Factors Affecting Reproductive Performance in the Nepalese Pakhribas Pig: Effects of Nutrition and Housing during Lactation

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ABSTRACT : The effects of housing and nutrition on the performance of first lactation sows of the Nepalese Pakhribas breed were investigated. A total of 36 sows, from a previous experiment on nutrition during gilt rearing, were allocated according to a factorial design with 2 levels of nutrition, 60 or 80% of the calculated lactation requirement, and two types of housing, traditional or improved. The mean live weight loss of sows during lactation was reduced to a slightly greater extent by improved housing ($p<0.05$) than by better nutrition ($p<0.10$). There was also a significantly lower loss of P_2 backfat thickness ($p<0.05$) and mean body condition score ($p<0.05$) for sows on the higher plane of nutrition. Piglet weight gain in early and mid lactation was influenced by gestation feeding of the gilt ($p<0.10$) and by housing ($p<0.05$). Late lactation gain was influenced only by lactation feeding ($p<0.05$). In consequence, piglet weight at 42 day weaning was increased to a similar extent by improved housing ($p<0.05$) and better lactation nutrition ($p<0.01$). Significantly more sows were remated by day 10 after weaning from a higher level of rearing nutrition (χ^2=13.57, p=0.001), and from improved housing and improved lactation (both χ^2 =4.57, p=0.033). It is concluded that, under Nepalese village conditions, improvements in housing may be a more cost effective way of improving sow performance than expenditure on additional feed resources. ***(Asian-Aust. J. Anim. Sci. 2003. Vol 16, No. 5 : 644-649)***

Key Words : Pig, Nepal, Nutrition, Housing, Lactation, Estrus

INTRODUCTION

The Pakhribas synthetic breed of pig was developed in Nepal to provide an animal with improved productive characteristics which could be used under rural farm conditions (Oli and Morel, 1985). However, survey data indicate that pigs of this breed show a longer weaning to service interval under village conditions than seen at the Pakhribas research centre where they were developed. (Shrestha, 2000). Earlier, Gatenby et al. (1990) had also reported farrowing intervals ranging from 5 to 15 months on village farms. This poor reproductive performance may be due to inadequacies of nutrition or of management. Nutritional status, particularly during lactation, is one of the important factors causing long weaning to service intervals. Reese et al. (1982) demonstrated that sows on a low level of feed on lactation lost a considerable amount of weight and this was associated with a significant delay in resumption of breeding activity following weaning. It has been repeatedly shown that the greater the weight loss during lactation, the longer is the weaning to oestrus interval and conception period (Cole, 1982; Aherne and Kirkwood, 1985; English, 1989). However, it might also be possible to improve reproductive performance of pigs on village farms without additional expensive nutritional inputs by improving their housing. The climate in Nepal can exert a big energy demand on pigs in traditional housing (Shrestha et al., 2001; 2002). By improving the housing, energy loss can be reduced and sows should maintain better condition through lactation. Such improvements in housing are also likely to benefit survival and growth of the neonatal piglets. An experiment was therefore carried out to quantify the relative effects of improvements in nutrition and housing for lactating sows of the Pakhribas breed.

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MATERIALS AND METHODS

Experimental design

Thirty-two gilts of the Pakhribas breed, which had previously been the subject of an experiment on gilt rearing (Shrestha et al., 2002), were allocated according to a 3×2×2 factorial design in which two lactation housing treatments, and two lactation nutrition treatments, were superimposed on animals derived from three previous rearing nutrition treatments (Shrestha et al., 2002). The lactation treatments were designed to see the effect of two levels of housing quality (Traditional housing based on typical village shelter provision vs Improved housing with improved flooring, bedding and windproofing) and two levels of feeding throughout lactation (Low: 60 per cent of the lactation diet requirement calculated using equations of ARC (1981) incorporating information on maternal liveweight, piglet number and target growth rate vs High: 80 per cent of the lactation diet requirement calculated similar to 60% of the lactation diet).

