

Effects of high temperatures on the reproductive physiology the sow

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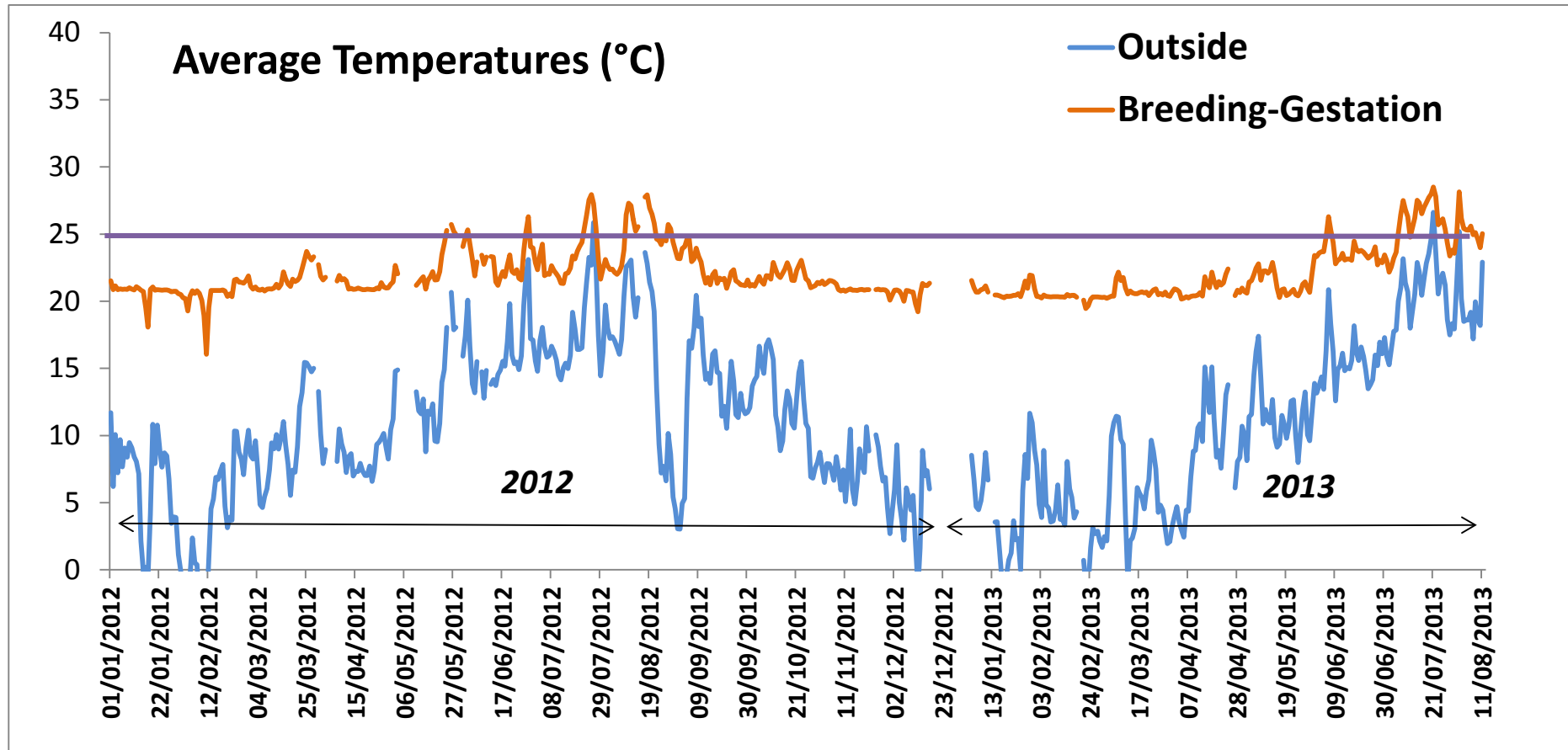
ANNUAL MEETING
OF THE EUROPEAN FEDERATION OF ANIMAL SCIENCE



- Concern about impact of **High Temperatures** on pig production-reproduction
- Heat exposure **is severe** in many areas where pig production is important or ↗ :
 - Mediterranean, Continental
 - Tropical : High T° + High Relative Humidity
- Heat Stress + Seasonal infertility : frequent even **in mild climates** and modern pig housings ...



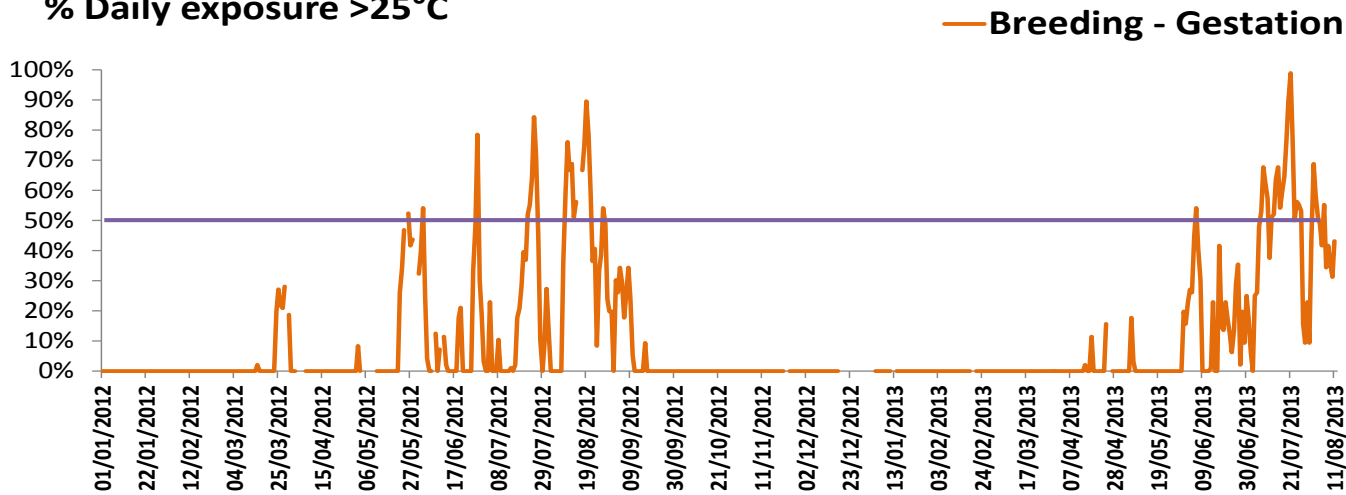
Sow housing prevents variations



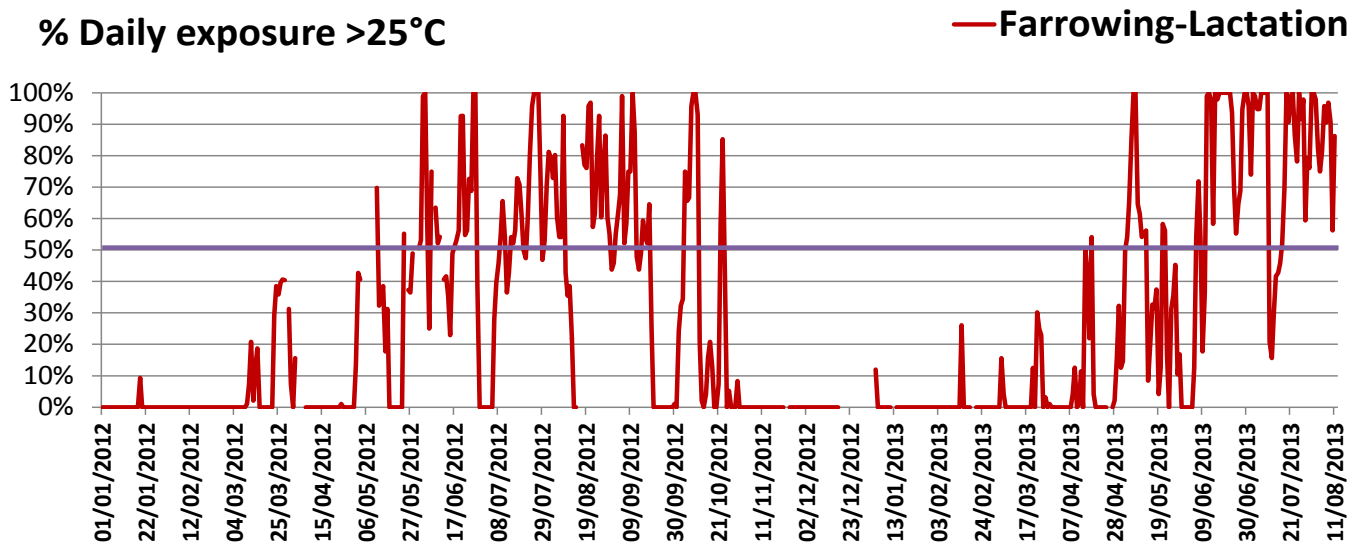
IFIP- Experimental Pig Farm (Rennes)

High T° for Lactating sows !

