for *ovulation rate* and *components of uterine capacity* (uterine and placental function)

Responses to selection for litter birth weight traits



(Knol, Topigs, personal communication, 2013)

Implications for management

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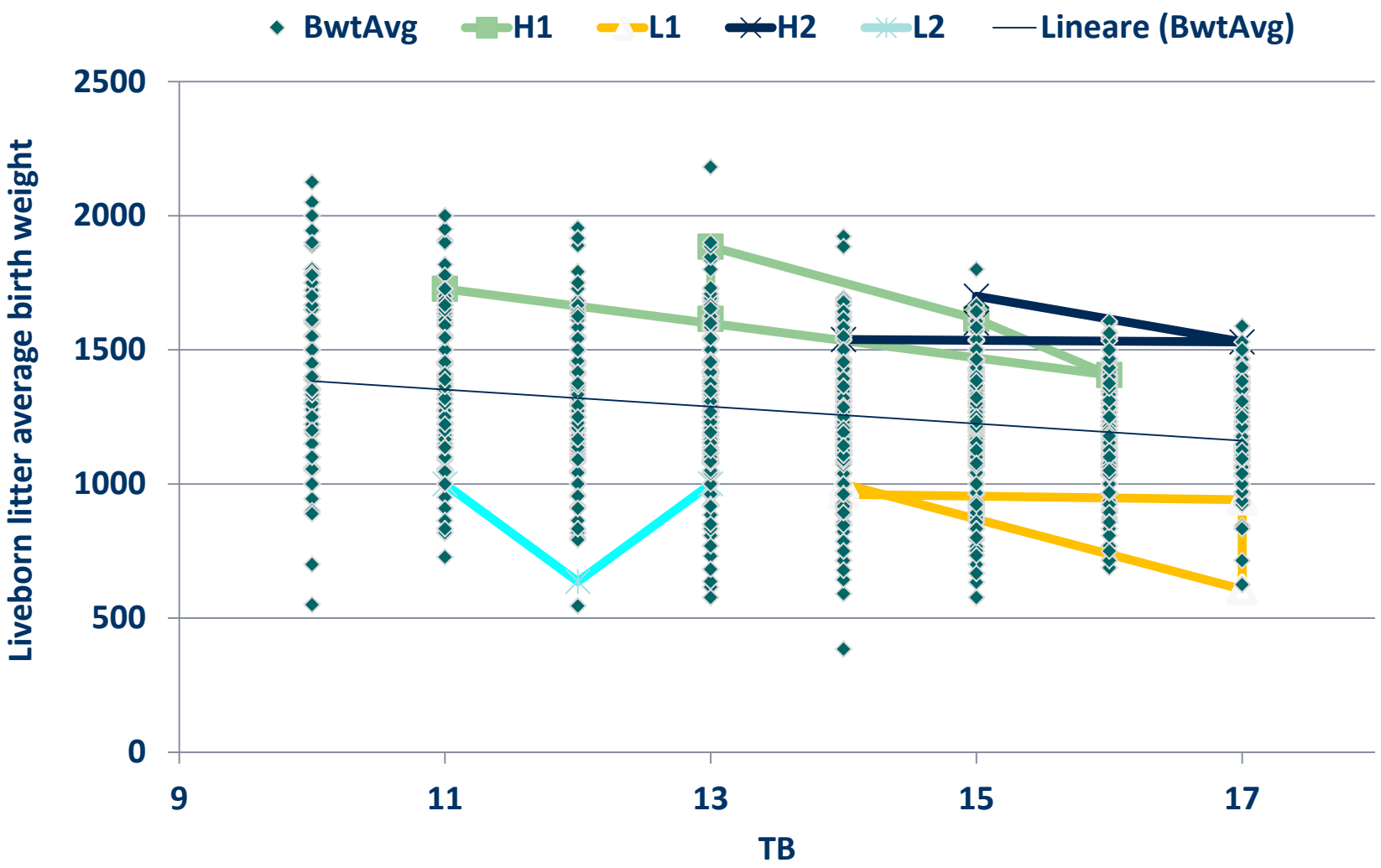
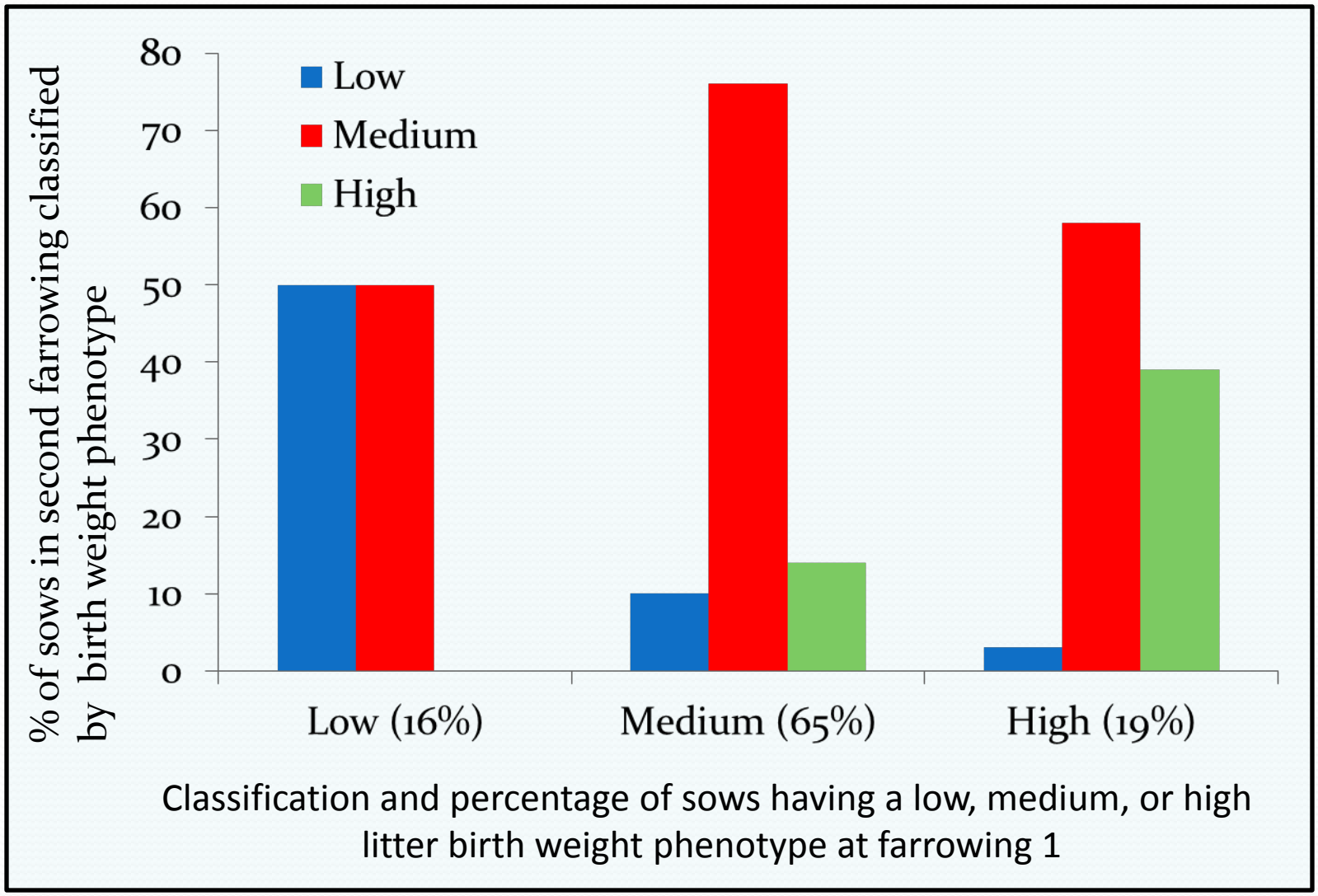
Usask / UofA / C-Pig study, 2010, preliminary data