The value of 60% of calculated requirement was

Table 1. Composition and chemical analysis of the experimental diet

Ingredients	Amount (%)	Chemical analysis (% DM) analysed using (AOAC, 1980)	
Corn	40	Dry matter	89.7
Rice bran	10	Crude protein	18.8
Rice bran extraction	16	Ether extract	2.4
Fish meal	5	Crude fibre	7.0
Deoiled ground nut cake	6	Total Ash	9.4
Deoiled sesame	7	Nitrogen free extract	62.3
Soya bean extraction	5	Phosphorus	1.7
Mustard cake expelled	4	Potassium	1.7
Calcite powder	5	DE Value*	13.6 MJ ME/kg
Salt	0.5		
Mineral mixture	0.5		
Total	1.0		

* Calculated from the results of proximate analysis (MAFF, 1991)

selected for one treatment as corresponding to the typical level of feed provided on village farms, based on a previous survey (Shrestha, 2000). The 80% level selected for the second treatment was designed to provide a more adequate nutrient intake which was potentially feasible to implement under village conditions, considering both feed availability and the predicted voluntary intake capability of first litter animals of this breed.

Housing and management : Sows were maintained on their respective treatment for housing and lactation nutrition throughout the 42 day lactation period. The pigs were housed individually in two different type of housing (Improved vs Traditional). Improved houses were built with the sty divided into two areas; an indoor sleeping area (1.82 m×1.82 m), fully enclosed by mud stone walls with exception of a small doorway (1.06 m×0.9 m), and an open exercise area outside (2.43 m×1.82 m) with fencing of bamboo poles. The floor was laid out with stone pointed by cement inside the lying area and was bedded with rice straw to a depth of about 6 cm. Traditional houses were built with no separate division between the roofed sleeping and unroofed exercise area, leaving the whole pen open without any provision for wind protection. The floor was left without any stone laid out and without any bedding materials.

The composition of the lactation diet is shown in Table 1. The amount of this diet offered was progressively increased from the day of farrowing until maximum permitted intake was achieved by day 3-6. The diet was fed twice daily with added water. The amounts of feed offered, and any refusals were recorded at each meal.

All the piglets in a litter were weaned together at 42 days after farrowing. Sows were fed a growing diet after weaning, at a level based on their live weight at weaning, until served. Sows were weighed at farrowing, mid-lactation and weaning and backfat thickness and depth of longissimus muscle at the P_2 position were measured ultrasonically using Meritronics Livestock Grader at the time of each weighing. Body condition score (0-5 scale) was also assessed by manual palpation. Piglets were individually recorded and weighed within 24 h of birth and weekly thereafter. Records were kept of all mortality or illness.

Statistical analysis

Data were analysed as a 3 way Analysis of Variance, using the Minitab software package, with rearing nutrition, housing and lactation nutrition as factors. The two and three way interactions between these factors were included in the model.

RESULTS

Since there were few significant interactions between treatments, data are presented in the results tables as main effects of rearing nutrition (residual influence), lactation nutrition and housing quality.

Sow liveweight and body condition

Table 2 shows the liveweight and fatness of sows on the different treatments at the different stages of lactation. At farrowing, the mean weight of the sows was 94.0, 96.9 and 104.8 kg for the Low (L), Medium (M) and High (H) rearing nutrition treatments respectively (sem 4.55, NS). There were no significant differences in body condition score, P_2 backfat thickness and eye muscle depth at farrowing between sows allocated to the different lactation nutrition and housing treatments.

The mean feed allocation of sows during lactation tended to increase with rearing treatment, since higher plane sows had a higher liveweight and calculated maintenance requirement. Animals on the high plane of lactation nutrition received 17% more feed than those on the lower plane of nutrition (Table 2).