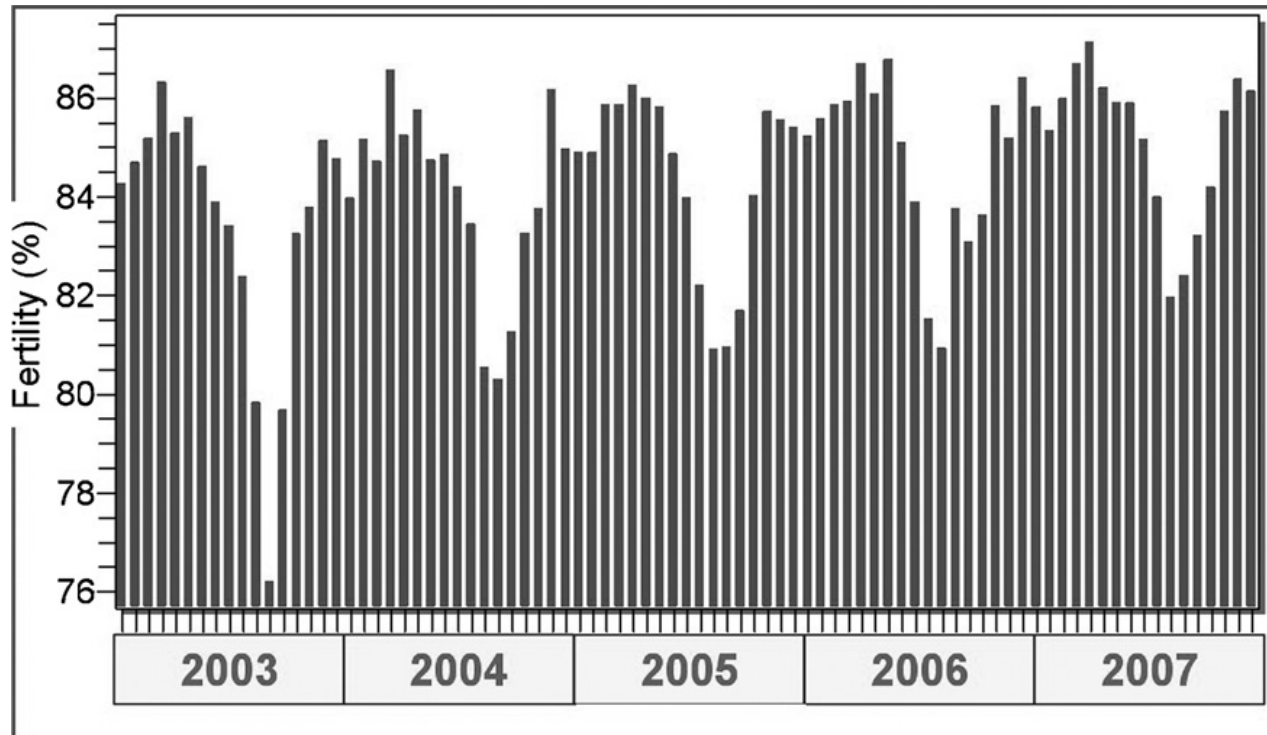
% Daily exposure >25°C



% Daily exposure >25°C



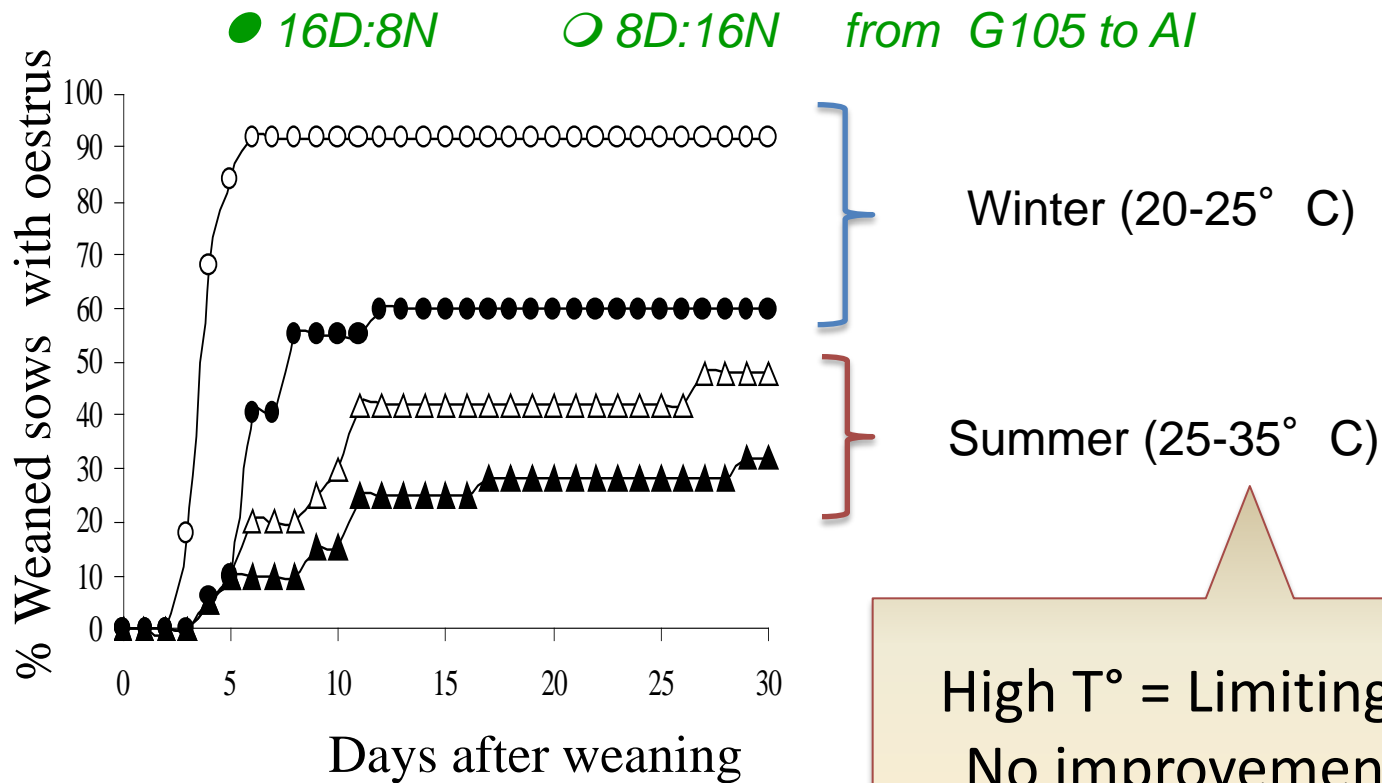
IFIP-
Experimental
Pig Farm
(Rennes)



Auvigne et al 2010

- Large variations between farms and years !
- Heat stress and farm management exacerbate the effect of photoperiod variations

Temperature >> Photoperiod



High T° = Limiting factor
No improvement with
short photoperiod

From Prunier et al 1994

Effects of Heat Stress ?