Repeatability within sows

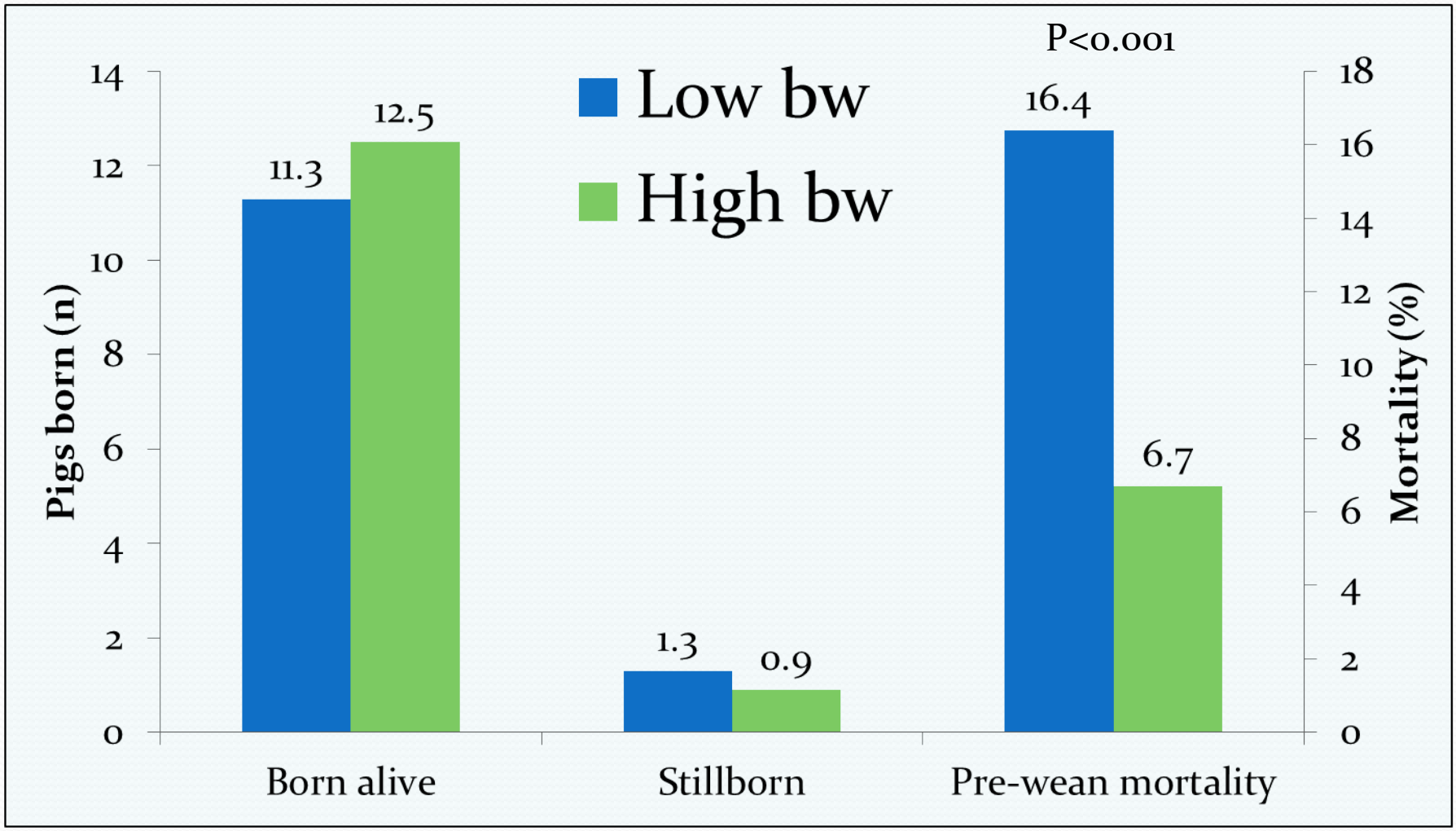


Classification and percentage of sows having a low, medium, or high litter birth weight phenotype at farrowing 1

As a Low Litter Birth Weight phenotype is repeatable ….

….. these sows/litters could be targeted for special management in sow herds

Pre-weaning performance



Effects of dextrose and L-arginine in sow diet on litter heterogeneity at birth

Hélène QUESNEL , Nathalie QUINIOU, Hervé ROY, Alexandra LOTTIN, Sylviane BOULOT, Florence GONDRET

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IFIP-Institut du Porc, Le Rheu, France
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Conclusions

- ✓ **L-arginine supplementation during the last third of pregnancy reduced variation of piglet birth weight within litter**

- ✓ **Combining L-arginine supply with a supply of dextrose before insemination provided no additional benefit**

➔ **The effect of L-arginine supply needs to be investigated on a large number of females.**

Effects of high fiber intake in late gestating sows on colostrum production and piglet performance

Florence LOISEL, Chantal FARMER, Peter RAMAEKERS, Hélène QUESNEL

INRA, UMR1348 PEGASE, Saint-Gilles, France
Nutreco R & D, Boxmeer, The Netherlands
Agriculture and Agri-Food Canada, Sherbrooke, Canada

