Effect Of Selection For Residual Feed Intake On Sow Reproductive Performance And Lactation Efficiency

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Introduction

Lactation is an energetically expensive process which can result in the mobilization of body fat and body protein when nutrient intake fails to meet daily requirements. This mobilization of body tissue results in a negative energy balance which can have negative consequences on health and reproduction. This has been shown in many studies involving dairy cattle, which are intensively managed (Veerkamp et al. 2001; Formigoni and Trevisi 2003; Llewellyn et al. 2007). The efficiency with which the female converts energy from food and body stores into milk production is the key to determining the rate and extent of maternal investment in reproduction (McDonald and Crocker 2006).

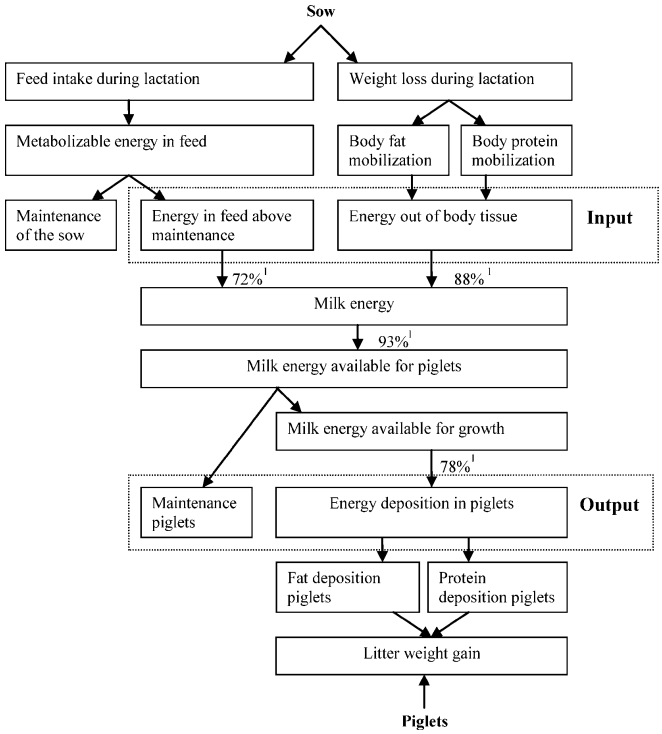

Figure 1: Schematic flow chart of the energy metabolism of sows during lactation (Bergsma et al. 2008, 2009)

Feed efficiency is becoming increasingly important because of the high cost of feed. Residual feed intake (RFI) is a measure of feed efficiency recorded during the finishing phase that is defined as the difference between observed feed intake and feed intake predicted from the average requirements for growth and maintenance. When developing strategies for genetic improvement of feed efficiency it is

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important to evaluate correlated responses to selection. Thus, the objective of this experiment was to evaluate sow reproductive performance and lactation efficiency in the selection lines for RFI that have been developed at Iowa State University.

Material and methods

Table 1: Number of sows per line per generation

	Generation						
	0	1	2	3	4	5	6
Select	126*	86	83	83	83	97	96
Control		24**	17**	45**	45	80	93

*These are the founding sows and had not been divided into lines.
**These sows were only used for one parity. All other sows have two parities recorded.

Experimental design and data collection. Using purebred Yorkshire pigs, a line selected for decreased RFI (LRFI line) and a randomly selected control (CTRL) line were initiated in 2001 and developed as described by Cai et al. (2008). The control line was selected for increased RFI starting in generation 5, which means data used for this analysis only include one generation of sows that are from the divergent selection. In each generation, two parities are produced, with feed intake being recorded on boars from parity 1 sows and gilts from parity 2 sows. Only pigs from parity 1 sows are used for continuing the selection experiment;

Table 2: Covariates used for data analysis

Traits*	Total born	Lactation length	Number weaned	Sow weight at farrowing	Sow fat mass at farrowing	Sow protein mass at farrowing
Litter birth weight	X					
Litter weaning weight		X				
Litter average daily gain		X	X			
Sow fat mass at farrowing				X		
Sow protein mass at farrowing				X		
Sow weight loss during lactation		X		X		
Sow fat mass loss during lactation		X			X	
Sow protein mass loss during lactation		X				X
Sow feed intake during lactation		X				