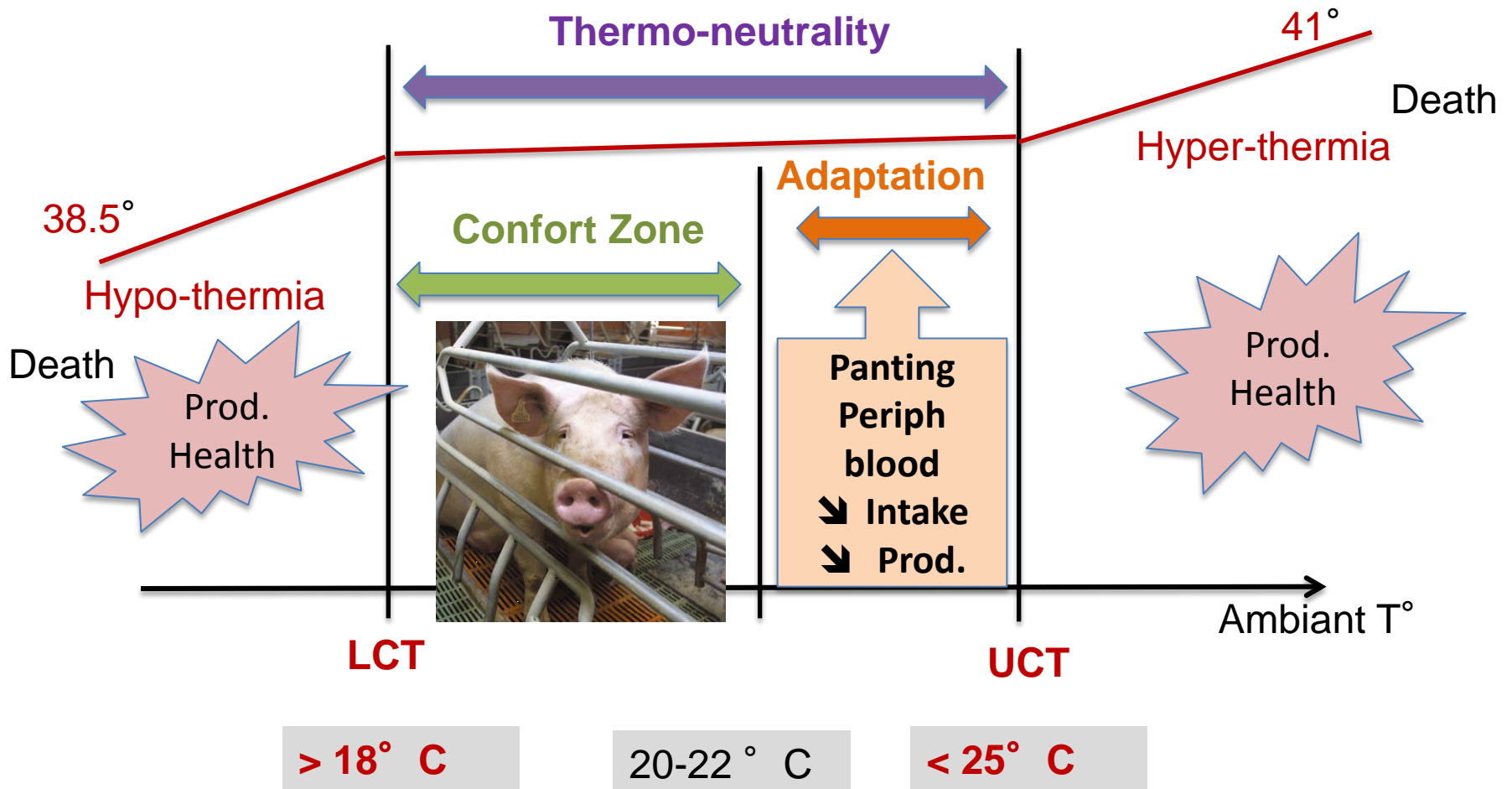
General



Reproduction



Thermo-regulation mechanisms



- Upper Critical Temperature varies with
 - Environment (Humidity...)
 - Animal factors (breed, age, weight, physiology ...)

	UCT
Gestation	20-23 °C
Lactation	18°C

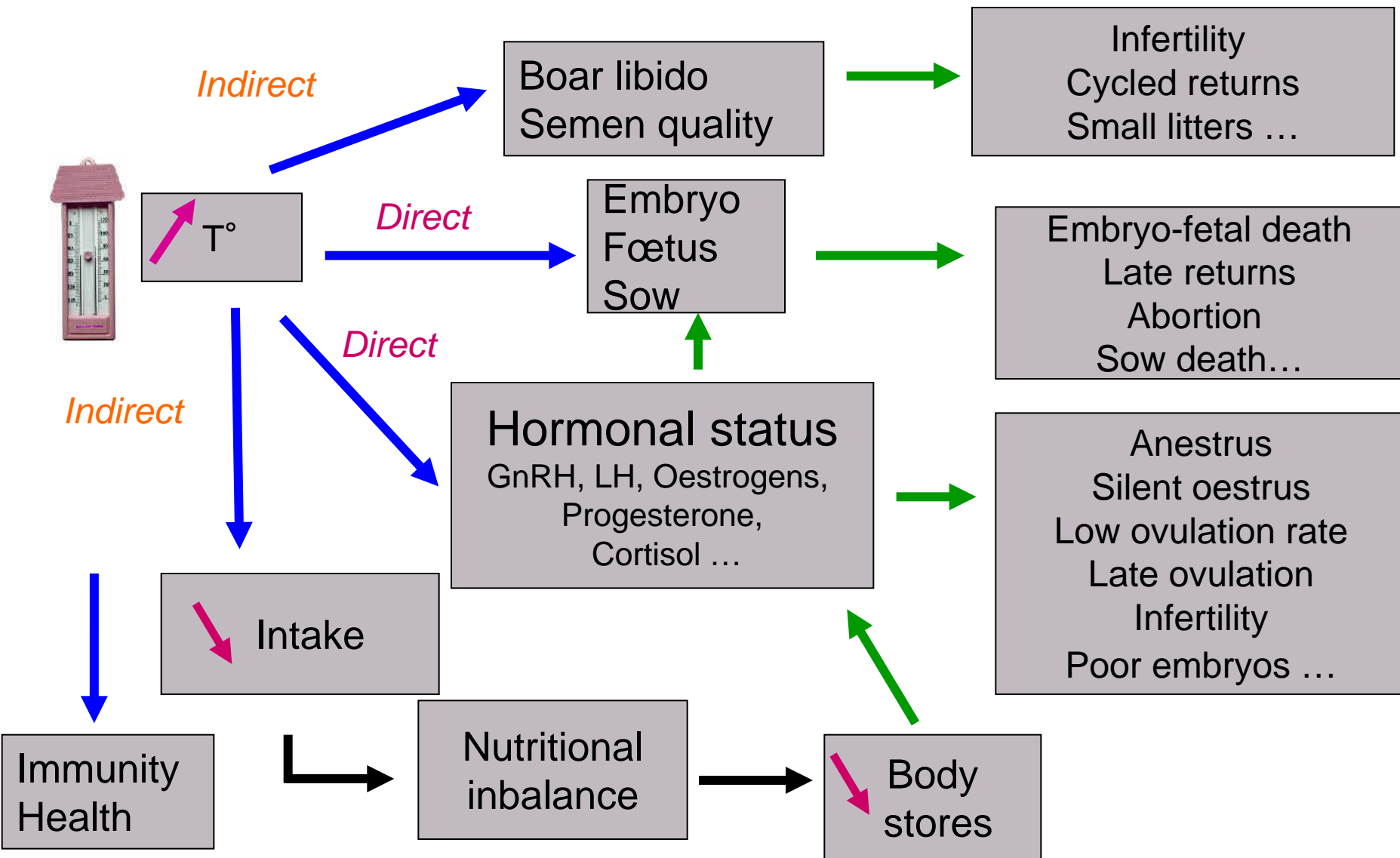


- Lactating sows = more susceptible !

