It would appear that marked ration ingredient change has little effect on pig performance. However it should be noted that in these trials, all known nutritional requirements were believed to be met on all diets fed. Furthermore, ingredients or level of ingredients used were those believed to be palatable to swine.

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# Effect of Protein Level on Nitrogen Balance and Reproductive Performance in Gilts

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## Story in Brief

Three trials involving a total of 90 gilts were conducted to evaluate the effect of crude protein intake on growth, nitrogen balance and reproductive performance of breeding gilts. Yorkshire gilts were fed graded levels of protein from approximately 146 days of age to slaughter at 30 days post-breeding.

Feeding a high protein ration (20 percent crude protein) resulted in little or no advantage in average daily gain to puberty, age at purberty or nitrogen retention prior to breeding when compared to the medium level diet (14 percent). Gilts fed the low protein ration (8 percent) gained significantly slower and tended to be older at puberty than gilts fed the 14 or 20 percent protein rations. The high protein diet (20 percent) resulted in a significantly greater nitrogen retention during early pregnancy.

The value of this increased nitrogen retention is not well understood. An increase in anestrous gilts seemed to be associated with the two lower protein levels; however, sufficient data were not obtained in

this study to establish a definite relationship. Number of corpora lutea, an indicator of ovulation rate, increased as protein level increased. Number of live embryos and percent embryo survival were not affected by protein levels used in this experiment.

## Introduction

Recent research has raised many questions as to the effects of dietary protein levels, fed before and after breeding, on subsequent reproductive performance in gilts. Reproductive performance, as assessed by litter size, birth weight and pig survival to weaning, has proven to be unresponsive to differences in protein intake during gestation. Variation in litter size due to boar influence, season, crowding effect in the uterus and other environmental factors have made it difficult to show an effect on litter data due to protein intake of the dam.

Nitrogen retention can be used to indicate the level of dietary protein which maximizes body protein synthesis; however, this technique does not differentiate between protein synthesis that is required for optimal reproduction and that which is simply stored protein. This study was undertaken to determine the effect of feeding various levels of crude protein, over an extended period of time, on the reproductive performance, nitrogen retention and growth of young gilts.

## Materials and Methods

Three trials were conducted using 90 Yorkshire gilts averaging 146 days of age. Ten gilts were randomly allotted to each of the three dietary protein levels within each of the three trials. The three rations (Table 1) were calculated to have 20, 14 or 8 percent crude protein. The 20 percent ration was a milo-soybean meal based ration and the 14 and 8

**Table 1. Composition of Experimental Rations**

| Ingredient | 20% C. P. | 14% C. P. | 8% C. P. |
|---|---|---|---|
| Milo (8%) | 68.52 | 47.96 | 27.41 |
| Soybean meal (50.9%) | 28.50 | 19.95 | 11.40 |
| Corn starch | | 28.61 | 57.39 |
| Dicalcium phosphate | 0.64 | 1.30 | 1.89 |
| Limestone | 1.34 | 1.18 | 0.91 |
| Vit-Mineral premix[1] | 0.50 | 0.50 | 0.50 |
| Salt | 0.50 | 0.50 | 0.50 |

[1] Vitamin-trace mineral premix supplied 1500 IU vitamin A, 150 IU vitamin $D_3$, 2 mg riboflavin, 15 mg niacin, 10 mg pantothenic acid, 500 mg choline, 7.5 mcg vitamin $B_{12}$, 0.22 ppm iodine, 99 ppm iron, 22 ppm manganese, 11 ppm copper and 99 ppm zinc per pound of feed.

percent protein rations were made by diluting the 20 percent ration with corn starch which contains virtually no protein. Constant amino acid ratios across treatments were maintained by this procedure. Adequate calcium (0.75 percent), phosphorus (0.50 percent), vitamins, trace minerals and salt were added to all three rations.

The rations were fed to their respective treatment groups at a level of 5 pounds per gilt per day until the group averaged 180 days of age, then the level was reduced to 4 pounds daily giving approximately .80, .56 or .32 pounds of crude protein daily to the respective treatment groups.

The gilts were fed once daily in individual feeding stalls and had access to drinking water and shelter. Gilts were checked daily for signs of estrus by introducing a teaser boar into the pen. Ages at first and second estrus were recorded and an attempt was made to breed all gilts on the third estrus (second post-puberal) with natural services on two consecutive days. Weights were taken every two weeks to monitor growth.

