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Prenatal mortality in pigs

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Content:

- Importance:
  - some quantitative data
- Mechanism:
  - global description
  - intra uterine crowding
- Factors affecting prenatal mortality:
  - Environmental factors affecting embryo and uterine quality and functioning :
    - **Nutrition !!!**
    - Other factors like Stress, Season, etc. will not be discussed
- Conclusions

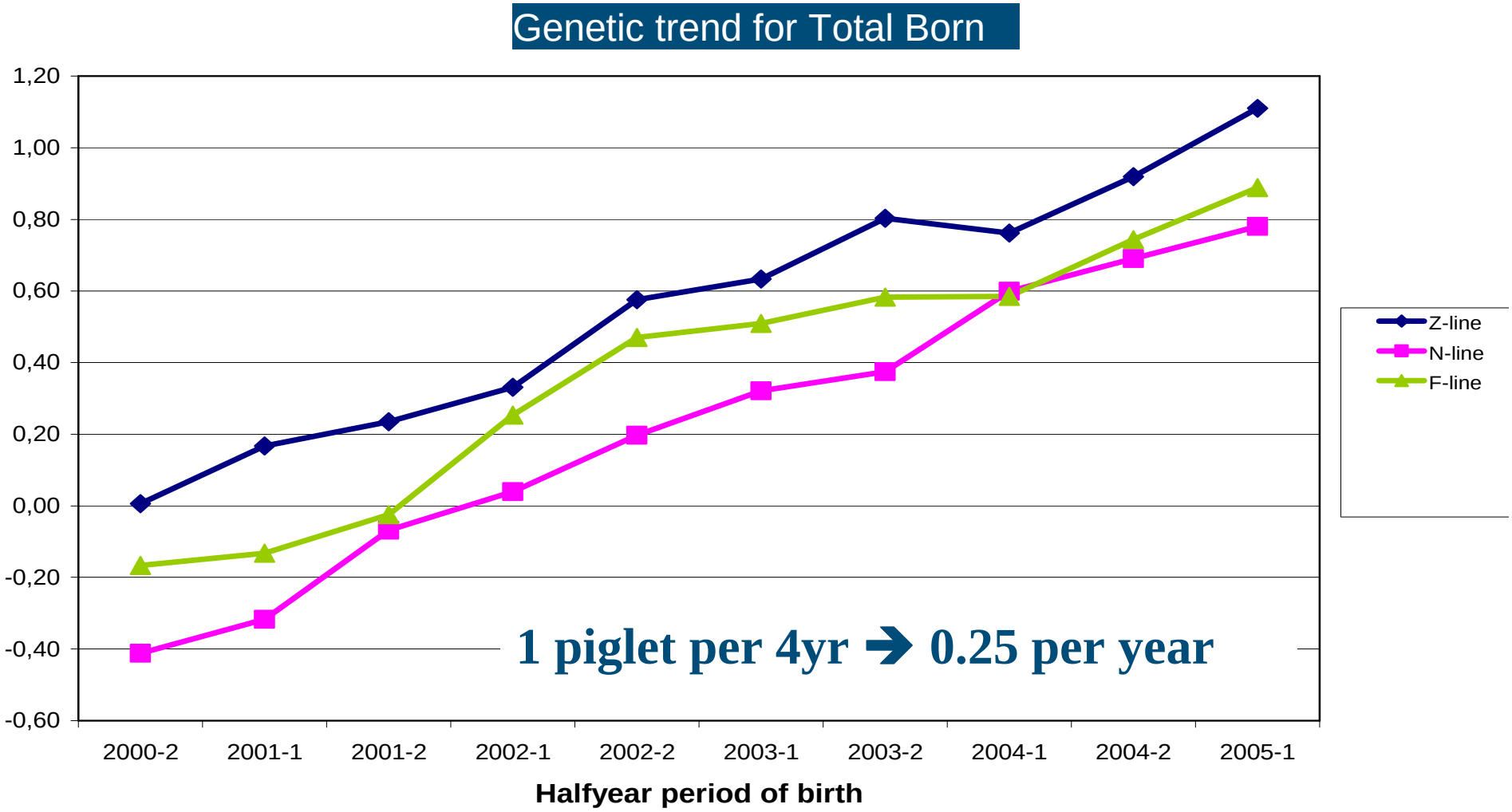
Selection for litter size

Year	farms (n)	farm size	pig/sow yr	born alive	born dead	total born	weaned
04/05	870	269	24.5	11.9	1.0	12.9	10.5
2004	1140	261	**24.2**	**11.8**	1.0	**12.8**	10.4
2003	883	260	23.8	11.6	1.0	12.6	10.3
2002	685	262	23.5	11.6	0.9	12.5	10.2
2001	563	23.9	23.0	11.3	0.9	12.2	10.0
2000	661	233	**23.0**	**11.2**	0.9	**12.1**	10.0
1999	751	224	22.8	11.2	0.9	12.1	10.0
1998	728	220	21.8	10.9	0.8	11.7	9.7
1997	542	199	22.2	10.9	0.8	11.7	9.6
1996	601	190	22.2	10.9	0.7	11.6	9.7
1995	665	185	**22.0**	**10.9**	0.7	**11.6**	9.6

NB In 04/05, farm size (27 to 1680 sows) does not affect total born

Kengetallenspiegel SIVA/Agrovision B.V. 1995-2005

Selection for litter size



From: Egbert Knol, IPG-Beuningen

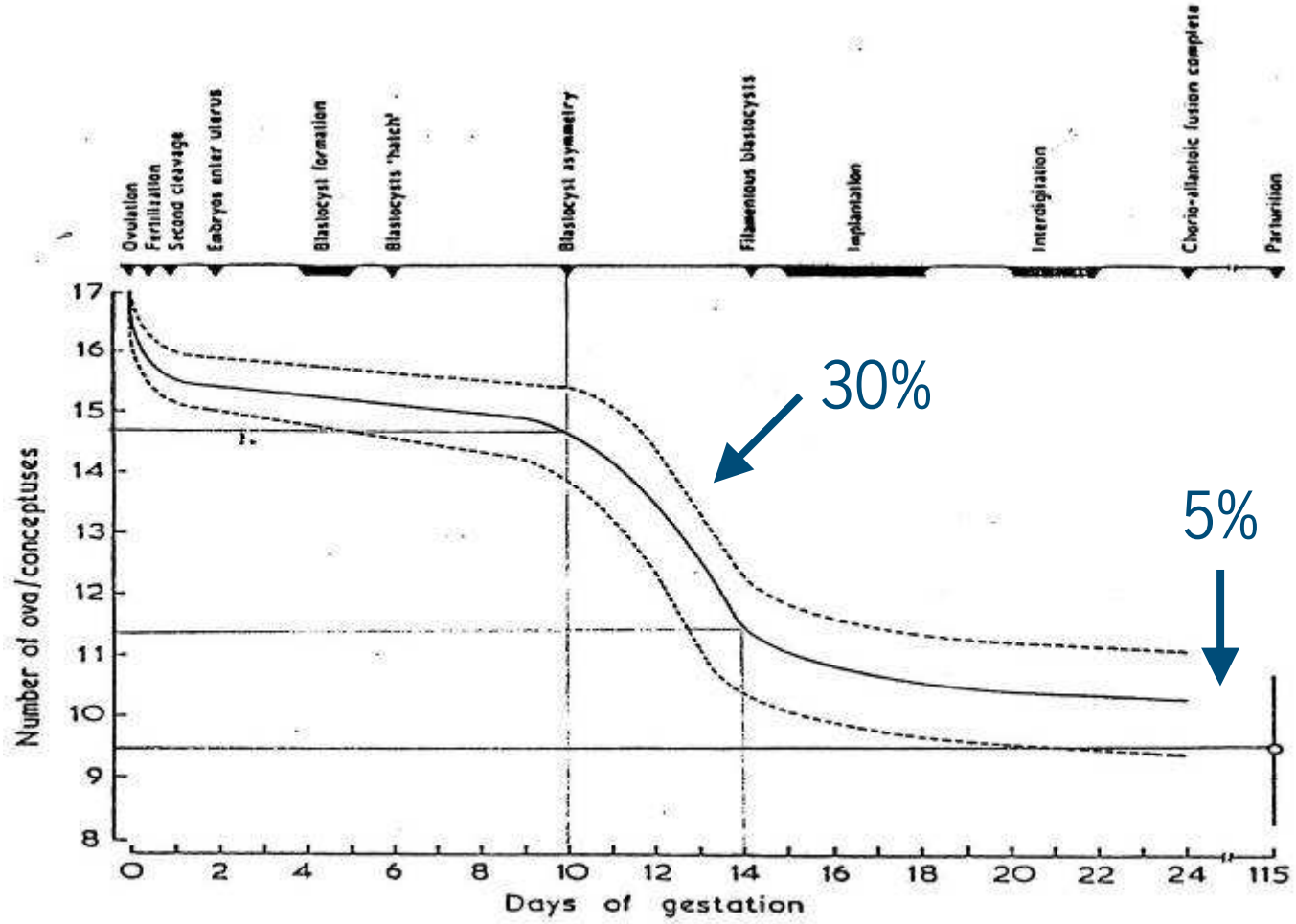
Ovulation rate and survival

	1954-1985	> 2000
Ovulation rate	13-15	20-30
Embryo survival	75-80%	60%
Embryo mortality (<D35)	**3**	**8-10**
Foetal survival	70-75%	50%
Foetal mortality (>D35)	**0-1**	**2-3**
Litter size	9-10	12-13

Conclusions on quantitative data:

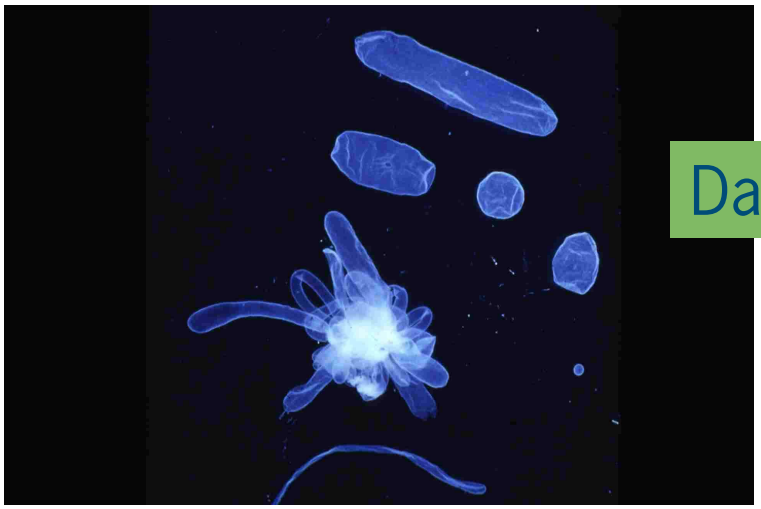
- Selection on litter size has resulted in very high ovulation rates
- Selection on litter size has resulted in a substantial increase in prenatal mortality

Mechanism and timing of prenatal mortality

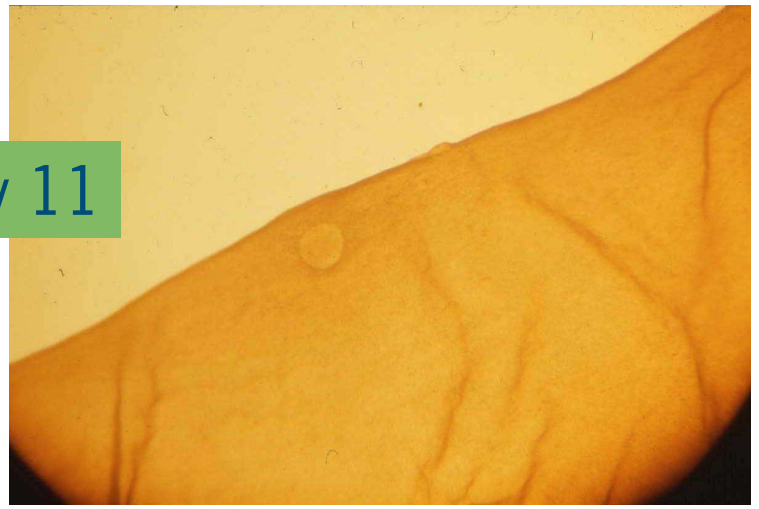


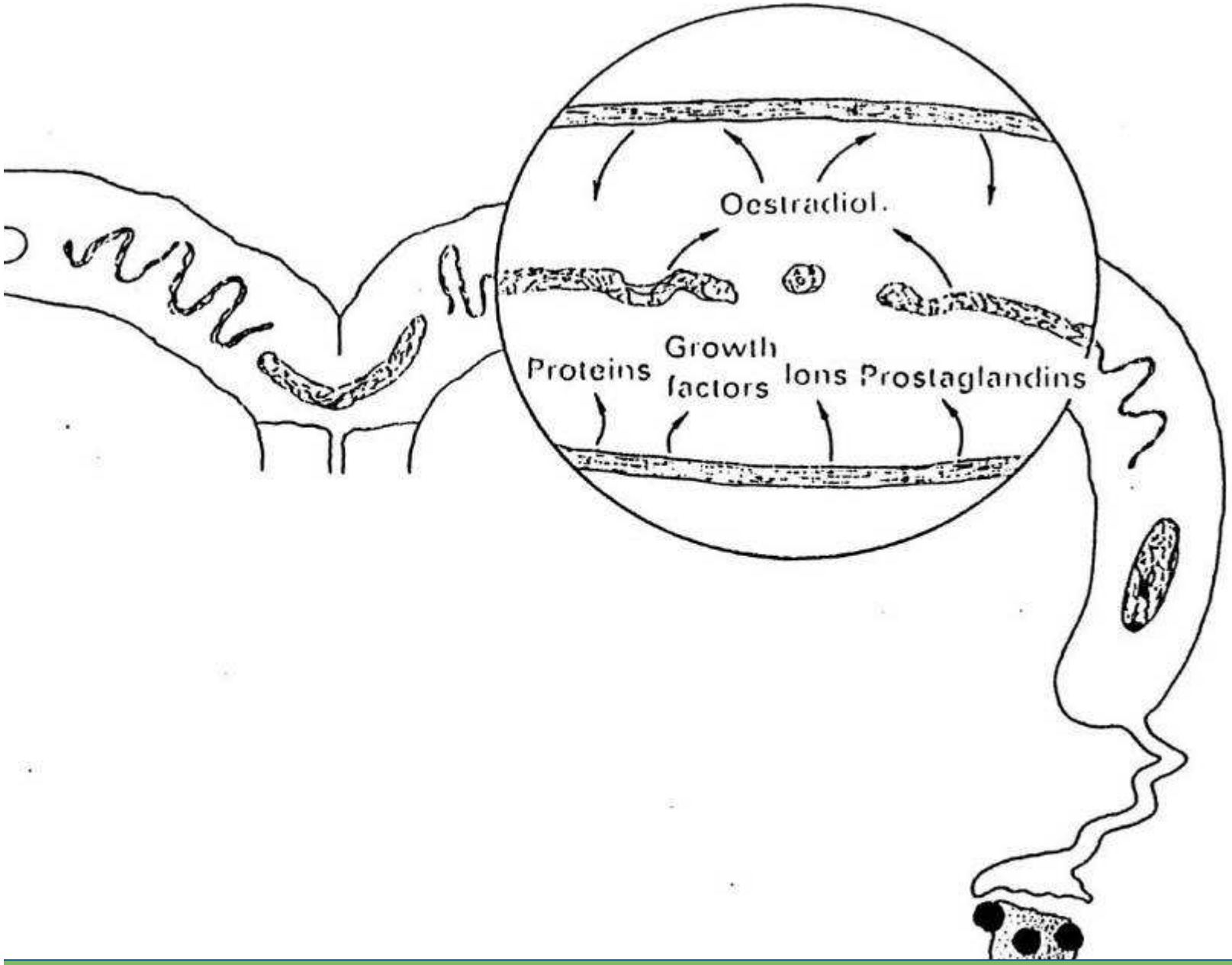
Stone 1985

Implantation and placentation



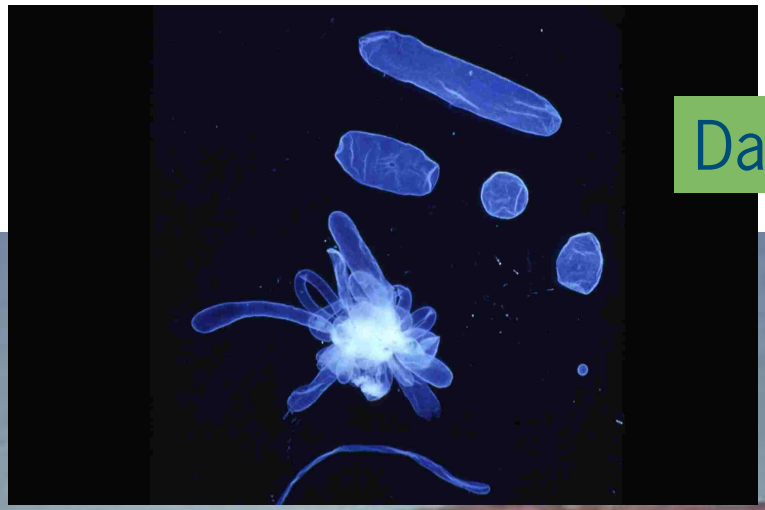
Day 11





Mechanism embryonic mortality (Day 12-15)