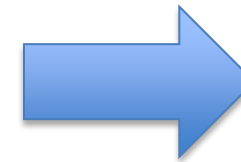
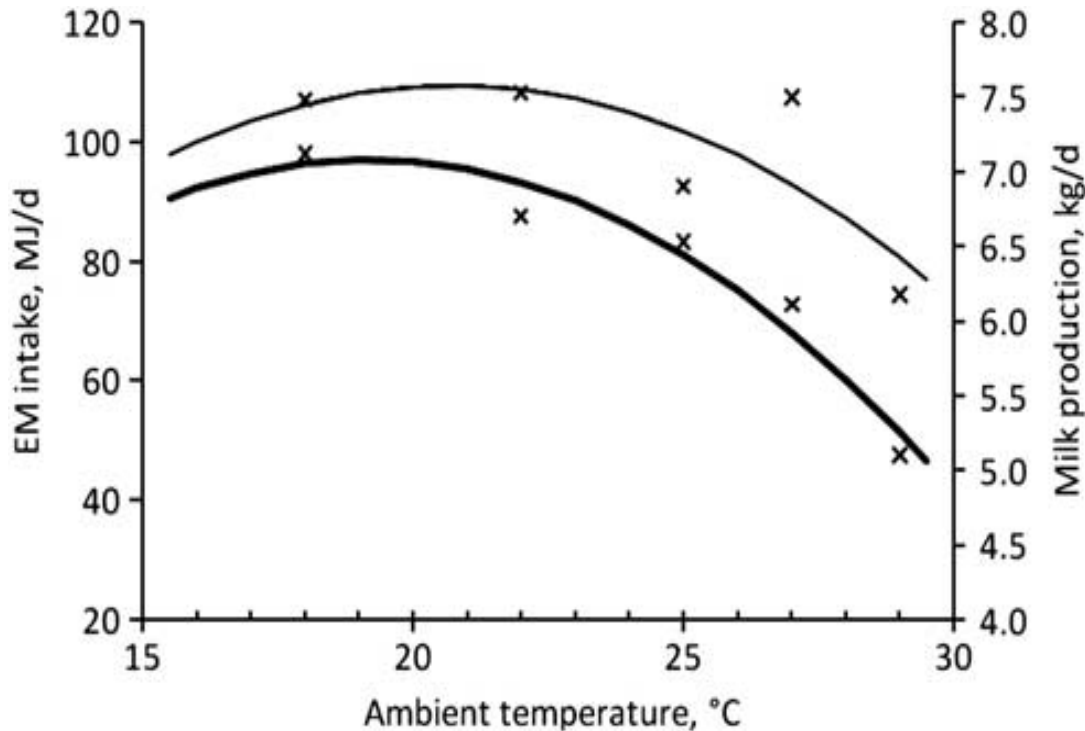
- Hansen (2009). Effects of heat stress on mammalian reproduction
- Takahashi (2011). Heat stress on reproductive function and fertility in mammals.
- Krisher (2013). In Vivo and In Vitro environmental effects on mammalian oocyte quality.

- **Einarsson et al (2009). Stress and its influence on reproduction in pigs: a review**
- **Bertoldo et al (2012). Seasonal variation in the ovarian function of sows**

Temperature and reproduction



Multiparous sows 21 d lactation

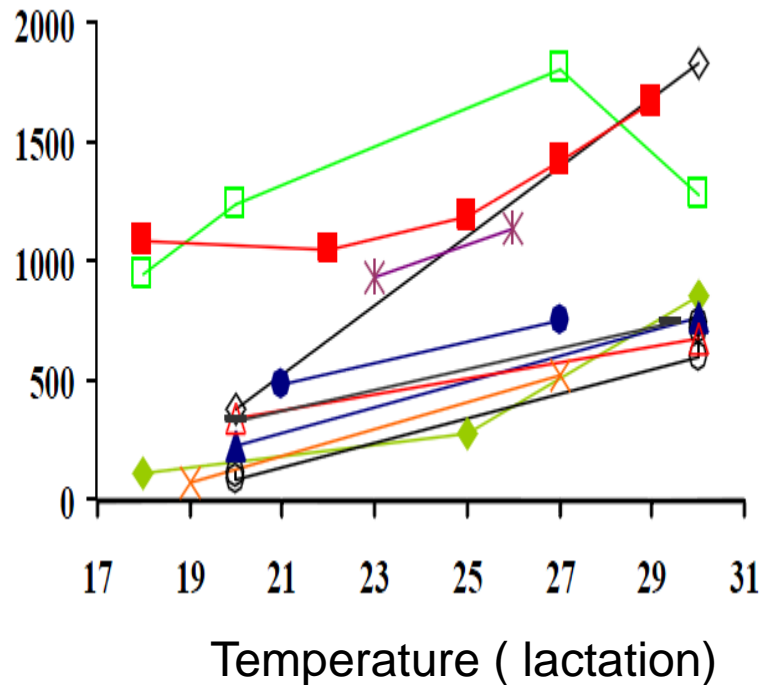


Energy deficit
BW loss

- ME intake (MJ/day)
- - - milk production (kg/day)

From Quiniou and Noblet (1999)

BW Loss g/d



Gourdine (2006, review)

Variable effects on reproduction




Low BW L : Few effects





Medium BWL : ↗ WEI

> 5% BW loss (Primiparous)

> 10% BW Loss (Multiparous)

High BWL : Fertility, Embryo...

- Low feed intake
- Excessive mobilisation of body reserves
- ↘ LH pulsatility
- ↘ Recruitment Follicles  Late estrus

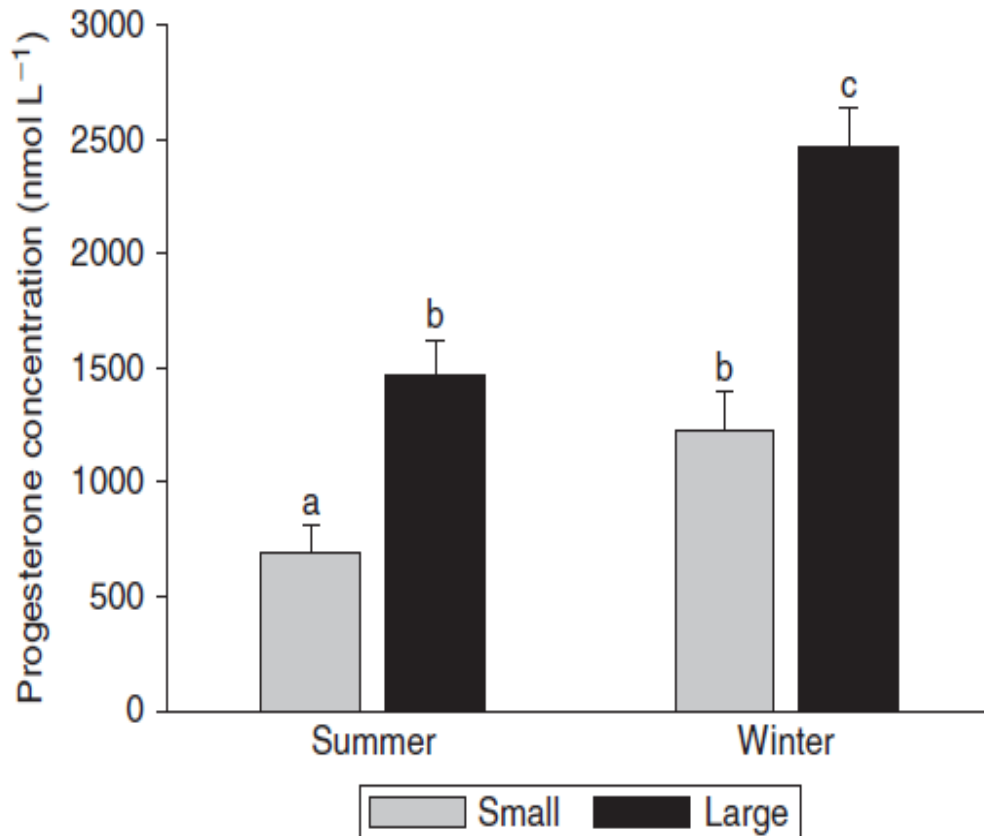
- ↘ Follicular growth 
- ↘ Quality Follicles  Ovulation rate
-  Embryo development
-  Embryo survival