By mid lactation, a residual effect of previous rearing nutrition was still apparent ($p<0.05$), but no significant effect of lactation nutrition or housing or interactions between factors had emerged. Backfat thickness ($p<0.05$),

Table 2. Sow performance in relation to plane of rearing nutrition, plane of lactation nutrition and quality of housing

	Rearing nutrition				Lactaction nutrition			Housing		
	Low	Medium	High	SEM	Low	High	SEM	Traditional	Improved	SEM
Lactation feed intake (kg/d)	3.7	3.9	4.0	0.30	3.6	4.2	0.24†	3.9	3.8	0.24
At start of lactation:										
Live weight (kg)	95.1	96.9	107.8	5.48	99.8	97.3	4.47	96.0	101.0	4.47
Body condition score	3.2	3.1	3.1	0.156	3.4	3.0	0.12	3.2	3.3	0.12
Backfat thickness (mm P_2)	19.6	18.9	20.4	1.791	20.7	20.0	1.46	19.2	21.4	1.46
Eye muscle depth (mm)	66.80	66.3	72.5	2.81	66.9	65.2	2.29	63.0	68.9	2.3
At mid lactation:										
Live weight (kg)	75.9	86.5	94.4	4.9*	81.9	89.2	3.9	85.4	84.7	3.9
Body condition score	2.3	2.6	2.7	0.1	2.2	2.9	0.1***	2.4	2.7	0.1†
Backfat thickness (mm P_2)	11.3	15.3	15.0	1.4	11.1	16.6	1.1*	12.6	15.1	1.1
Eye muscle depth (mm)	47.0	54.0	59.2	2.0*	50.4	56.0	1.6*	52.4	54.6	1.6
At weaning:										
Live weight (kg)	80.5	80.7	92.9	5.3	80.6	88.8	4.4	85.4	84.0	4.2
Body condition Score	1.9	2.2	2.2	0.1	1.9	2.4	0.09**	2.0	2.2	0.09
Backfat thickness (mm P_2)	8.8	11.7	11.7	1.1	8.9	12.5	0.9*	9.0	12.4	0.9*
Eye muscle depth (mm)	44.9	49.8	53.9	2.3*	45.3	53.8	1.7*	48.7	50.4	1.7
Lactation change:										
Live weight loss (kg)	14.6	16.2	14.9	1.5	16.7	13.7	1.2†	17.7	12.7	1.2*
Body condition score loss	1.2	0.9	0.9	0.1	1.2	0.8	0.1*	1.1	0.9	0.09
Backfat loss (mm P_2)	10.9	8.2	8.7	1.0	11.0	7.6	0.87*	10.2	8.3	0.85
Eye muscle loss (mm)	21.9	16.5	19.6	3.6	20.2	18.4	3.0	21.3	17.3	3.0
Weaning to remating interval (days)	12.3	7.3	7.3	1.8†	11.2	6.7	1.5*	8.8	9.2	1.4

† $p<0.10$; * $p<0.05$, ** $p<0.01$, *** $p<0.001$

eye muscle depth ($p<0.05$) and body condition score ($p<0.001$) were all improved in sows given the higher plane of lactation nutrition. The exact day of recording for mid lactation differed between sows and was therefore tested as a covariate in the model, but proved not to exert any significant covariance effect on any of the liveweight or body condition measurements.

Over the course of lactation, there were no residual effects of rearing nutrition on the loss of liveweight, backfat or muscle depth. Improved lactation nutrition reduced weight loss ($p<0.10$) and loss of backfat ($p<0.05$). Improved housing reduced weight loss to a similar degree to that achieved by improved nutrition ($p<0.05$) and showed a similar, but not significant trend in backfat loss.

At weaning, therefore, the only significant residual effect of rearing nutrition was on eye muscle depth ($p<0.05$). The high plane of lactation nutrition significantly improved backfat thickness ($p<0.05$), eye muscle depth ($p<0.05$) and body condition score ($p<0.01$), but the improvement in liveweight was not significant. Improved housing resulted only in greater backfat depth ($p<0.05$). No significant interaction effects were found between nutrition, housing and lactation.

Weaning to remating interval : χ^2 analysis showed that a significantly higher proportion of sows were remated by day 10 after weaning in both improved planes of rearing nutrition ($\chi^2=13.57$, 2df, $p=0.001$). The percentage of sows remated by day 10 after weaning was also improved by lactation nutrition and by improved housing (both $\chi^2=4.57$, 1df, $p=0.033$).