Implantation and placentation

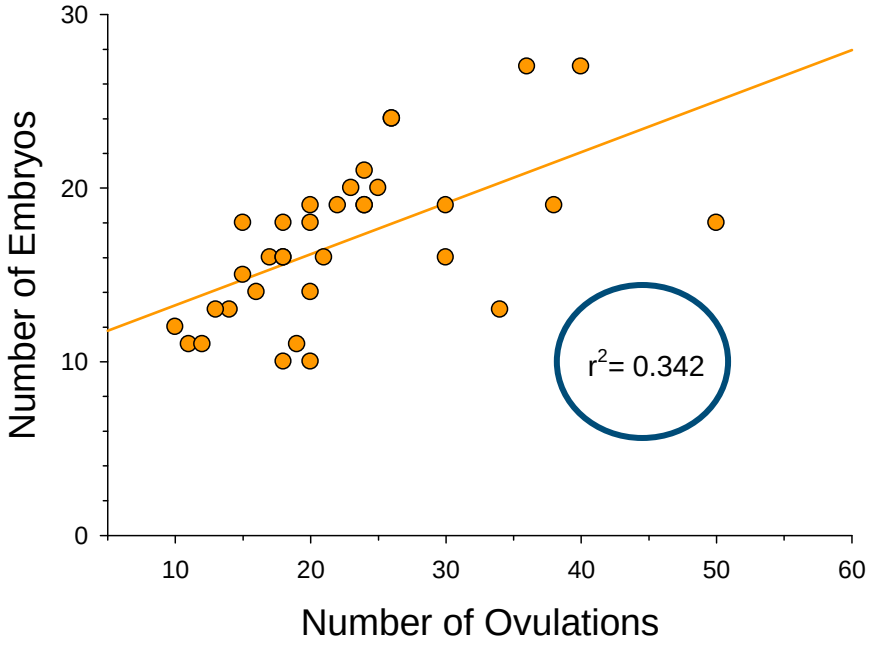


Day 11

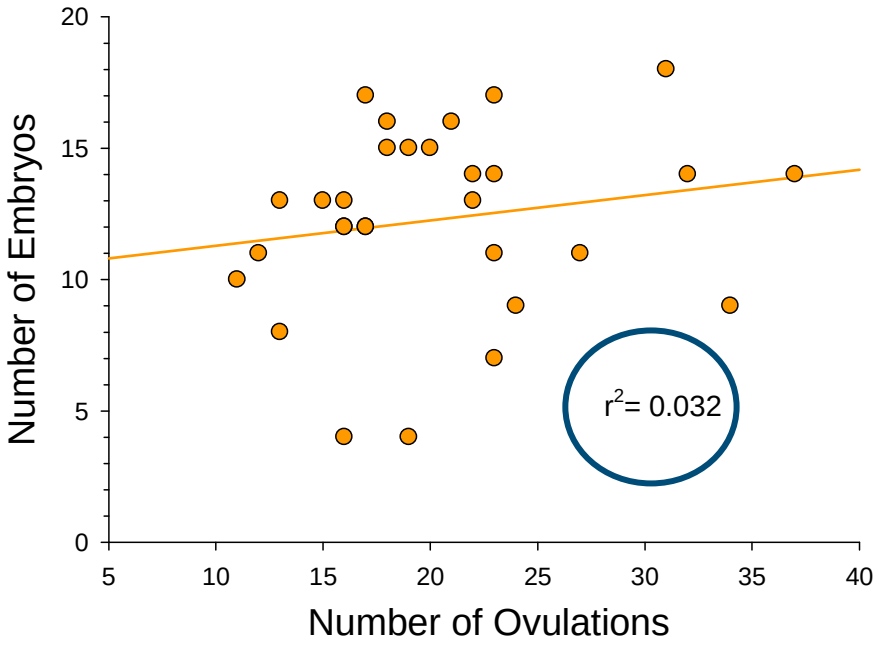
Implantation: d12 – d14

Day 35

Day 30 and Day 80: Correlation between ovulation rate and embryo/fetus number in German Landrace sows



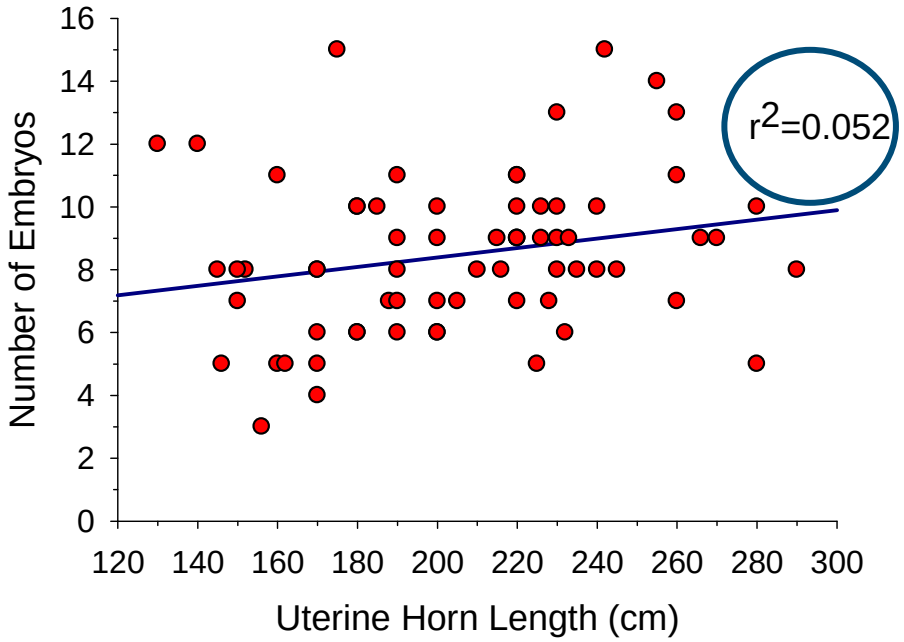
Day 30 of Pregnancy



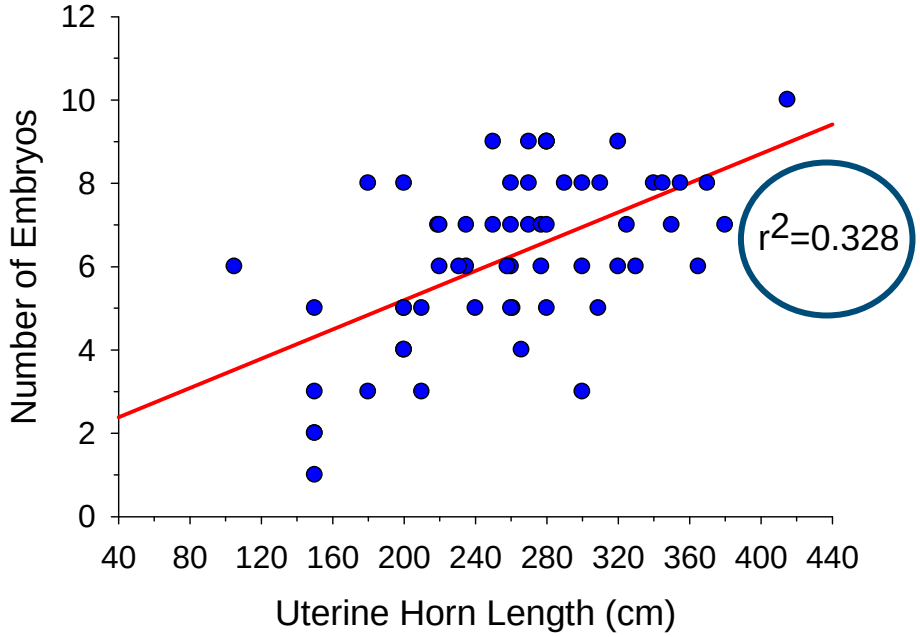
Day 80 of Pregnancy

(Brüssow & Wähner 2008)

Correlation between Uterine Length and Embryo Number in German Landrace Sows



Day 30 of Pregnancy



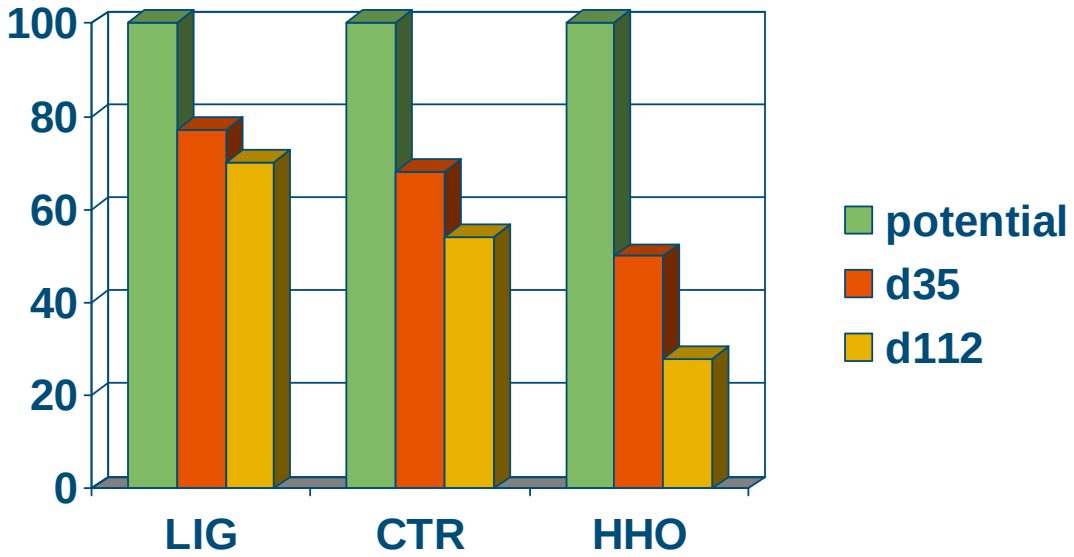
Day 80 of Pregnancy

(Brüssow & Wähner 2008)

Crowding → increased mortality

LIG; ligature around left oviduct at 38kg -> embryo number halved (**spacious**)
HHO: right hemi-hystero-ovariectomy at 38kg -> embryo number doubled (**crowded**)

embryo survival per horn



Foetal weight at D112:	1.50kg (LIG)a	1.38kg (CTR)b	1.27kg (HHO)b
Placental weight at D112:	0.31kg (LIG)a	0.32kg (CTR)a	0.27kg (HHO)b
Mummies at D112:	0.2 (LIG)	1.2 (CTR)	2.0 (HHO)

Pere et al., 1997

Embryonic mortality:

- Early embryonic mortality due to retarded development of embryos
- Late embryonic and fetal mortality due to variation in embryonic development and crowding

Consequences uterine crowding:

- Reduced placental size, reduced placental exchange surface (reduced functioning)
- Decreased survival (increase in mummified foetuses) and poor foetal development (IUGR)
- Low birth weight (IUGR); poor postnatal survival; poor muscle development

Nutritional factors affecting prenatal mortality

- Nutritional measures before pregnancy (optimize oocyt and embryo quality)
- Nutritional measures during pregnancy (optimize nutrient supply and quality of embryo/foetus)