Poor pregnancy recognition
or Later pregnancy disruption



Infertility
Small /heterogenous litters

Ovarian Follicular progesterone

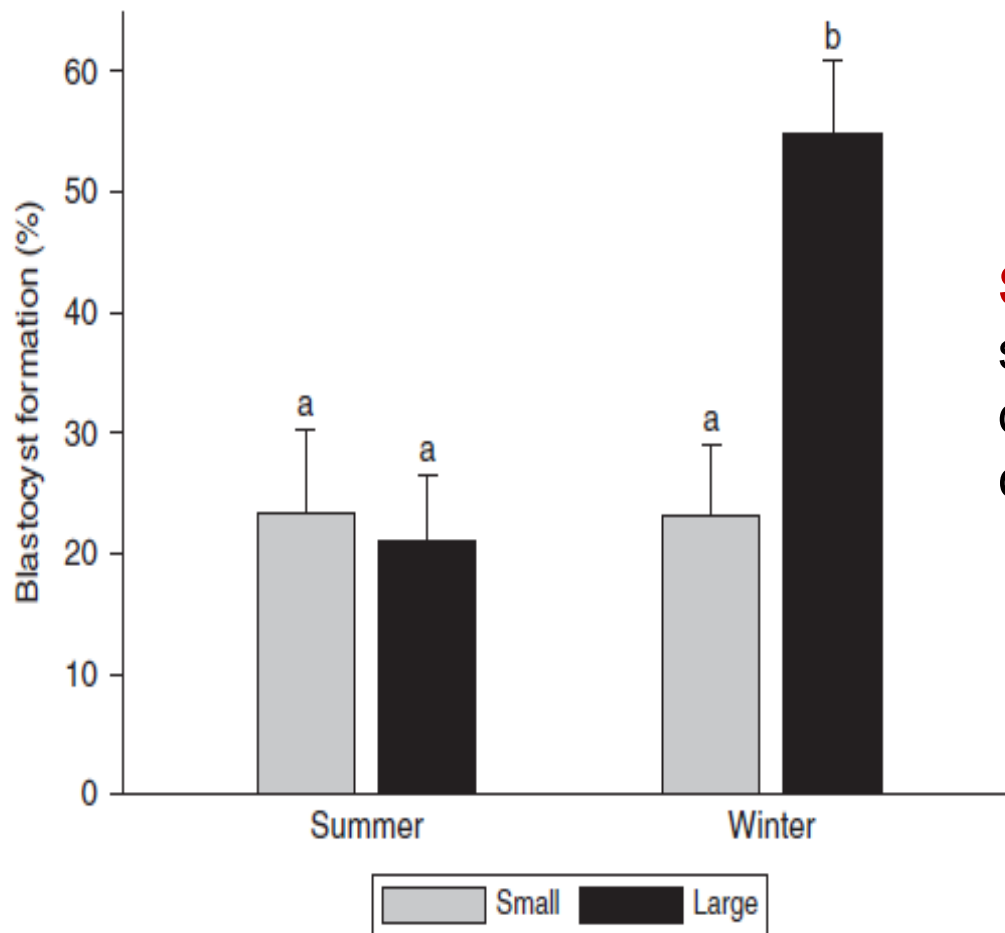


Summer : Pre-ovulatory follicles have low P4.

Refractoriness of the ovary to Gonadotrophins ?

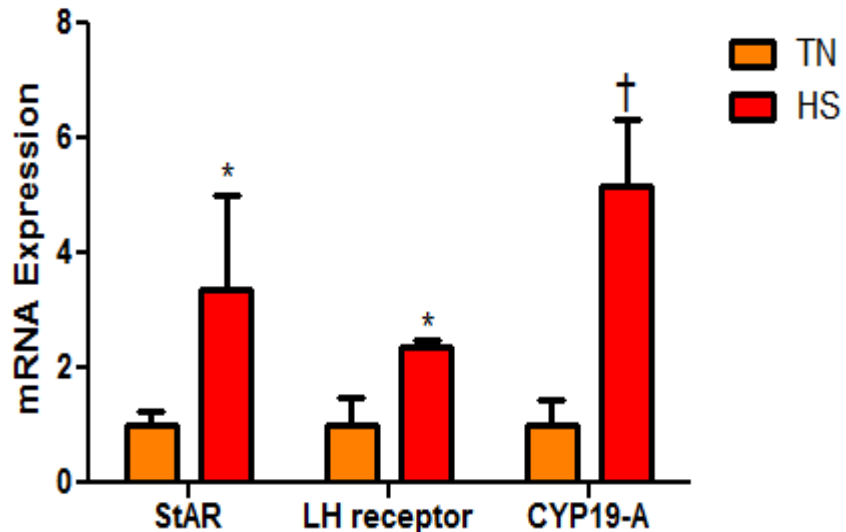
Subsequent poor oogenesis / maturation?

Embryo development is compromised



Summer / Oocyte from both small and large follicles have depressed developmental competence

- Pre-pubertal gilts (35d)
- HS (35° C) vs TN (20° C), 1 month
- Ovary : Alterations of mRNA expression of estrogen synthesis pathway members



- Malproduction of ovarian hormones ?
- Poor Follicular recruitment ?
- Low Oocyte viability ?

Nteeba et al 2013. Effects of Chronic Heat Stress on Ovarian Steroidogenesis Pathway Members in Gilts.(Iowa State University report)

- **HS Proteins expressed** by somatic cells in response to thermal stress. Is synthesis altered in HS ovaries or embryos ?
 - *Pennarosa et al 2012*
 - *Sirotkin et Bauer 2011 ...*
- **Oxydative process** associated with Heat Stress
 - Mechanisms ? *Lasota et al (2009)*.
 - Protective anti-oxydants ? (*Van Wettere et al, 2012*)

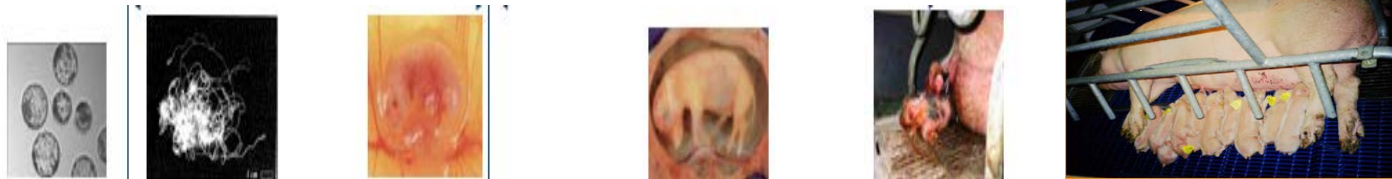
- In other species HS may impact :
 - Oviduct
 - Uterine environment
 - Placenta
 - Foetal development (thermal imprinting)

- Few specific studies on pigs

- Death rate x 4 (Canada, $T^{\circ} >30^{\circ} \text{ C}$, D'Allaire et al.1996)
 - Hyperthermia
 - Heart failure

- Health, Welfare ?
 - Stress : Activation of adeno-corticotrope axis (Cortisol)
 - Immune function altered (Canaday et al 2013....)