Piglet performance

The detailed breakdown of information on piglet survival and growth is shown in Table 3. Litter size was tested as a covariate in all analyses but in no case exerted a significant effect. Piglet liveweight gain in early and mid lactation was influenced by residual effects of gestation feeding of the gilt ($p<0.10$) and, to a greater extent, by quality of housing ($p<0.05$). Late lactation gain was influenced only by lactation feeding ($p<0.05$). In consequence, piglet weight at 42 day weaning was increased to a similar extent by improved housing ($p<0.05$) and better lactation nutrition ($p<0.01$).

DISCUSSION

Effect of gilt rearing nutrition

There were few residual influences of rearing nutrition on live weight or body composition of gilts during lactation. The exception was a greater eye muscle depth which persisted to weaning for gilts from the higher rearing planes, indicating a greater body protein mass in these animals. Many studies have reported that there is a carry over effect of nutrition during growing in attaining higher live weight (King, 1989; Edwards, 1998; Den Hartog and Noordewier, 1984; Den Hartog and Verstegen, 1990). This was not

Table 3. Piglet performance in relation to plane of rearing nutrition, plane of lactation nutrition and quality of housing

	Rearing nutrition				Lactaction nutrition			Housing		
	Low	Medium	High	SEM	Low	High	SEM	Traditional	Improved	SEM
Litter size at farrowing	7.0	7.4	8.2	0.75	8.1	6.8	0.47	7.6	7.4	0.57
Litter size at weaning	7.0	6.8	7.5	0.58	7.3	6.8	0.48	7.1	7.0	0.46
Piglet wt. at birth (g)	0.850	0.950	0.904	0.02*	0.886	0.922	0.04	0.872	0.930	0.016*
Piglet wt. gain at 15d (kg)	1.70	1.72	1.87	0.05†	1.72	1.81	0.048	1.67	1.84	0.045*
Piglet wt. gain 15-30d (kg)	1.78	2.00	1.86	0.09†	1.85	1.95	0.078	1.80	2.00	0.074*
Piglet wt. gain 30-42d (kg)	1.40	1.53	1.60	0.13	1.37	1.70	0.110*	1.60	1.48	0.104
Piglet wt. at weaning (kg)	5.90	6.30	6.00	0.128	5.85	6.33	0.109**	5.9	6.25	0.103*
Overall growth rate to weaning at 42 days (kg/d)	0.119	0.126	0.125	0.003	0.12	0.13	0.002*	0.12	0.12	0.002*

† $p<0.10$; * $p<0.05$, ** $p<0.01$, *** $p<0.001$

apparent in the present study, despite numerically greater mean liveweight at weaning for animals from the high plane treatment, which may reflect the variance in the relatively small sample size. Gilts from the low rearing treatment tended to have longer weaning to estrus intervals. This could be explained by their lower body protein mass (Edwards, 1998) and accords with the results of Mullan and Williams (1989), who also stated that rebreeding performance depends on the amount of reserves present at the beginning of lactation.

Piglet growth was not very much influenced by plane of nutrition gilt rearing. There was a tendency for lower piglet growth in early lactation from gilts on low rearing nutrition but this did not persist to give an overall effect. Mullan and Williams (1989) also reported that the early growth rate of the litter appeared to be related to the total body reserves of the sows, whereas later growth was more influenced by food intake during lactation.