Effects feeding level: hormone levels & oocyte maturation

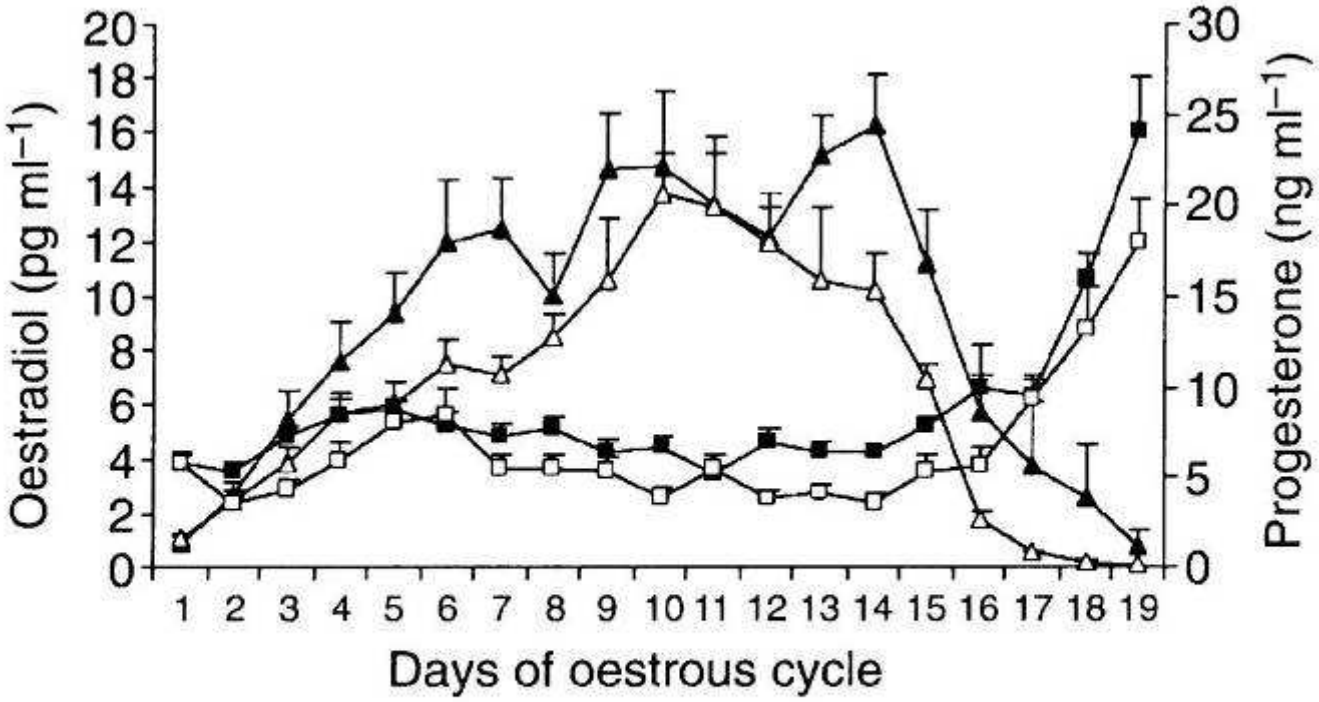


Fig. 4. Mean oestradiol (square symbols) and progesterone (triangles) concentrations throughout the oestrous cycle for gilts fed the maintenance (■, ▲ $n = 8$) and high (□, △, $n = 8$) diet.

Matured oocytes (% MII): Maintenance 68%; High 88%

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Ferguson et al. 2003

Follicle development and embryo survival: sugar beet pulp

	Control	**Fibre rich**
Day 19 cycle	(n=12)	(n=12)
Plasma oestrogenes (pg/ml)	28.4	7.15
Of the 15-16 largest follicles:		
Follicles >7mm (%)	38%	9%
Volume (ul)	109	63
MII (%)	**66%**	**76%**
Day 28 pregnancy	(n=10)	(n=7)
Ovulation rate	16.9	16.7
Vital embryos	12.4	14.7
Embryo survival (%)	**73%**	**91%**

Feed: (3rd cycle), 2.4 kg/day

Control: 2.4 kg, 15% cp, 9.7 MJ NE/kg

Fibre rich: 2.8 kg, 14% cp, 8.4 MJ NE/kg, **50% sugar beet pulp**

Ferguson et al., 2007

Postnatal consequences:

Dextrose before insemination affects birth weight variation

	Dextrose			
	yes	**No**	sem	P-value
farrowing%	88.2	88.3		
# litters	91	85		
Litter size (alive)	12.9	12.7	0.62	>0.25
Piglet weight				
mean	1.61	1.59	49	>0.25
CV	**17.5**	**21.2**	1.3	0.03
% <1000g	5.1	8.1		0.17
Piglet mortality	6.9	7.4		>0.25

Van den Brand et al., 2006

Nutrition before insemination:

Nutrition (level & composition) before insemination affects:

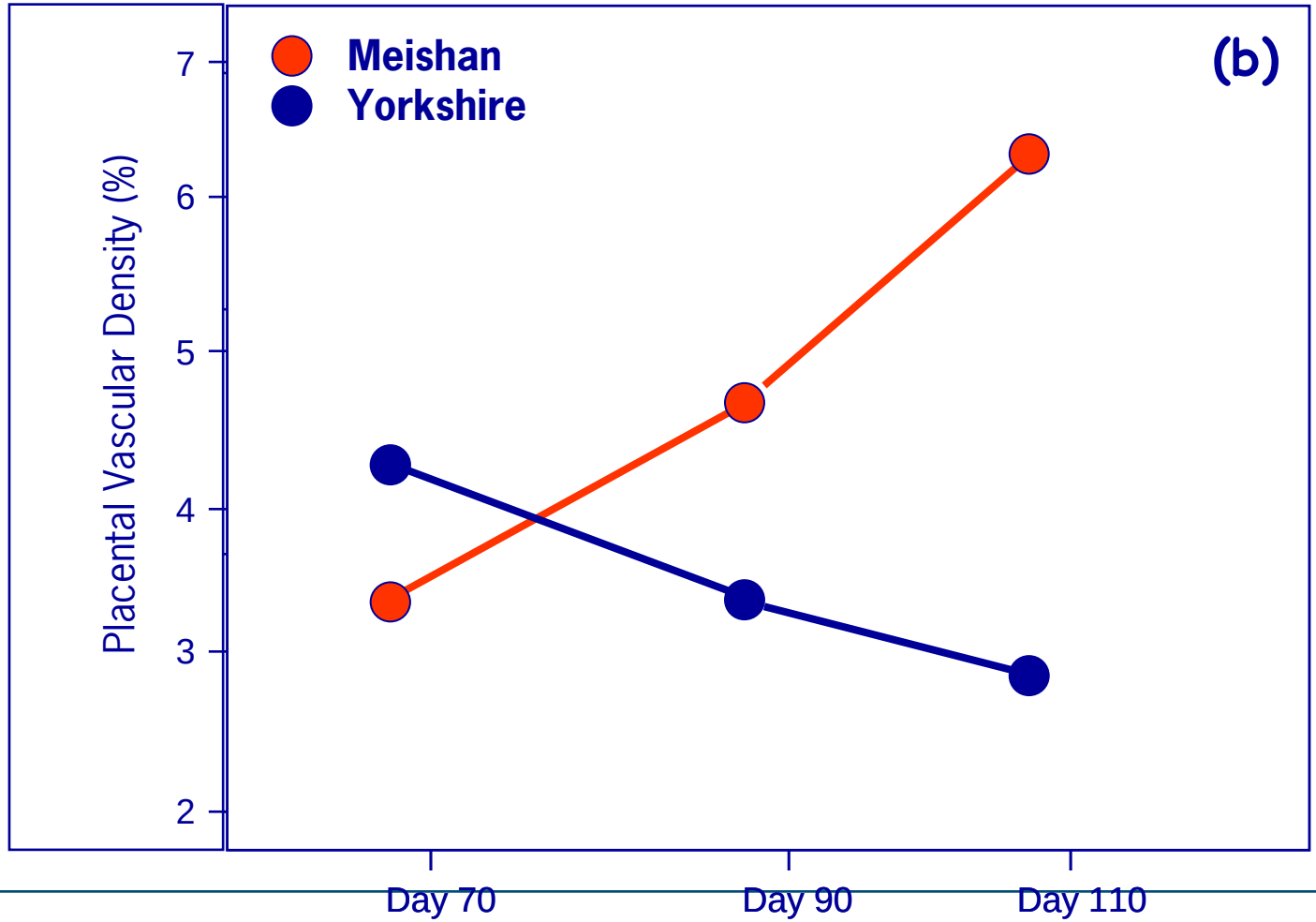
- Oocyte maturation
- Embryo survival
- Foetal development (birth weight CV)

Nutritional measures during pregnancy

(optimize nutrient supply and quality of embryo/foetus)

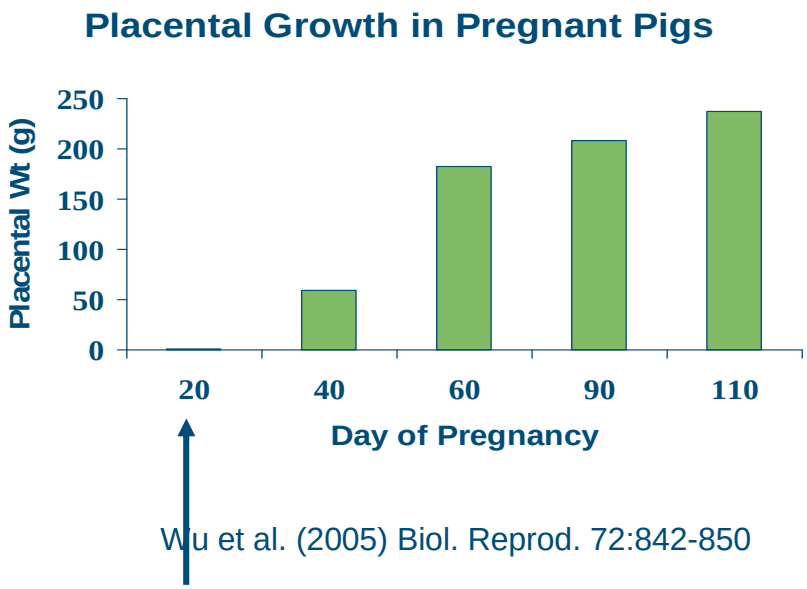
- **Consequences uterine crowding:**
  - **Reduced placental size, reduced placental exchange surface (reduced functioning)**
  - Decreased survival (increase in mummified foetuses) and poor foetal development (IUGR)
  - Low birth weight (IUGR); poor postnatal survival; poor muscle development
- **Nutritional measures to compensate negative effects of crowding?**