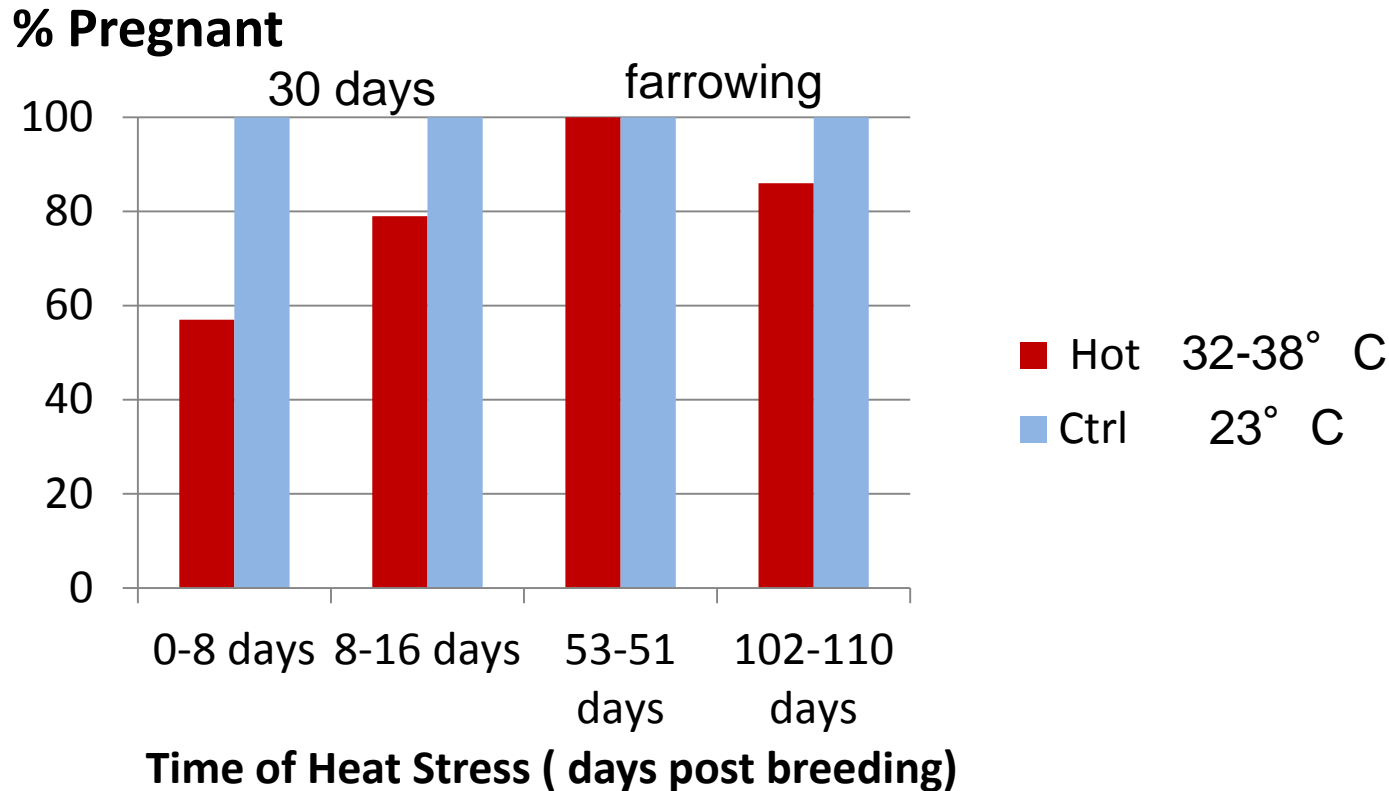
■ Critical stages for Heat stress ?



Critical stages : Gilts

Omtvedt et al 1971

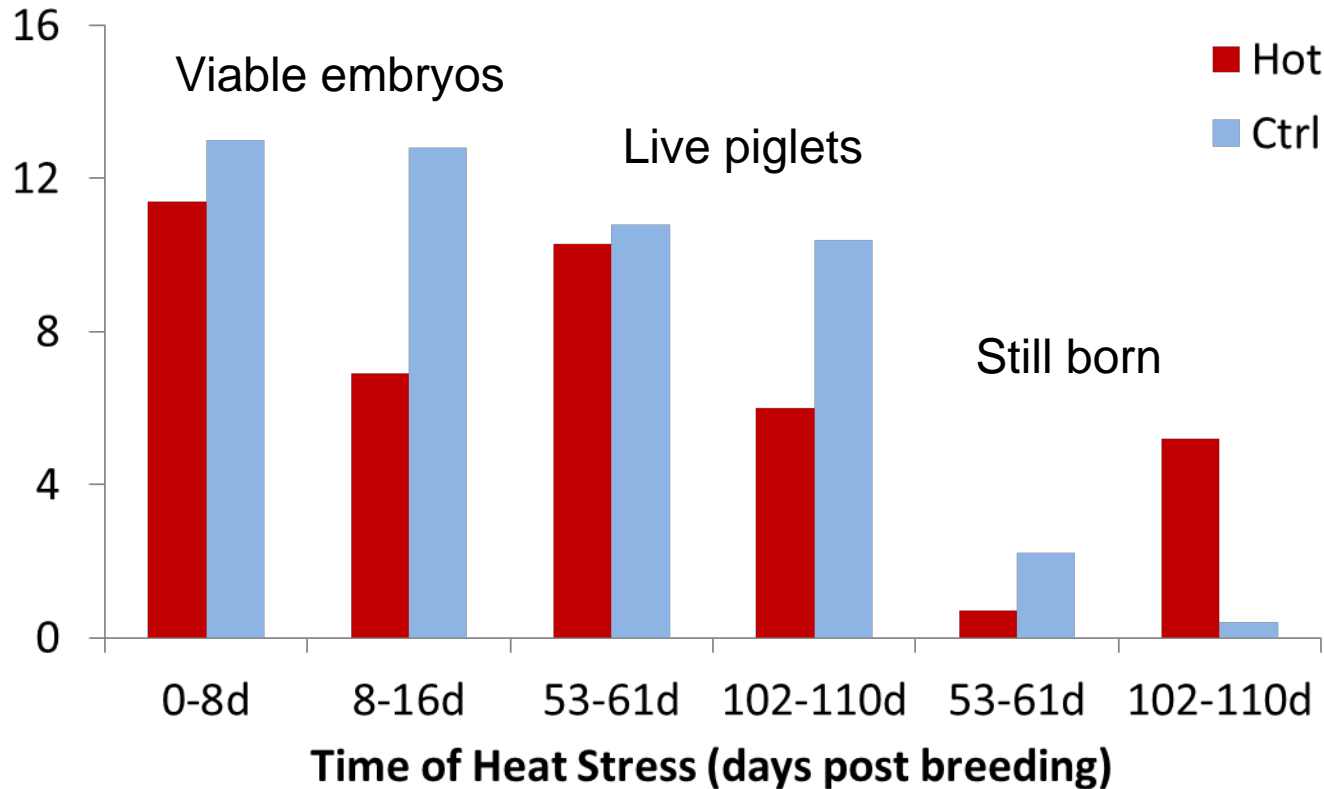
■ Gilts in controlled environment



Maintenance of pregnancy : 0-8d post- breeding

Critical stages : Gilts

Omtvedt et al 1971

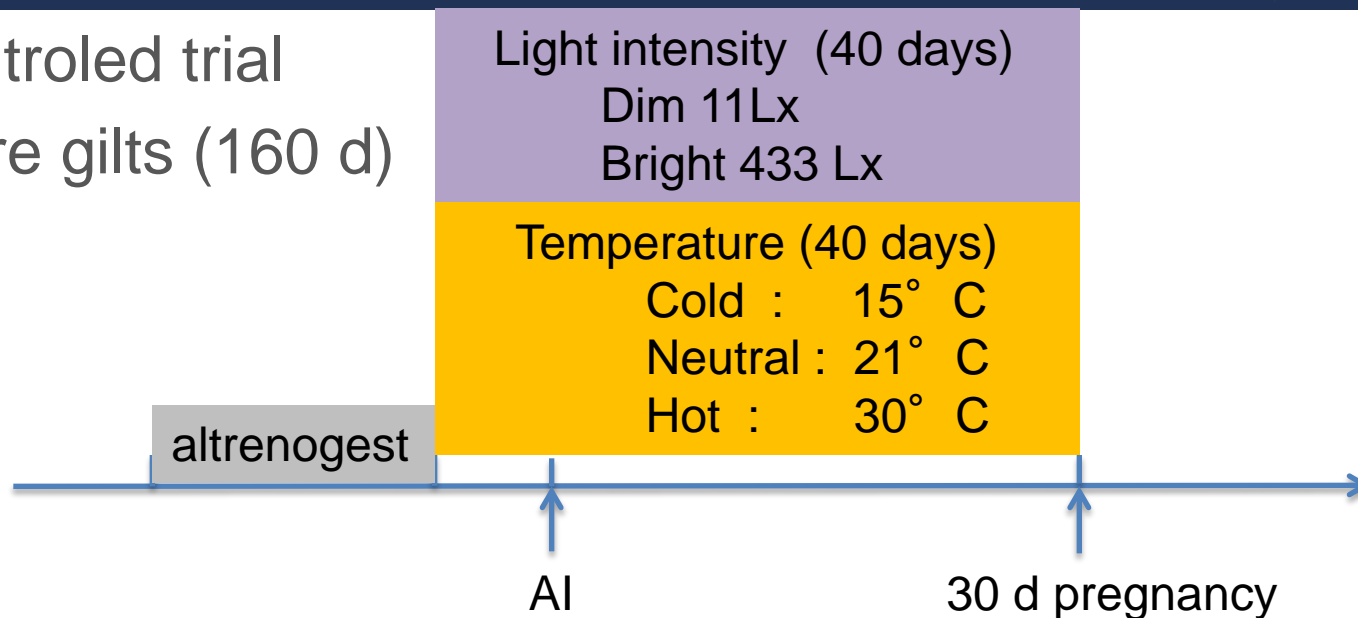


- Embryos = 8-16d Pregnancy recognition + Attachement
- Foetus : late gestation

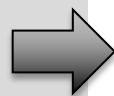
Follicular phase + 30 d Pregnancy

(*Canaday et al 2013*)