Effect of lactation nutrition

As expected from the differential feed allocation, there was a reduction in loss of weight, backfat and muscle depth with the higher plane of lactation nutrition. As demonstrated repeatedly, a high weight loss during lactation results in an increase in weaning to estrus interval (Den Hartog, Vesseur and Kemp, et al., 1994). Kirkwood et al. (1990) reported losses of 13.8 and 26.6 kg of body weight and 3.6 and 6.5 mm P_2 backfat thickness respectively in N. American sows fed with 6 or 3 kg of cereal/soya per day during a 28 day lactation. Prunier et al. (1993) also reported that primiparous Large White sows, when fed either 2.5 or 5.5 kg of feed per day during a 28 day lactation, lost 44 or 23 kg of live weight and 7.2 or 3.5 mm P_2 backfat thickness with a difference of 11.3 or 7.6 days of weaning to oestrus interval. The absolute live weight loss was much lower in the present study, which may be due to lower live weight of the Pakhribas pig at farrowing and lower litter size as compared with European breeds reported elsewhere (Shrestha, 2000). The mean live weight at first farrowing for the Pakhribas pig was 98 kg and the mean live weight loss during lactation was 15% of their body weight, which ranged from 9.6 to 18.5% based on their nutritional regimes. Mullan and Williams (1989) reported that the mean weight loss was 18% of body weight in gilts, which ranged from 3 to 27% based on their nutritional regimes during pregnancy and lactation. Sinclair (1997) has reported the mean weight loss of 6.5% of body weight in UK breeds, which ranged from 2 to 10% based on their nutritional regimes during lactation. The percentage loss of live weight is therefore lower in Pakhribas breed when compared with Mullan and Williams (1989), where feed intake under hot Australian conditions was low, but it was higher compared to Sinclair (1997) with higher intakes under Scottish conditions. These results indicate that the relative weight loss depends heavily on nutritional regimes during pregnancy and lactation rather than genotype.

Piglet growth was significantly influenced by lactation treatment. This suggests that improved lactation diet increased milk yield of the sows, which is crucial for gaining appropriate weaning weight of the piglets (Den Hartog et al., 1984; English and Edwards, 1996). The effect of lactation nutrition on piglet growth was more apparent in late lactation, because milk supply at this time is less influenced by body reserves (Mullan and Williams, 1989).

All the sows given better lactation nutrition were re-mated within 15 days after weaning, whereas all sows with poorer lactation nutrition were only re-mated 35 days after weaning. This therefore clearly suggests that there is a strong potential for improved nutrition during lactation to shorten weaning to oestrus interval in sows under Nepalese feeding and management conditions. Lactating sows need both energy and protein for maintenance and milk production (Edwards, 1998). The function of the sow lactation is to produce sufficient milk to wean an adequate number of piglets of an acceptable body weight, with minimum variation, yet without utilizing excessive body reserves to prejudice subsequent reproductive performance (Mullan et al., 1989). In the Pakhribas breed, considerable amounts of body lipid and protein may be mobilised during lactation to buffer nutritional stress resulting from low feed intake, but at the expense of reduced piglet growth and a prolonged interval from weaning to oestrus. Many authors have provided evidence that excessive loss of body mass causes an extended weaning to oestrus interval and an increased incidence of anoestrus (Aherne and Kirkwood, 1985; King and Williams, 1984; King and Dunkin, 1986; Baidoo et al., 1992). This is especially the case for young sows (Den Hartog et al., 1994). A similar finding was obtained in the present study, coupled with a reduction of 1.2 piglets in subsequent litter size. This possible reduction in future output requires further investigation with greater replication.

Effect of housing

The live weight loss of sows during lactation was higher in traditional housing, and a similar trend was found for P_2 loss of backfat. This was associated with a significantly higher number of sows remated by 10 days after weaning in the improved housing group, as discussed above.

There was also a significant difference in the piglet growth between housing treatments. The piglets reared under traditional housing had poorer growth rate than the piglet reared under improved housing. Since sow results for feed intake and condition loss did not suggest any difference in milk yield, it indicates that the effect of an inadequate thermal environment was a major direct reduction in piglet growth. This effect was greater in early lactation when piglets were smaller and would have a higher Lower Critical Temperature and sensitivity to climatic penalty (Shrestha et al., 2001).

CONCLUSION

There are a number of ways in which the poor reproductive performance of Pakhribas pigs under Nepalese village conditions might be improved. Improved plane of nutrition during rearing has some positive residual effects on early piglet growth and on rebreeding of weaned gilts. The effect of improved lactation nutrition on piglet weaning weight and gilt rebreeding is more pronounced, but similar benefits can be achieved by improvements in housing conditions. It is concluded that, under Nepalese village constraints, improvements in housing may be a more cost effective way of improving sow performance than expenditure on additional feed resources.

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