Two five-day nitrogen balance studies were conducted on a random sample of the gilts. Gilts were put into crates equipped for feces and urine collection on day 11 after the second estrus and again on day 21 after breeding. A two-day adjustment period was allowed, then feces were weighed daily and urine volume was measured daily. Ten percent of each daily urine and fecal collection was frozen for nitrogen analysis by the Kjeldahl procedure.

Gilts were slaughtered at approximately 30 days post-breeding and the entire reproductive tracts were removed. Ovaries were examined for numbers of corpora lutea and live embryos were counted and measured for length. All data was analyzed by the least squares procedure with number of live embryos and percent embryo survival adjusted to equal numbers of corpora lutea and embryo length adjusted to equal age of embryo. Differences in least squares means were tested for significance by Student's "t" test.

## Results and Discussion

Total weight gain and average daily gain from the first day on test to date of first estrus were used to evaluate the effect of level of protein on growth (Table 2). Average daily gain increased with increasing protein intake; however, rate of gain was apparently beginning to plateau at the high level of intake. Gilts fed the low protein level (.32 pounds) gained significantly slower than gilts fed .56 or .80 pounds of protein. These data suggest that protein was a limiting factor in growth of the gilts; however, none of the treatments resulted in optimal weight at recommended breeding age. Energy restriction may have been too severe for these gilts.

The mean ages at first, second and third estrus (Table 3) tended to increase with decreasing protein intakes, but this trend was not significant (P<.1). These data did now show the estrual cycle irregularities which tended to be associated with the two lower protein levels (Table 4). Only one gilt (3.6 percent of total) fed the 20 percent ration failed to exhibit estrus, whereas seven (23.3 percent) and six (20.7 percent) anestrous gilts were observed in the groups fed 14 and 8 percent protein, respectively.

This study did not provide sufficient data to show a significant increase in anestrous gilts on the lower protein intakes. However, this form of reproductive failure might be the most serious problem encountered in gilts on low protein diets.

**Table 2. Total Weight Gain and Average Daily Gain to First Estrus**

| | 20% C. P. | 14% C. P. | 8% C. P. |
|---|---|---|---|
| No. of gilts exhibiting estrus[1] | 27 | 28 | 25 |
| Total weight gain, lb. | 77.2 | 76.8 | 69.0 |
| Average daily gain, lb.[2] | .96[1] | .93[1] | .74[2] |

[1] One gilt died and one crippled gilt removed from 20% group and one gilt died in 8% group.
[2] Values without a common letter differ significantly (P<.001).

**Table 3. Age at First, Second and Third Estrus[1]**

| | 20% C. P. | 14% C. P. | 8% C. P. |
|---|---|---|---|
| First estrus | 226.7 | 229.9 | 238.0 |
| Second estrus | 248.5 | 249.3 | 259.6 |
| Third estrus | 268.9 | 269.3 | 279.0 |

[1] Age in days.

**Table 4. Estrus Irregularities Observed**

| | 20% C. P. | 14% C. P. | 8% C. P. |
|---|---|---|---|
| No. of gilts on trial[1] | 28e | 30 | 29 |
| No. of anestrous gilts | 1 | 2 | 4 |
| No. of gilts exhibiting estrus once | - | 1 | - |
| No. of gilts exhibiting estrus twice | - | 4 | 2 |
| Total anestrous at breeding | 1 | 7 | 6 |

[1] One gilt died and one crippled gilt removed from 20% group and one gilt died in 8% group.

Boaz (1962) and Pond *et al.* (1968) found similar increases in anestrous gilts and sows fed low protein diets; however, numbers were too small to justify association of treatments with reproductive failures.

Fecal, urinary and retained nitrogen for collection periods I (before breeding) and II (after breeding) are presented in Table 5. Before breeding, the 20 and 14 percent protein rations appeared to allow maximum nitrogen retention with high, medium and low protein intake giving 14.2, 14.9, and 10.2 grams of retained nitrogen, respectively. These values suggest that an intake of 4 pounds of the 14 percent protein diet is adequate for protein tissue development before breeding. At this stage of development in the gilt, most of the protein absorbed from the gut is probably used in maintenance and growth of structural muscles (ham, loin, etc.) with only a very small amount going to development of the reproductive tract.