Effect of Conceptus Genotype on Placental Surface Area (a) and Placental Vascular Density (b) from Day 70 to 110 of Pregnancy

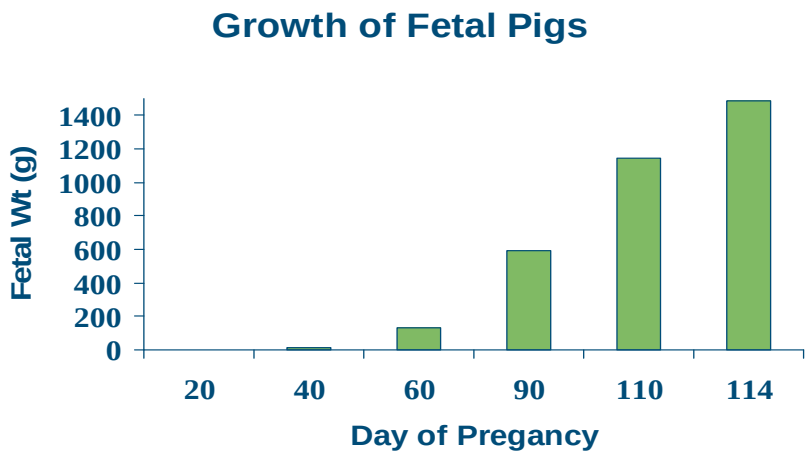


(Biensen et al. 1998)

Placental development preceeds fetal growth



Wu et al. (2005) Biol. Reprod. 72:842-850



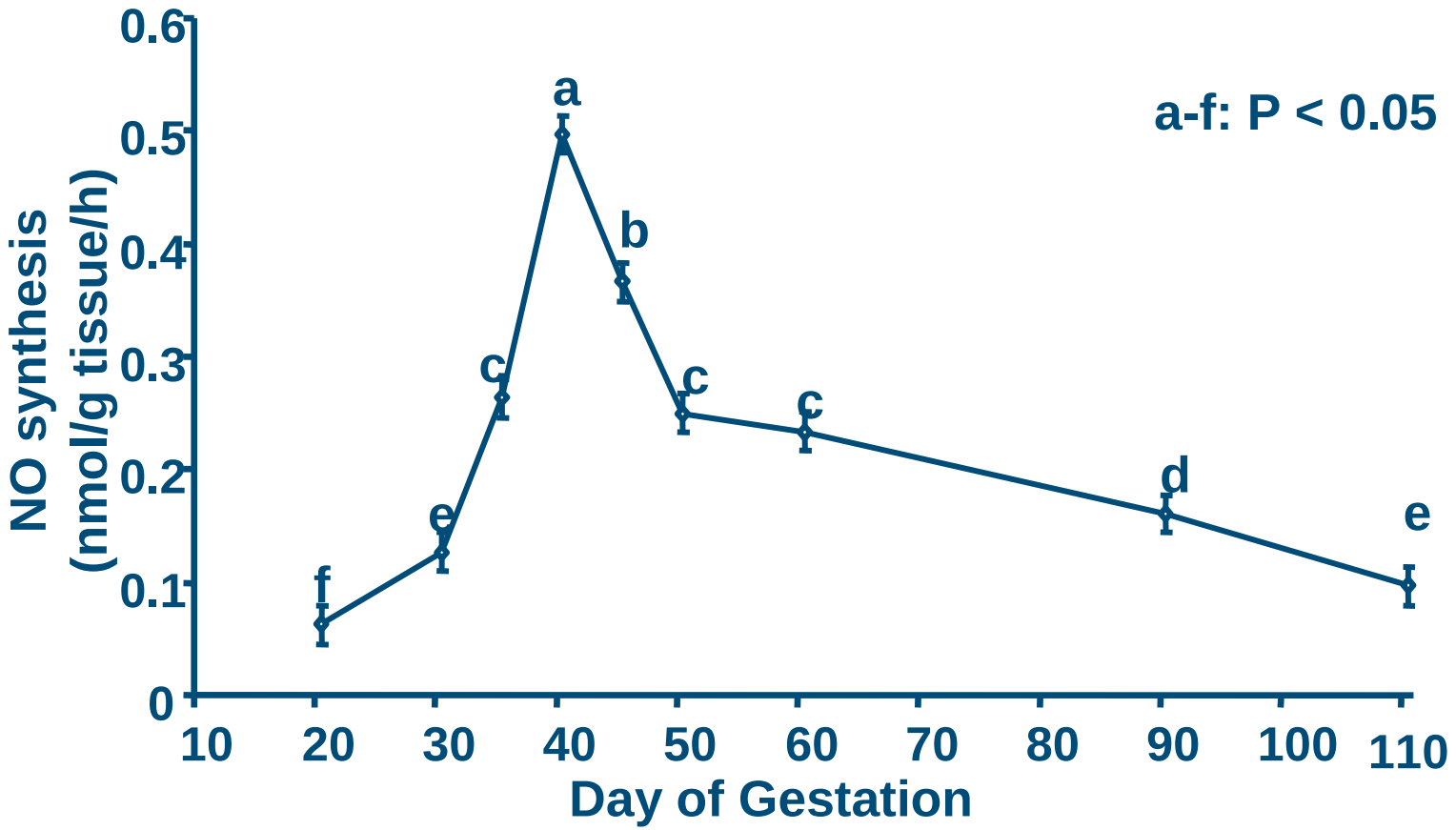
Wu et al. (1999) J. Nutr. 129:1031-1038

Start **vascularization** phase at d13 with VEGF as important growth factor
(Dantzer and Winter, 2001)

VEGF (+ many more factors) is stimulated by hypoxic situations

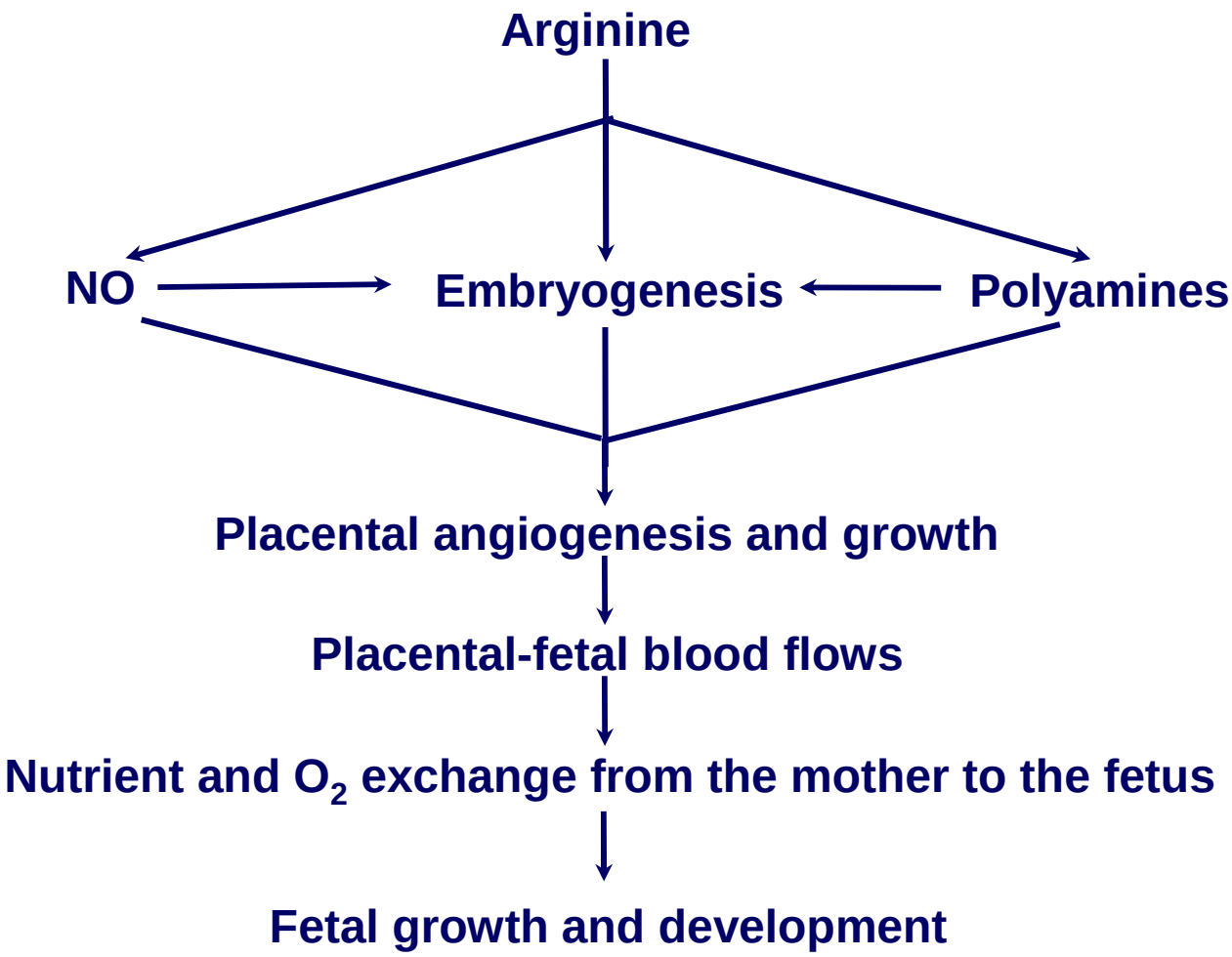
NO stimulates VEGF and vascularisation in hypoxic situations