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AGRO CAMPUS OUEST

Conclusion

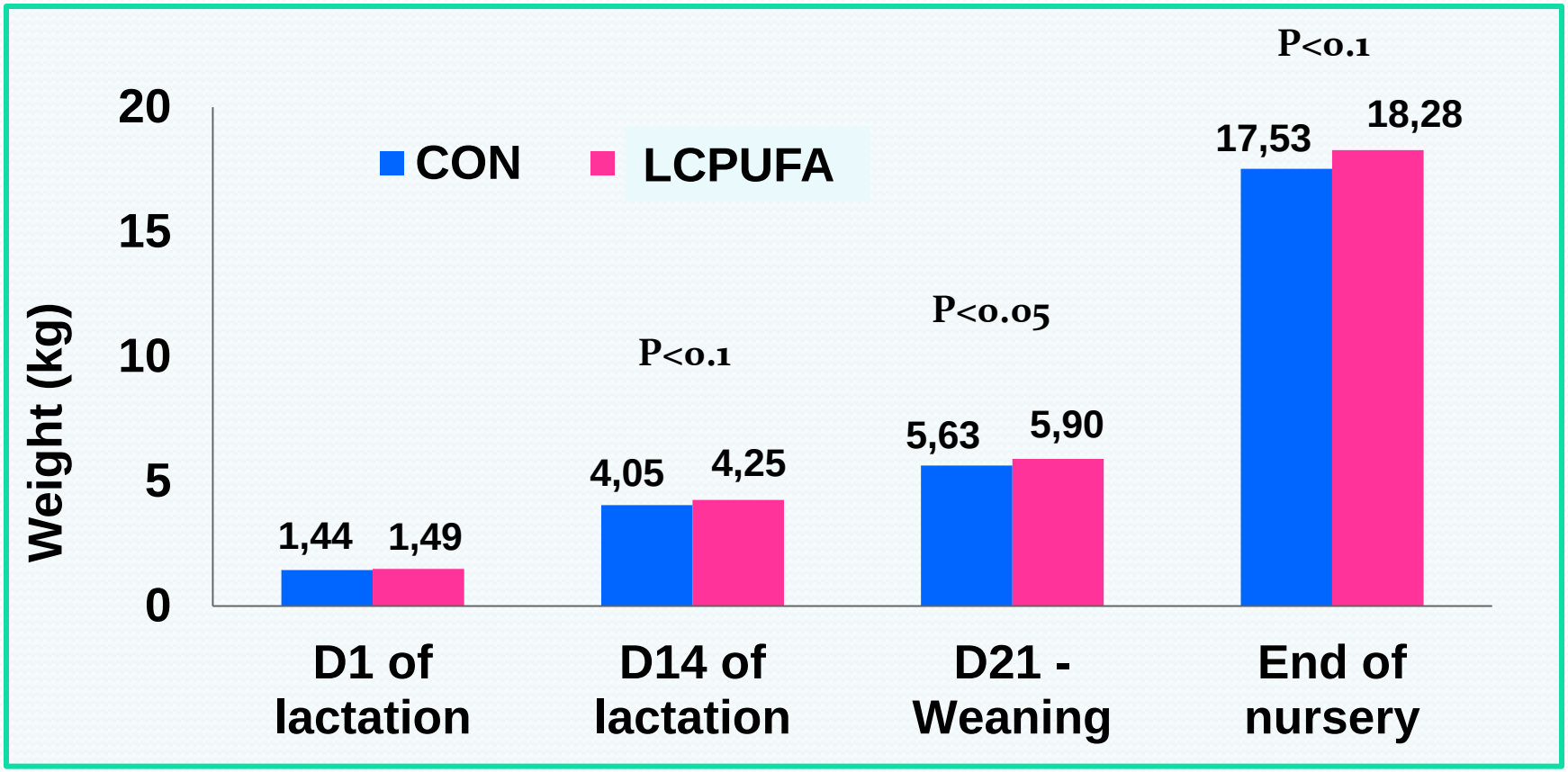
Increasing dietary fiber intake in late gestating sows

- **Did not influence colostrum yield or piglet weight gain during lactation**
- **Increased colostrum intake of low birth weight piglets**
- **Decreased piglet mortality during lactation**
- **Influenced colostrum composition**
- **These effects were not related to a change in progesterone and prolactin concentrations during the peripartum period**

Potential role of maternal behavior and piglet vitality at birth?

Effect of n-3 LCPUFA on piglet growth

- Feeding O3FA to gilts/sows during rebreeding, (parts of) gestation and lactation improved piglet growth after birth. (Rooke et al., 2001, Rooke et al., 2000; Mateo, 2007)



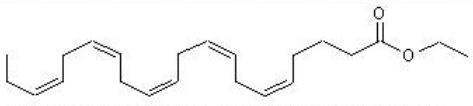
Materials and Methods

- Collaborative trial with JBS United
- Ranked sows at weaning based on average birth weight of past 3 litters
- Sows then pair-matched and fed diets with or without n-3 LCPUFA supplement during rebreeding, gestation and lactation

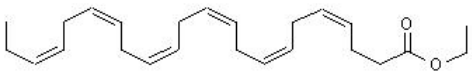
Conclusions

Maternal n-3 LCPUFA supplementation:

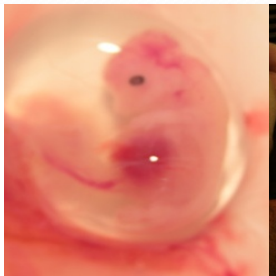
- **Increased n-3 LCPUFA supply to offspring pre-natally and post-natally**
- **Had lasting effects on litter development**
- **Did not improve growth performance and carcass quality of low birth weight litters**



EPA: ethyl ester of eicosapentanoic acid



DHA: ethyl ester of docosahexaenoic acid



Conclusion: It looks as if complex situations will need complex answers!

Thank you for your attention