Collection period II was conducted on days 23 through 27 post-breeding and was probably well after implantation of the embryo in the uterus. Nitrogen retention increased linearly with increasing protein levels (P<.01), and the 20 percent protein ration allowed a significantly greater (P<.05) nitrogen retention (21.0 grams per day) than the 14 or 8 percent rations (9.8 and 7.2 grams, respectively).

This increased retention might indicate that the 20 percent ration fed at 4 pounds per day allowed greater protein synthesis than the 14 or 8 percent diets. This additional protein may have been deposited in uterine or mammary tissue or used for growth of structural muscle. It is also possible that the extra nitrogen retained was stored as "protein reserves" in the liver, muscles, skin, etc., Advantages of increased nitrogen retention with respect to gestation and parturition performance are not well documented.

Pregnant gilts retained slightly less nitrogen than non-pregnant gilts fed the two lower protein rations. This decreeased retention might

**Nitrogen Balance of Gilts Fed Graded Levels of Protein**

| | 20% C. P. | 14% C. P. | 8% C. P. |
|---|---|---|---|
| | **Collection Period I** | | |
| | $33.4^{1}$ | $19.2^{2}$ | $8.8^{3}$ |
| | 7.2 | 6.5 | 3.9 |
| | 14.2 | 14.9 | 10.2 |
| | **Collection Period II** | | |
| | $26.8^{1}$ | $25.9^{1}$ | $11.6^{2}$ |
| | $8.2^{1}$ | $6.3^{1,2}$ | $3.8^{2,3}$ |
| | $21.0^{1}$ | $9.8^{2}$ | $7.2^{2}$ |

In grams per day.

... a common letter differ significantly (P<.01) and linear effect significant (P<...).

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onset of pregnancy. The calculated first-limiting amino acid in the experimental rations was methionine.

Reproductive performance is summarized in Table 6. Number of corpora lutea increased as protein intake increased. Each increase in protein level resulted in an average increase of .9 ova or potential embryos. No differences in live embryo numbers, percent survival or lengtl of embryos were observed. This suggests that reproductive efficienc during early gestation was not severely impaired by the feeding of re atively low levels of protein. However, Pond *et al.* (1969) found th higher protein levels fed during the first 24 days of pregnancy signi cantly improved birth weight and postnatal growth rate of pigs. Hold *et al.* (1968) noted that increased protein intake during gestation i proved subsequent lactation and growth of offspring.

In conclusion, high protein levels fed before and after breedi seem to produce a slight improvement in overall reproductive per mance; however, numbers of gilts used in this experiment were not ficient to establish a relationship between increased protein intake greater reproductive efficiency.

Table 6. Reproductive Performance

| | 20% C. P. | 14% C. P. | 8% C |
|---|---|---|---|
| No. of corpora lutea[1] | 14.7 | 13.8 | 12. |
| No. of live embryos | 10.3 | 9.3 | 10 |
| Percent survival | 77.4 | 68.7 | 74 |
| Embryo length, in. | 1.03 | 1.03 | 1 |

[1] Linear effect significant ($P < .05$).

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# Feedlot Performance and Carcass Merit of 2-Breed and 3-Breed Cross Pigs

**R. K. Johnson, I. T. Omtvedt, L. E. Walters and T. W. Williams**

## Story in Brief

This study was initiated to evaluate differences in the feedlot performance and carcass merit for 2-breed and 3-breed crosses involving the Duroc, Hampshire and Yorkshire breeds. The data included the post-weaning feedlot performance on 606 barrows and gilts and the carcass data on 110 barrows.

There were no significant differences between 3-breed and 2-breed crosses for any of the feedlot and carcass traits evaluated. Overall, 2-breed and 3-breed cross pigs had nearly identical growth rates, feed consumption and feed efficiencies. The ½ Hampshire: ¼ Duroc: ¼ Yorkshire crossbred gilts had less backfat than the other groups and this resulted in the backfat thickness for the 3-breed crosses being 0.05 in. less than that for the 2-breed cross gilts. The carcasses from the 3-breed and 2-breed cross barrows were nearly the same for length, backfat thickness and loin eye area. The 2-breed cross carcasses averaged slightly higher yield of lean and higher color score but had a somewhat lower quality score for marbling.

In general, there appeared to be little added heterosis from 3-breed crosses over 2-breed crosses for measures of feedlot performance and carcass traits. Some interesting differences in performance between reciprocal crosses were noted, but more data are needed before drawing any definite conclusions regarding the relative importance of maternal effects.

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