NO synthesis in porcine placental tissue



Wu et al., 2005

The mode of action of L-Arginine:



Wu et al., 2004, 2006

Arginine treatment during pregnancy

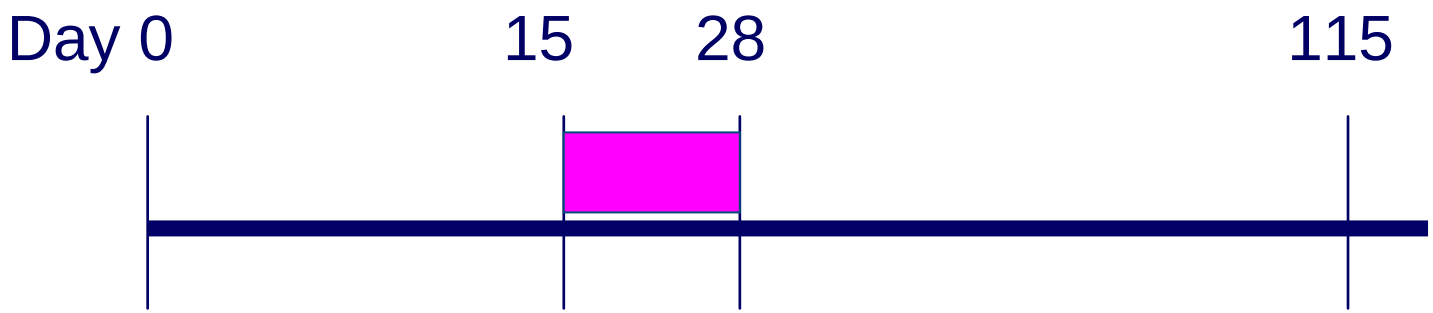
Two initial experiments on commercial farms (Ramaekers et al 2006)

Objective: The effect of Progenos (L-Arginine) supplementation on litter size

3rd experiment at Wageningen University (Hazeleger et al 2007)

Objective: Effect of Progenons (L-Arginine) supplementation on placental and fetal development and survival