- A controlled trial
- Mature gilts (160 d)



Pregnancy rate (83.2%)
Litter size (14.3 ± 0.5)
Follicle development
Expression of estrus
Ovulation rate
Progesterone 14d
Fetal development at 30d



No Light x Temperature effect

No effect of Hot T°

Cold T° : Stress, Growth, Immunity

Heat Stress at successive stages

Williams et al 2013

Primiparous – Controlled chambers

18-20° C

24-30° C

	Late Gestation (90-111d)	Farrowing-Lactation (25 d)	Breeding (13 d)
18-20° C	TN	TN	TN
24-30° C	HS	HS	HS
	TN	HS	TN
	HS	TN	HS

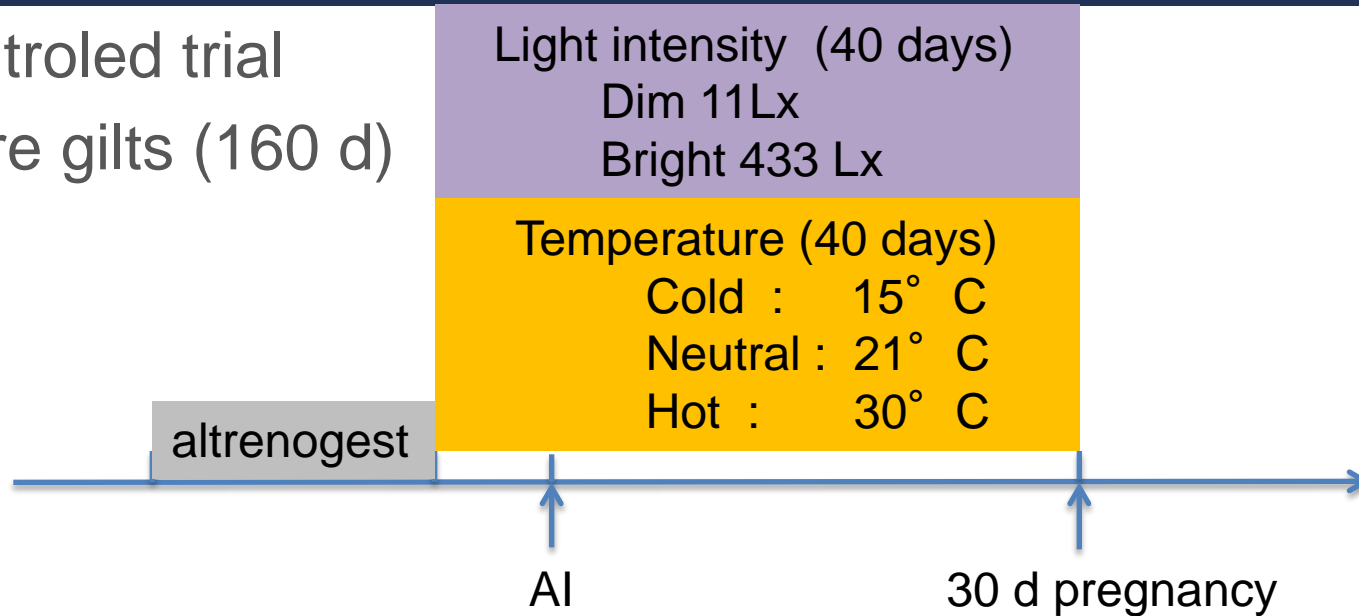
Next
Cycle
in
a
Farm

- No effect on reproduction !
- Short exposures
- Low BW losses
- Individual resistance ?

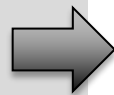
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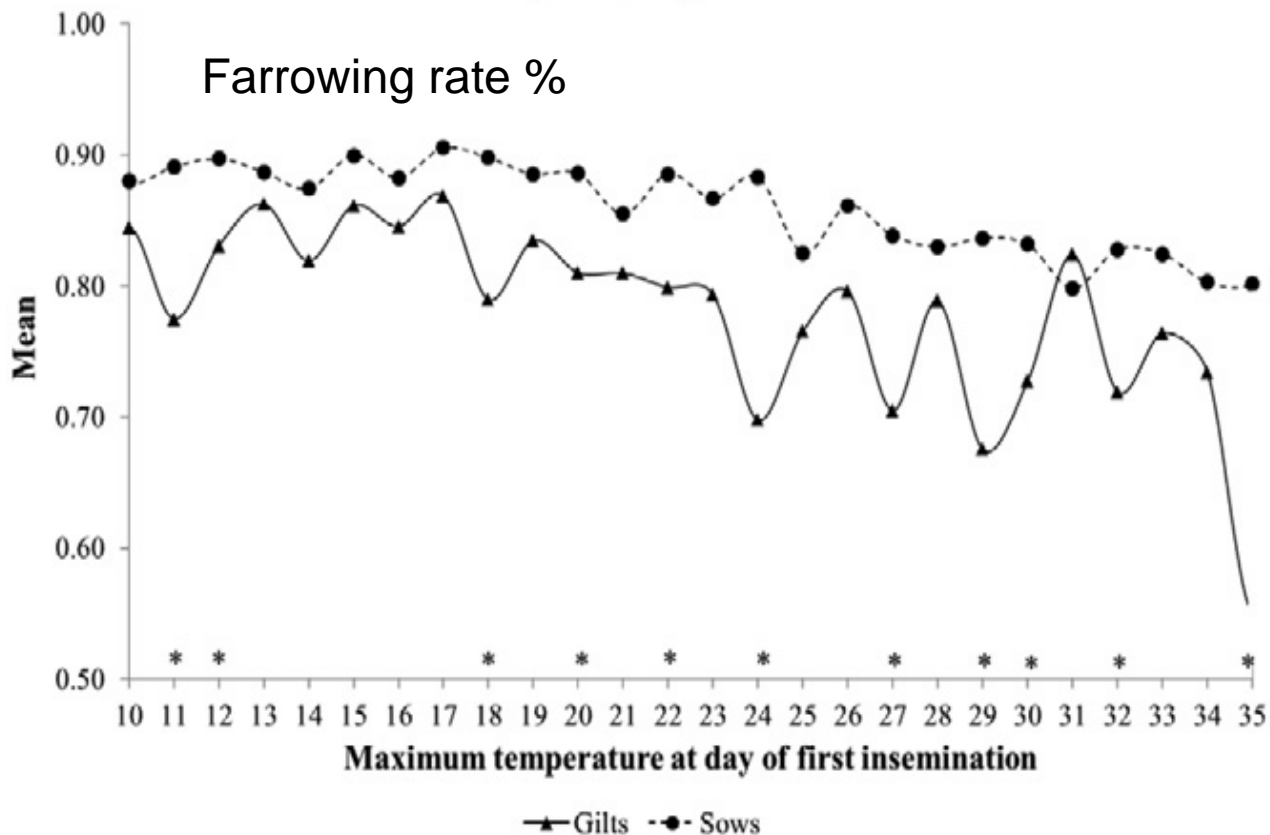
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Critical stages : Field trial

