TECHNICAL NOTE

LowInputBreeds

Adaptation of sows to rising temperatures

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About

Pork is the world's most consumed meat. With further growing demand pig production tends to move from moderate to somewhat harsher climates. Heat stress is expected to have negative effects on sow production. But as a result of genetic improvement, sensitivity of pigs to high temperatures has increased. This technical note presents an overview of research results on the genetics of heat stress sensitivity of sows, as obtained in the Low-InputBreeds project.

Introduction

Pork is consumed all around the world. Some religions do not allow pork as part of the menu, but in general pork is the world's most consumed meat.

Pork is produced in large integrated systems in the Midwest of the USA, with on occasion more than 100,000 sows; in small farms in Scandinavia, with an average farm size of around 100 sows; in family farms in Asia with perhaps half a dozen of sows; and finally in some areas in the world as backyard production, almost pets or scavengers. In general, pig production tends to move from moderate to somewhat harsher climates, hotter, dryer, and on higher altitudes. In addition, global temperature will increase as a result of climate change and availability of resources for climate control, energy and water will decrease.

Genetic improvement in pigs focuses on improving total feed efficiency, that is, output of pork per unit of resource, mostly measured in feed. Protein accretion per day will increase, fatness of carcasses, an energetic costly activity will decrease. More piglets per litter and more litters per year to reduce the cost of maintaining a sow for a whole year. Losses in terms of mortality or spoiled feed are very detrimental to this efficiency. As a result of genetic selection pigs nowadays have a higher internal heat production through higher metabolism. This leads, in combination to more challenging environments and increasing global temperatures to pigs that are more sensitive to high temperatures.

Picture 1: 2400 sow production in a hot area of Brazil. Picture: E.F. Knol

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Our question, therefore, was if current and future pigs fit within these production environments of today and the near future.

Theoretical concept of thermo-neutral zone

Pigs experience heat stress when temperature exceeds the upper critical temperature of their thermo-neutral zone. The thermo-neutral zone is the range of temperatures between the pig's lower critical temperature and the upper critical temperature. Below the lower critical temperature the pig will experience cold stress and needs to increase heat production through shivering and increasing their feed intake. Above the upper critical temperature the pig will experience heat stress, and starts to increase respiration through the lungs to maintain body temperature.

The thermo-neutral zone in general is based on the body temperature of the pig. However for pig production traits such as finisher growth, farrowing rate, and litter size there is a lower and upper critical temperature as well. Below the lower critical temperature the pig has to reduce performance to use the energy for maintaining body temperature. Above the upper critical temperature the pig has to reduce performance to avoid extra heat production. This concept is visualized in Figure 1.

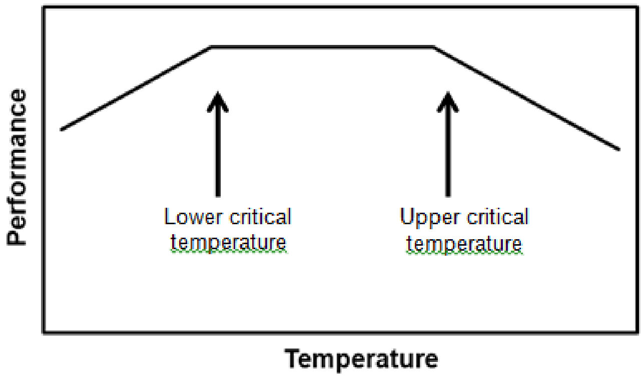

Figure 1. Concept of the thermo-neutral zone

Current piglet production in Spain

Sows from a Yorkshire dam-line inseminated during summer months in Spain show a reduction in litter size of around 0.8 piglets compared to being inseminated during winter months (see Figure 2, dotted line). In terms of efficiency this is a considerable loss. However sows from a Large White dam-line showed in general a lower level of production but also a lower loss when inseminated in the same summer months on the same or similar farms.

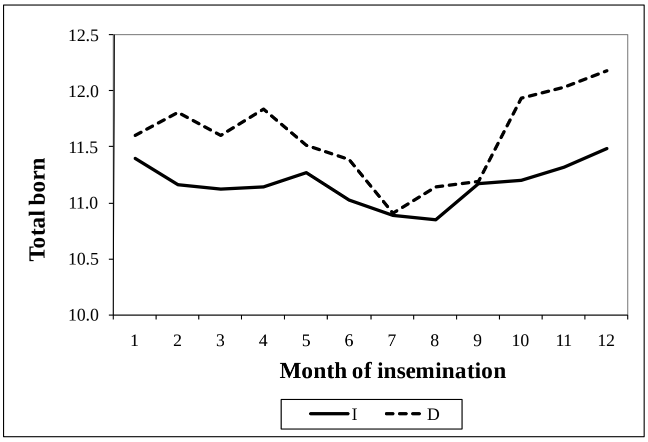

Figure 2. Number of piglets born per month of insemination for a Yorkshire dam line (D), and a Large White dam line (I).