EXPERIMENTAL DESIGN



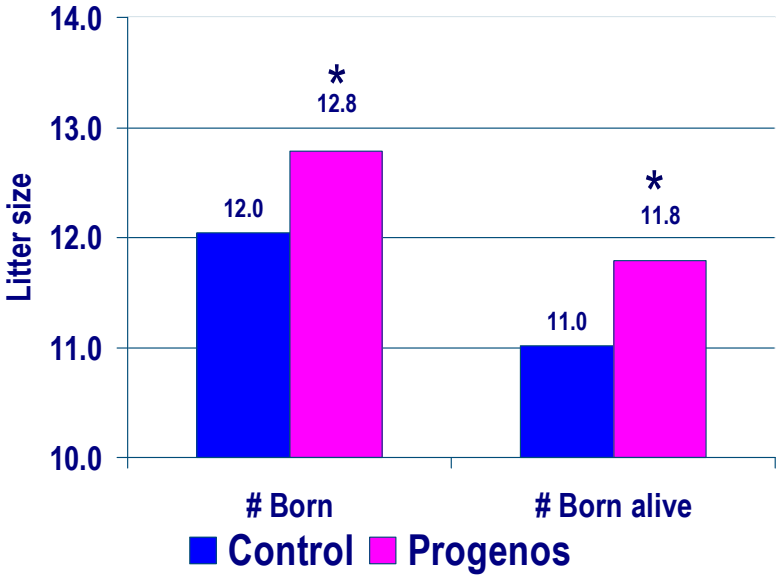
Progenos
or Control
Supplement

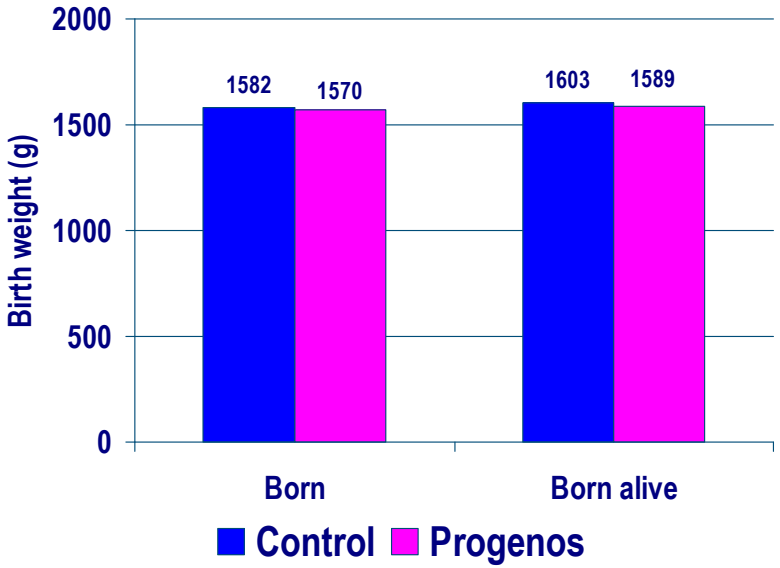
Progenos with 25% L-Arginine

Daily intake 25 g L-Arginine

Ramaekers et. al., 2006

Arg. D15-28; Experiment 1,
Litter size and birthweight



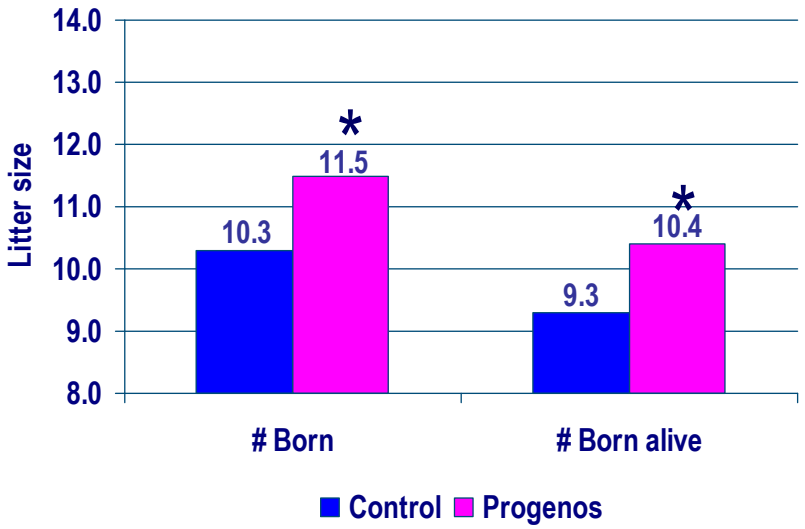


*** P<0.05**

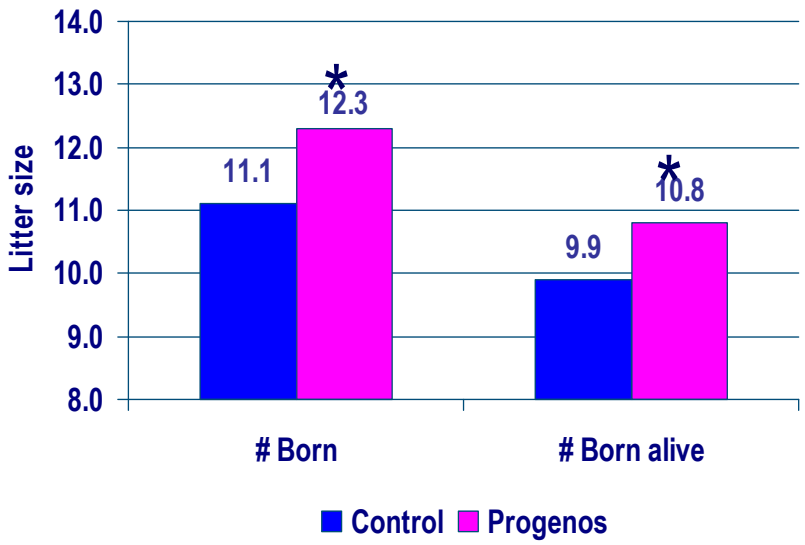
Ramaekers et. al., 2006

Arg. D15-28; Experiment 2, Litter Size

Primiparous sows



Muliti parous sows

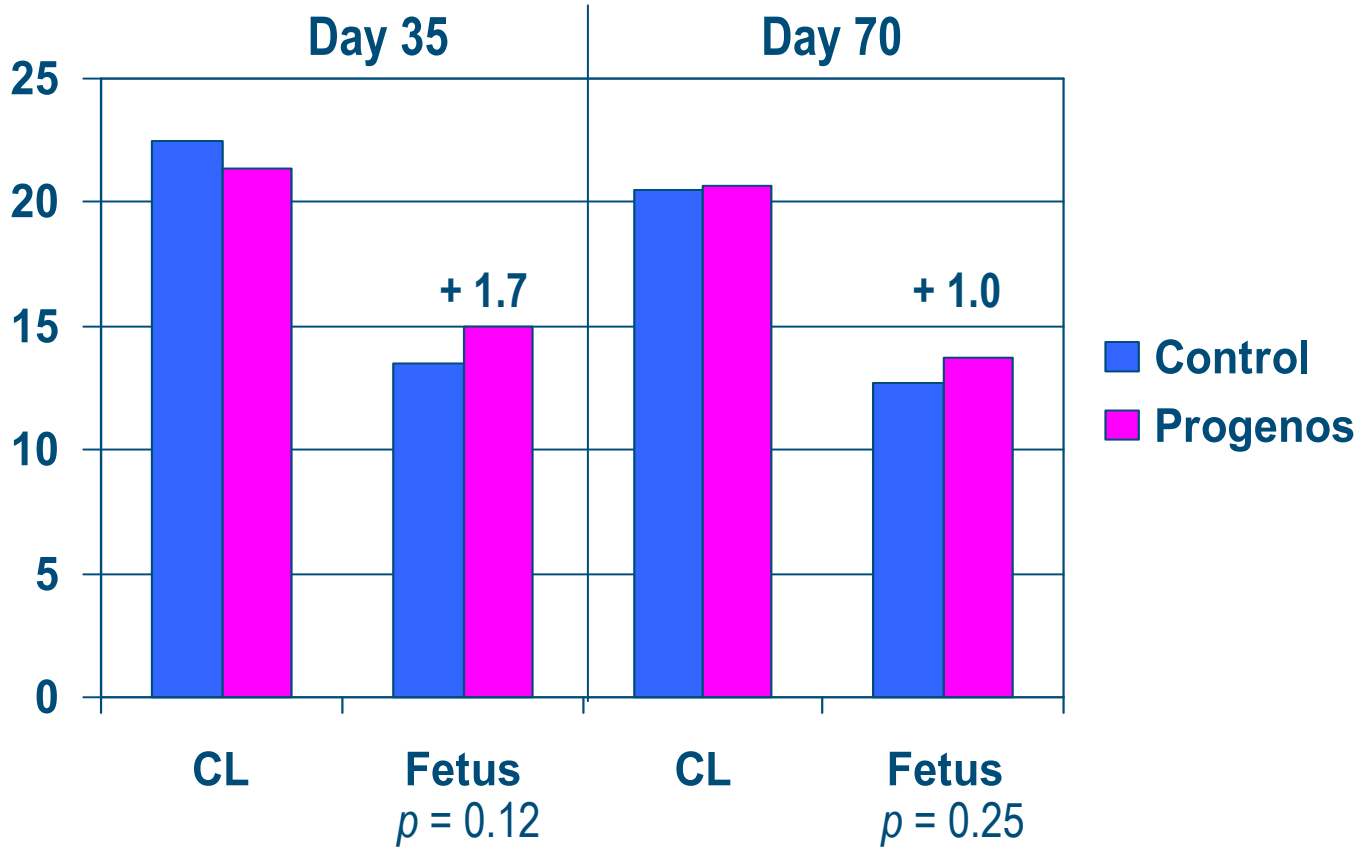


*** P<0.05**

Ramaekers et. al., 2006

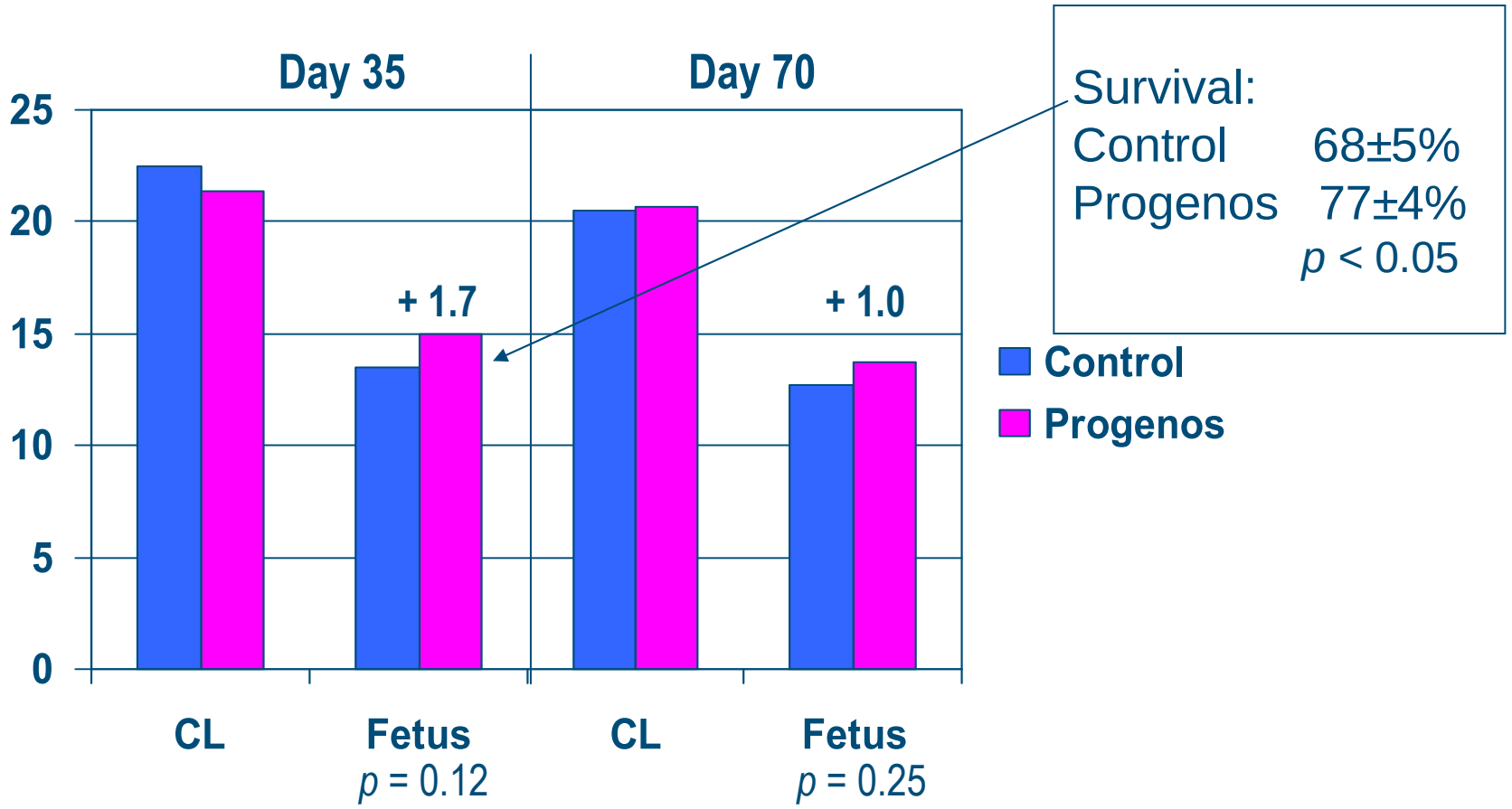
Arg. D15-28; Experiment 3:

Nr of CL and vital fetuses at D35 and D70



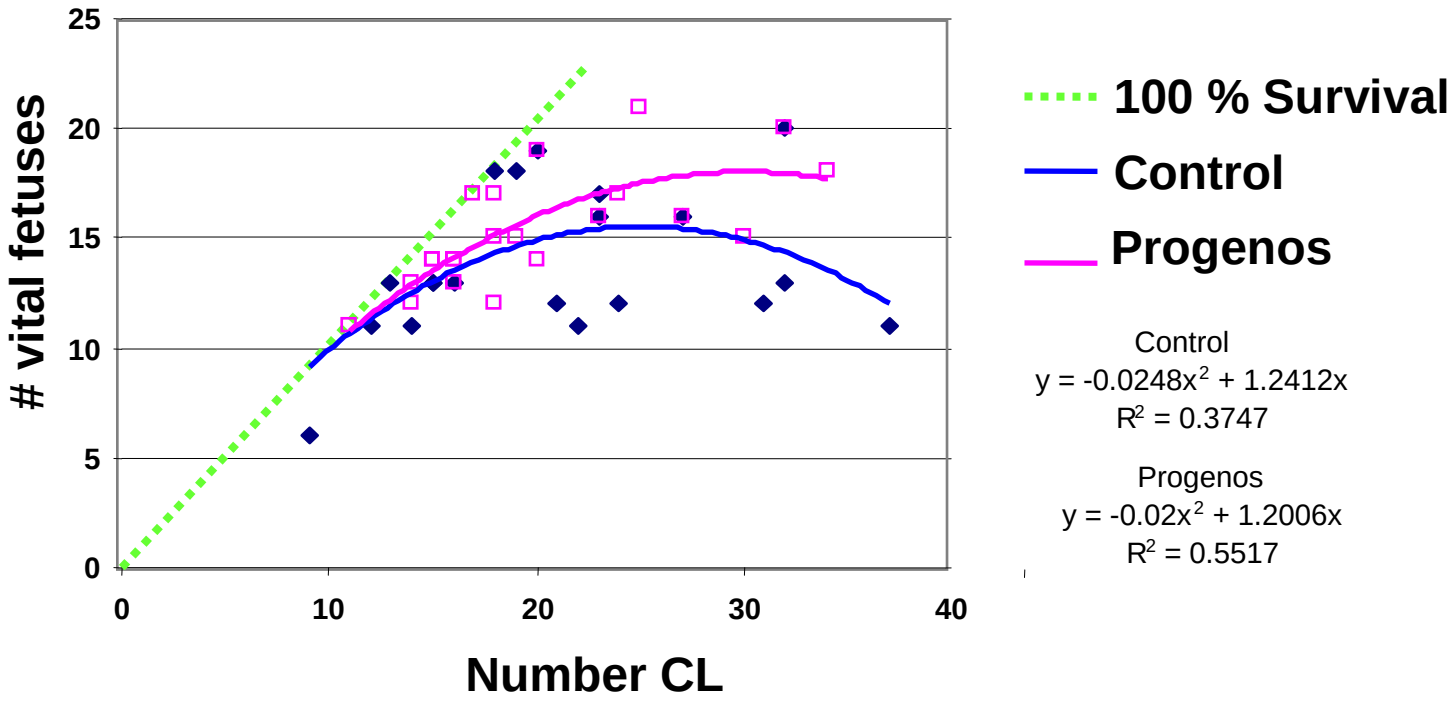
Hazeleger et. al., 2007

Arg. D15-28; Exp.3: nr of CL and vital fetuses at D35 and D70



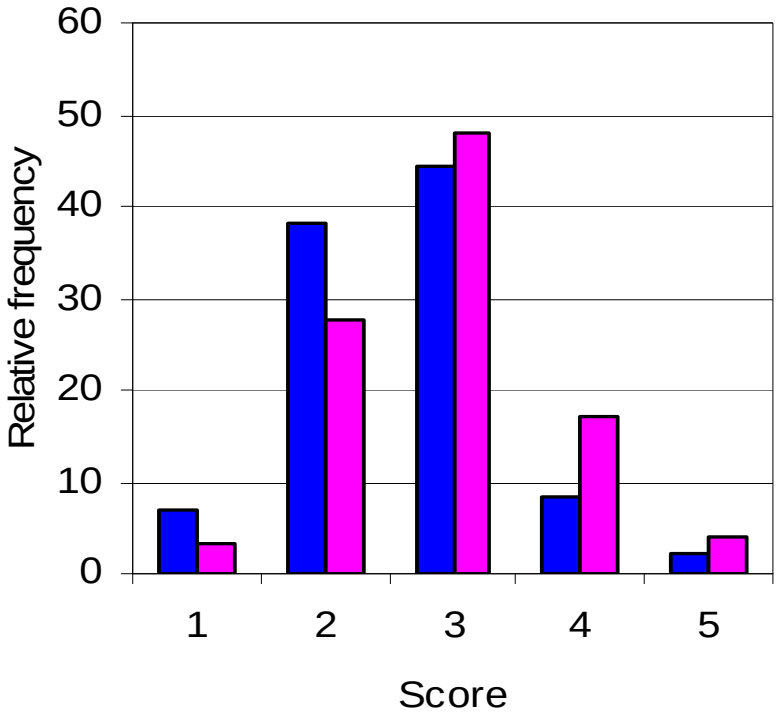
Hazeleger et. al., 2007

Arg. D15-28; Relation # CL and vital fetuses D35



Hazeleger et. al., 2007

Arg. D15-28, Exp.3; D35 Blood vessel score (placenta tip)

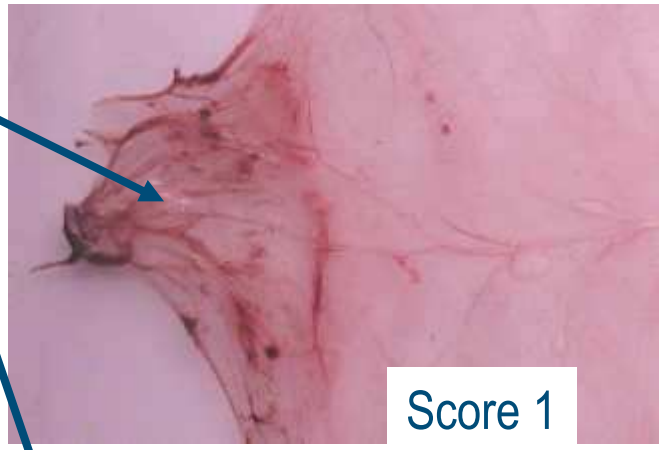


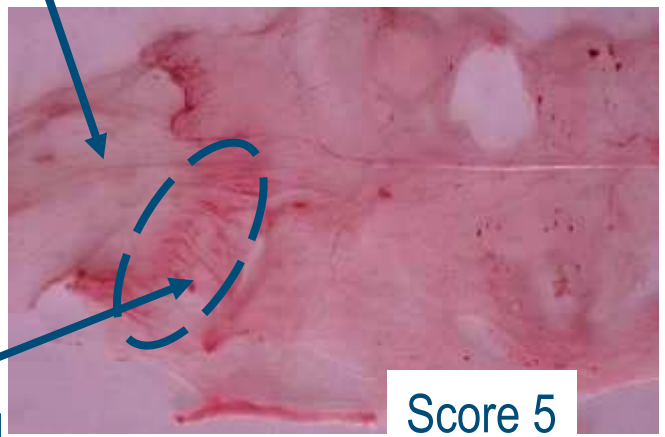
Control

Progenos

$p < 0.01$

Necrotic tip





Blood vessels

Hazeleger et. al., 2007

Arg. D15-28, Exp. 3: Summary D35 parameters

	Control (n=21)	Progenos (n=23)
Fetal survival	**.68 ± .05** [a]	**.77 ± .04** [b]
Fetal weight (g)	4.6 ± .2	4.7 ± .2
Fetal length (cm)	4.2 ± .1	4.2 ± .1
Placental weight (g)	30 ± 2	32 ± 2
Placental length (cm)	36 ± 2	37 ± 1
Vascularisation score	**2.6 ± .08** [a]	**2.9 ± .08** [b]
Placental color a	**4.1 ± .2** [a]	**5.3 ± .3** [b]
Placental color b	**8.1 ± .2** [a]	**8.8 ± .1** [b]

[a, b] $p<0.05$

Hazeleger et. al., 2007

Arg. D15-28; Conclusions:

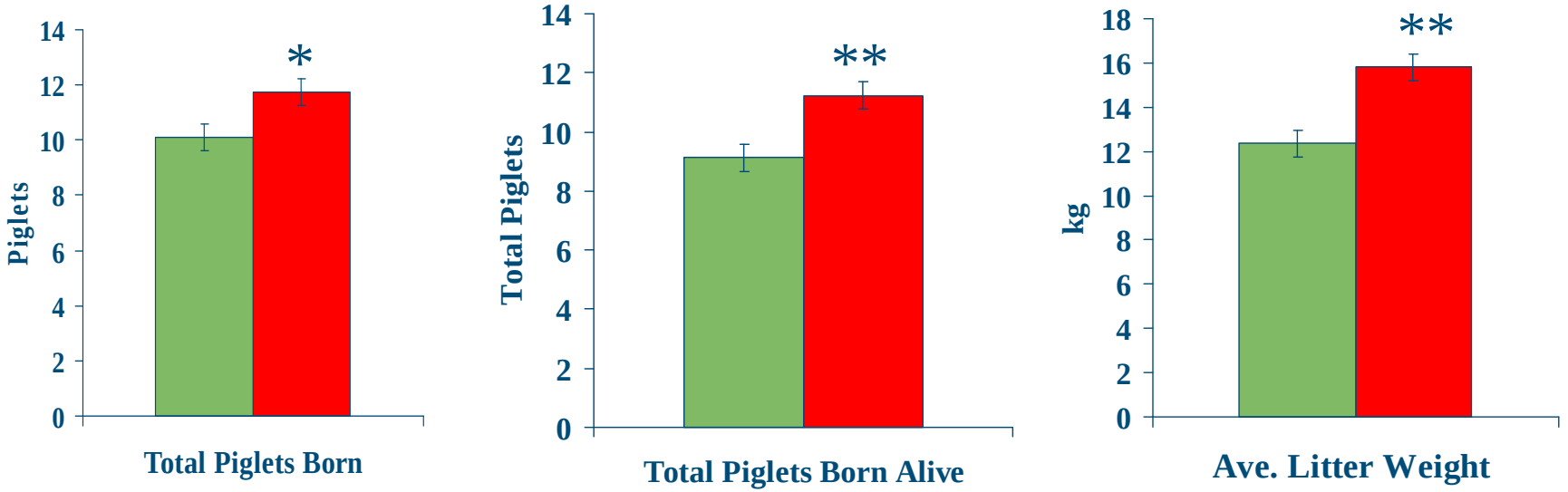
- Changes in placental parameters seem indicative for improved placental function (vascularisation) at Day 35 in gilts fed Progenos from day 16 to 28 of gestation.
- Progenos supplementation improved fetal survival at Day 35 of gestation.
  - This effect was more pronounced in gilts with a high ovulation rate
- No effect of Progenos on fetal development (D 70).

Hazeleger et. al., 2007

Arg. D30-114; Supplementation to gilts

* P = 0.10
* * P<0.03

Alanine Arginine



Gilts (n = 53) were fed a corn- and soybean meal-based diet supplemented with 1% L-arginine or isonitrogenous L-alanine between Days 30 and 114 of gestation.

Mateo et al, 2006

Conclusions Arginine:

- In early gestation (D15-28)
  - Increasing placental functionality
  - Increasing embryonic survival (in crowded situations)
  - Increasing litter size
  - No decrease in birth weight
  - Increasing litter weight
- During fetal development (D30 - parturition)
  - Increasing litter size
  - No decrease in birth weight
  - Increasing litter weight

Effects of some other functional nutrients

- **Folate and vit B12**

  Promotes implantation of embryos (+ 1 piglet).

  (Matte et al., 2006; Lindeman et al 1993).

- **L-carnitine**
  - Alters **IGF** system (D60-D90) which affects **placental development** and may affect fetal growth and development (Waylan et al., 2005, Brown, 2006, Doberenz et al., 2006).

Conclusions nutritional measures during pregnancy:

- In crowded situations L-Arginine improves embryonic survival, probably by stimulating placental functioning
- Nutritional components like Folic acid, Vit. B12 may have a positive effect on embryonic and placental development.
- Post-partum piglet performance may be enhanced by nutritional measures during pregnancy

Take home messages:

- Embryonic quality, diversity and survival can be affected by nutritional measures before fertilization
- Crowding is a major problem in modern breeds, compromising placental and foetal development and survival
- Nutritional measures can be developed to enhance placental functioning and embryonic and foetal survival
  - (further optimalisation is needed)
- Spin off: postnatal performance can be increased by these measures

Thanks for your attention !

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