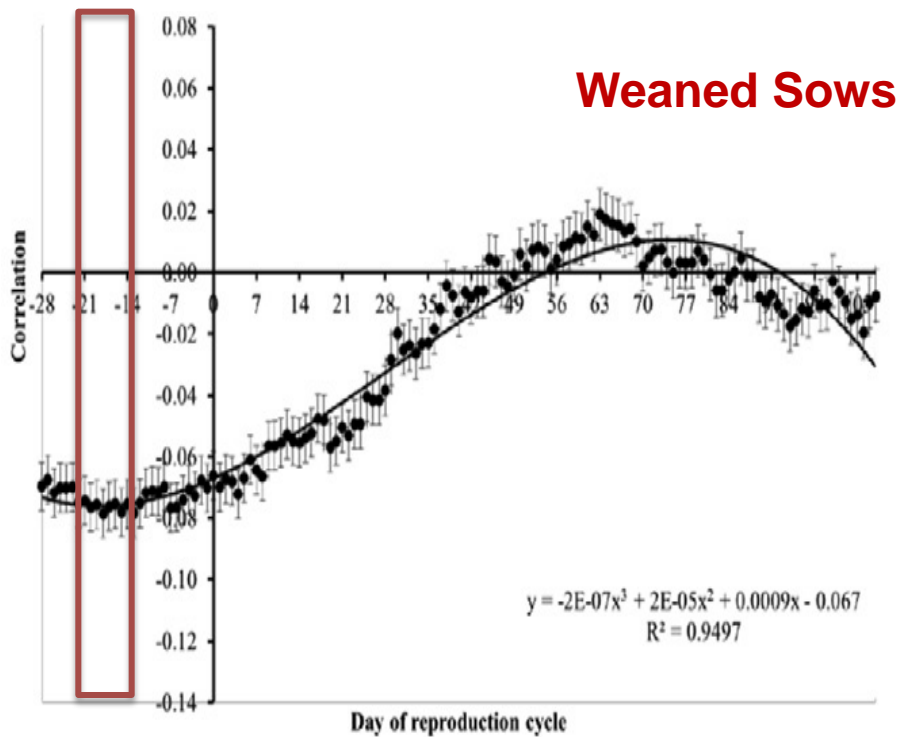
(Bloemhof et al 2013)

- A large field trial in Spain and Portugal
- 16 farms, > 22 000 sow records (Farrowing Rate, Litter size)
- Outside T° : Average, Max, Heat Load (Max –UCT)

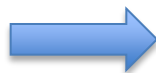


Critical stages : Field trial

Correlation Farrowing Rate – Daily maximum T°



**-21 to -14 d
before AI**

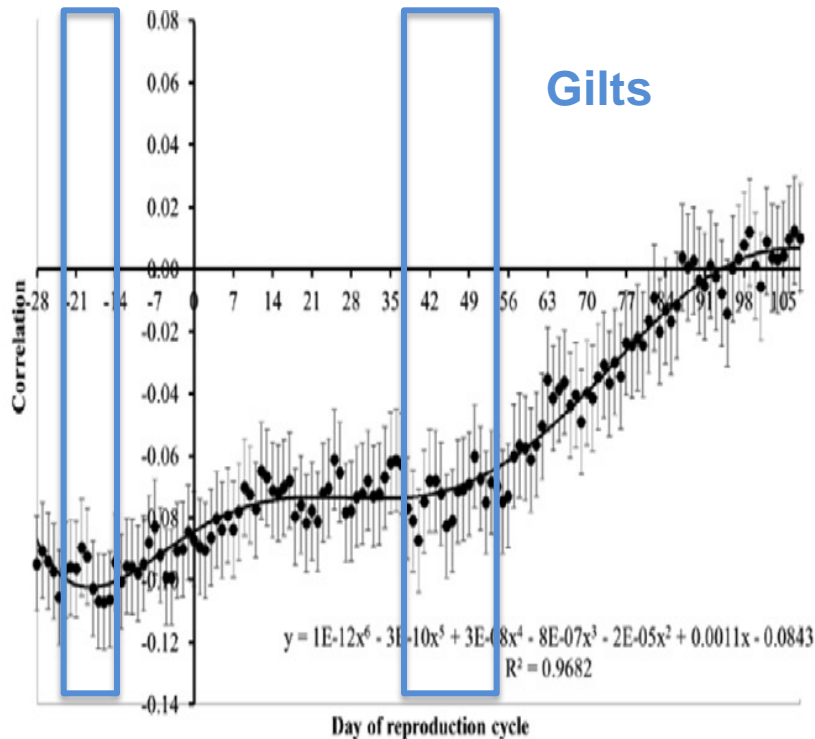


Lactation period

From Bloemhof et al 2013

Critical stages : Field trial

Correlation Farrowing Rate – Daily maximum T°



↔
**-21 to -14 d
before AI**

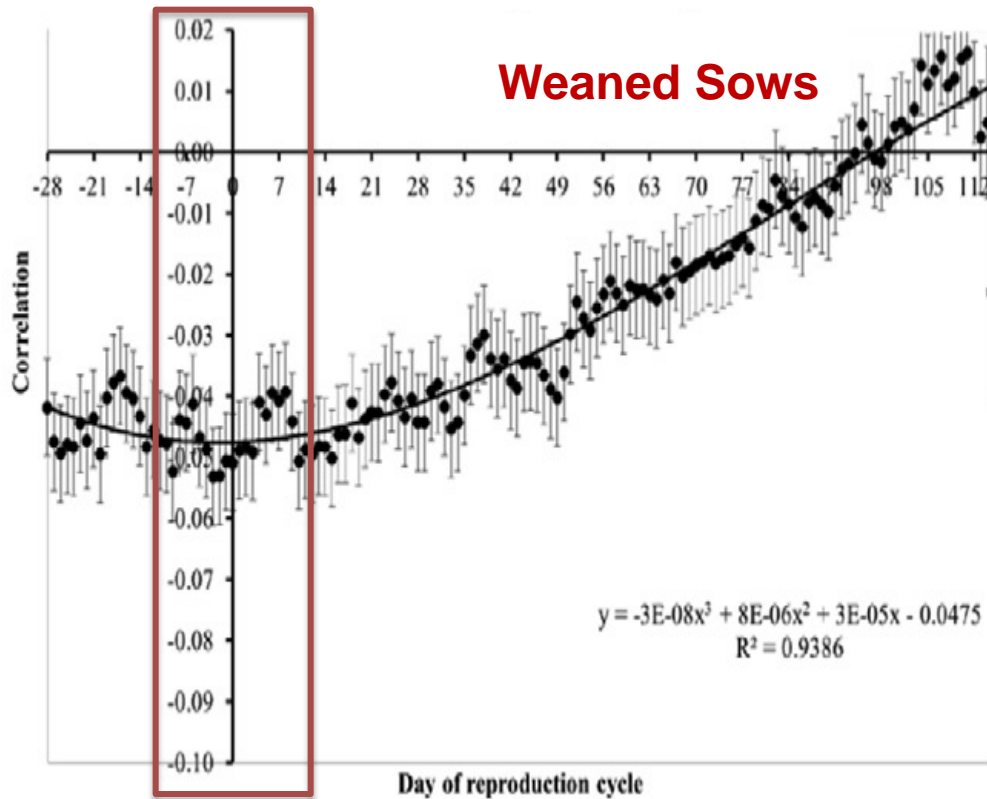
↔
**+38 to 55d
after AI**

➔ **Previous cycle
Early feto-placental devt ?**

From Bloemhof et al 2013

Critical stages : Field trial

Correlation Litter Size – Daily maximum T°



**-7 d before
to +12 d after AI**

Estrous and Early pregnancy

(Bloemhof et al 2013)

- Gilts : More susceptible
 - Growth (puberty, in utero ?)
 - Previous cycles

- Weaned sows
 - Previous lactation (FR, Oocyte, embryo quality, litter size)

- All females :
 - 0-14 days post breeding
 - 1st month pregnancy
 - Late pregnancy (mummies, stillborn)

- **Conflicting results ! Conclusions depend on :**
 - Severity of Heat Stress : level (25-30° C), fluctuations
 - Duration : Single vs Multiple expositions
 - Physiological status, age, parity
 - Photoperiod
 - Others : genetic, management, previous exposure ...

- **Criteria :** FR%, Litter size...
- **Method of evaluation :**
 - Experiments with strictly controlled T °
 - Field trials : outside T ° , large fluctuations

- Mechanisms of heat-stress associated disorders need further investigations
- Models to fit complex real exposures : variability, micro-environments, long-term
- More efficient use of Alleviating solutions
 - Hormonal support
 - Other treatments
 - Feeding strategies
 - Environmental management
 - Triggering resistance through controlled exposures
 - Selecting resistant females (bio-markers?)

Some reviews : Quesnel et al (2005), Renaudeau et al (2004, 2012), van Wettere and Hughes (2012, Piglink)

Thank you for your attention



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