The same dataset was used to study the effect of temperature on farrowing rate. Farrowing rate results were plotted against temperature in Figure 3. It shows that sows from the Yorkshire sow line (line D) maintain production with increasing temperature to a certain level (see Figure 3, dotted line) and after that start to drop. Interestingly, the temperature at which the slope starts is, in this and other data sets, very close to the upper critical temperature from literature, i.e. 20 °C.

The second point of interest is performance of sows from the Large White line (line I, the black line in Figure 3), which is clearly lower for farrowing rate at low temperatures, but increasingly comparable to performance of the Yorkshire sows after 23 °C. This is a strong indication that genetic differences may exist.

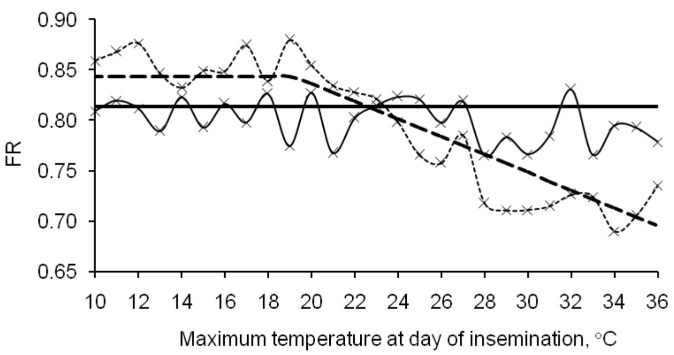

Figure 3. Farrowing rate of two dam lines, a Yorkshire line (D) and a Large White line (I), in relation to maximum temperature at day of insemination.

Since pedigree of the sows in this data set was known, genetic parameters could be estimated, to answer the question whether there are differences in heat tolerance between families. The answer is that there are quite relevant differences; most probably not so much in upper critical temperature, but more so in how animals respond to increasing temperatures. Some families within lines drop dramatically when temperature rises above upper critical temperature, other react more mildly and some families (Large White line in Figure 3) appear not to react at all.

The catch, however, is the correlation with production in the thermo neutral zone; families which keep up production under heat stress have a lower performance level in the thermo neutral zone. The conclusion is that specialization of breeds is an option. Select breeds and lines with high production levels, but keep them in moderate climates or under artificial management control. Other breeds or lines can cope better with challenges, but at the cost of efficiency.

Another option is to try to understand the situation better and to optimize the balance between production and the ability to withstand challenges. The genetic correlation between the two is definitely not unity. A combined effort could benefit both, the moderate climate and/or large industrialized production environments and the lower input/more challenged farms in the world.

Picture 2: White pipe provides cool air to the sow to keep temperature in the thermo neutral zone. Photo: E.F. Knol

Sensitive phases

It was somewhat surprising that upper critical temperatures can be estimated in real life production data. We took the temperature at the day of insemination, mostly because of the straightforwardness of the approach. Link the day of insemination to the data of the local weather station and pick up the temperature. As a side step, we experimented with other environmental definitions, including humidity, temperature range and temperature collected within the farms, but all definitions were less effective in explaining farrowing rate and litter size than maximum daily temperature recorded at the nearest official weather station.

To identify the most sensitive phase in the production cycle of the sow we repeated the temperature analysis, but now for each day from 4 weeks prior to insemination up to the day of farrowing.

High temperatures during early gestation seem most detrimental for litter size. Just before implantation the sow and embryos seem to decide how large the litter will be.

Farrowing rate is influenced by the temperature three weeks before insemination. This makes sense in two ways:

(1) for higher parity sows three weeks before insemination is the phase of lactation. If temperature is high in that phase then feed intake will be low and the sow might lose quite a bit of body condition, resulting in a 'skip a heat' situation or a lower ability to maintain later gestation and

(2) three weeks is the length of the cycle of the sow, three weeks before insemination the recruitment of the new wave of ova takes place.

It was interesting to see that the period identified for first parity sows is highly similar to that of sows, suggesting that the recruitment phenomenon might be more relevant than the body condition loss during lactation.

Farmers have anticipated on this knowledge by implementing cooling systems near the head of the sow (the white pipe in Picture 2) in the lactation barn. This cooling helps the sow to stay close to her thermo neutral zone and to maintain feed intake for her piglets and for maintaining her next gestation.

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Title photo

Pigs on the Sao Marcelo Farm in Brazil. Photo: JaschaLeenhouvers, IPG

LowInputBreeds

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