*Traits across top are traits used as covariates, traits down the side are the traits being analyzed

therefore, no sows used for breeding have RFI data collected on them. The number of sows by line are recorded in Table 1. Weight and ultrasonic backfat for the sow were recorded when entering the farrowing house and at weaning and were used to estimate fat and protein mass at the beginning and end of lactation in order to evaluate loss of fat and protein during lactation. Fat and protein mass were estimated using equations derived by Bergsma et al. (2009). Feed intake was recorded on the sows during lactation. Sows were fed to appetite over the approximately 21 d lactation period. All piglets born to a sow were recorded and coded for live, stillborn, or mummy. Individual birth weights of all live and stillborn piglets were recorded. Some cross-fostering was performed to equalize litter sizes at birth. Cross-fostering was not performed within line. At weaning, individual weights of all piglets were recorded. Weaning traits were evaluated on a sow and on a litter basis. Weaning traits by litter describe the litter itself regardless of what sow nursed the piglets from the litter. Weaning traits by sow describe the piglets the sow nursed regardless of what sow farrowed the piglets. Farrowing and weaning dates were also recorded for all pigs. Lactation efficiency was derived as described by Bergsma et al. (2009) based on the diagram of energy flow during lactation shown in Figure 1. Sow reproduction was evaluated based on traits pertaining to the piglets (i.e. litter size and litter weights) and traits pertaining to the sow (i.e. sow weight and sow feed intake).

Statistical analyses. Data were analyzed using the PROC MIXED procedure of SAS (SAS Institute Inc., Cary, NC). Fixed factors included in the model were line, line*generation, and generation*parity, where generation refers to the generation the piglets belonged to. Random factors included sow for all traits and sire for litter weaning weight and total piglet average daily gain. Covariates depended on the trait being analyzed (Table 2).

Results and discussion

Although previous literature has looked at feed efficiency and others at sow reproductive performance, the relationship between RFI and reproductive performance has not been evaluated. Results are contrary to what was hypothesized. Due to differences in market hogs for backfat and feed intake, it was expected that sows from the select line would be leaner and consume less feed during lactation which would result in poorer reproductive performance. After 6 generations, selection for residual feed intake impacted sow reproductive performance and lactation efficiency (Table 3). These results show that sows from the select line produce more piglets that are heavier at birth. Although there is no difference in the number of piglets weaned per sow per lactation period, there is an effect of line on piglet survivability during lactation as shown by the extra piglet weaned per litter ($P=0.03$). Although piglets nursed by select line sows perform better during lactation than those nursed by control sows, it comes at a cost to the sow. The select line sows are mobilizing more of their body tissue in order to support the growth of their piglets.

Conclusion

These results show that selection for decreased RFI during the growing period has no detrimental effect on sow reproductive performance and, in fact, has resulted in increased litter size and pre-weaning growth. The higher piglet performance is made possible by a greater loss of body condition for sows selected for decreased RFI during the growing

period. An implication of results from this research is that sow feed intake and body condition change during lactation must be taken into consideration when selecting for pigs that are more feed efficient during the growing period.

Table 3: Line differences after 6 generations of selection for residual feed intake

	Least square means		
Traits	Select	Control	P-value
Total born (n)	13.2	11.5	<0.001
Number born alive (n)	11.4	10.6	0.09
Number of stillborns (n)	1.5	0.8	<0.001
Number of mummies (n)	0.3	0.1	0.20
Number weaned by litter (n)	9.6	8.7	0.03
Number to be nursed by sow (n)	10.8	11.1	0.52
Number weaned by sow (n)	9.6	9.3	0.22
Litter birth weight, adjusted for total born (kg)	15.8	14.8	<0.01
Litter weaning weight by litter (kg)	57.4	47.9	<0.001
Weight of piglets to be nursed by sow, adjusted for number to be nursed by sow (kg)	14.5	13.7	0.04
Litter weaning weight by sow (kg)	55.9	51.4	<0.01
Litter average daily gain by sow (kg/d)	1.8	1.7	0.03
Sow weight at farrowing (kg)	207.3	211.4	0.40
Fat mass at farrowing, adjusted for weight at farrowing (kg)	49.4	53.3	0.02
Protein mass at farrowing, adjusted for weight at farrowing (kg)	28.2	27.6	0.02
Weight loss during lactation (kg)	7.7	-3.8	<0.01
Fat mass loss during lactation (kg)	5.8	-0.7	<0.001
Protein mass loss during lactation (kg)	2.9	0.6	0.10
Sow feed intake (kg)	112.9	126.4	<0.001
Energy input (MJ ME/d)	58.4	58.3	0.99
Energy output (MJ ME/d)	20.7	19.5	0.07
Lactation efficiency (Output/Input, %)	38.1	33.7	0.67

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