NUTRITION AND THE POSTPARTUM INTERVAL OF THE EWE, SOW AND COW

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Summary

The effects of nutrition on the length of the postpartum interval (PPI, the interval from parturition to the first postpartum estrus that is accompanied by ovulation) were reviewed for the ewe, sow and cow. Unfortunately, information on the effects of nutrition on the PPI of the mare is nonexistent. Absence of estrus following weaning is a problem in postpartum sows, especially during the summer. High feed intake (more than 3 kg daily) immediately after weaning decreases the incidence of anestrus in sows of some breeds, but not in others. The incidence of prolonged intervals between weaning and estrus and the incidence of anestrus is more frequent in primiparous than in multiparous sows. The effect of nutrition on the PPI of the ewe is more controversial than that for the sow. In mature Merino ewes, neither lactation nor undernutrition during lactation affects the duration of the PPI while both factors increase the length of the PPI in coarse-wool breeds. Undernutrition during lactation increases the incidence of anestrus in primiparous fall-lambing Merino ewes. A cow must conceive by 80 days postpartum to have a 365-day calving interval. Excessive length of the PPI in dairy cows does not appear to be one of the major detriments to fertility since most dairy cows have a PPI of considerably less than 80 days. While feeding high protein diets to high-producing dairy cows shortens the PPI; this practice also increases the interval from parturition to conception. Weight changes, both before and after calving, and body condition at calving interact to affect the PPI of suckled beef cows. The length of the PPI in cows that are in good body condition at calving is not affected by either pre- or postpartum weight changes. More cows in moderate and thin body condition showed estrus by 60 days postpartum if the cows had gained weight prior to calving compared with those that lost weight prior to calving. A high percentage of thin cows that lose weight prior to calving does not show estrus following calving unless they gain weight after calving. The length of the PPI is affected by many factors, for example: parity, breed, lactation, environment and endocrine status. Designs of future experiments must be cognizant of these factors and the possible interactions of these factors with the nutritional status of the animal.

(Key Words: Postpartum Interval, Nutrition, Sheep, Swine, Dairy Cattle, Beef Cattle.)

Introduction

The postpartum interval (PPI) is the period of time from parturition until the first postpartum estrus (FPPE) that is accompanied by ovulation. Length of the PPI varies among domestic animals. In the ewe, the PPI for most breeds extends from lambing in the spring until resumption of estrous activity during autumn. Sows have complete lactational anestrus and the FPPE does not occur until suckling ceases. Variability in the length of the PPI is greatest in cattle where intervals as short as 15 days and longer than 100 days are common.

Length of the PPI is influenced by a number of factors, several of which have been discussed (Edgerton, 1980; Christensen, 1980; Kiracofe, 1980). The purpose of this review is to examine the effects of nutrition, both pre- and postpartum, on length of the PPI in sheep, swine, dairy cattle and beef cattle.

PPI of the Ewe. Length of the PPI in ewes is affected by season, breed, presence of rams and, perhaps, by lactation (see review by Hunter, 1968, especially his appendix tables 1 and 2). Various nutritional restrictions during the spring and summer months have failed to affect onset of the breeding season (Hafez, 1952; Hunter and Lishman, 1967; Ducker and Boyd, 1974; Allison, 1977; Dufour and Wolyhnetz, 1977). Some notable exceptions, however, have been reported from Australia.
Smith (1964) found more anestrous ewes in those that grazed poor quality pasture than in those that received .9 kg of supplemental alfalfa hay from lambing until mid-summer. Recently, Kenney (P. A. Kenney, personal communication) has suggested that supplemental feed provided at lambing time shortened the anestrous period.

Since the onset of the breeding season and hence the length of the PPI is affected by so many variables, it seemed appropriate to examine the effect of nutrition on the length of the PPI in fall-lambing ewes. In Alabama, 82 to 85% of fall-lambling Rambouillet ewes had PPI of less than 4 months (Barker and Wiggins, 1964). These authors also studied the effects of lactation on the length of the PPI. Nonlactating ewes had a PPI of 58 and 55 days in 2 different years which was significantly shorter than 72 and 88 days for ewes nursing single lambs, and 87 and 88 days for ewes nursing twin lambs. Other investigators claim that lactation does not lengthen the PPI if the diet of the nonlactating ewes is restricted to the recommended level (Hunter, 1968). Hunter and van Aarde (1973) examined the interaction of lactation, season and nutrition on the length of the PPI in Merino ewes (figure 1). Only season exerted a significant effect on the length of the PPI, being longer in winter-lambing ewes than in either fall- or spring-lambing ewes. These findings do not agree with those of Mallampati et al. (1971) who reported a significant effect of lactation. Unfortunately, the plane of nutrition of the nonlactating ewes was not controlled in the later study.

In a 6-year study involving 761 Merino and 360 Merino-cross, fall-lambing ewes, Lishman et al. (1974) found that weight loss due to undernutrition during an 84-day lactation period had little effect on the length of the PPI (range from 39 to 53 days) or the percentage of anestrous ewes (3 to 20%) in mature animals. Likewise, weight loss during lactation did not affect length of the PPI in primiparous ewes (46 vs 52 days in Merino ewes and 47 vs 49 days in Merino-cross ewes). There was, however, a marked difference in the percentage of anestrous ewes. Eighty-five percent and 33% of the primiparous Merino and Merino-cross ewes that lost weight during the 84-day lactation failed to show estrus compared with 17% and 4% of those that gained weight. The effects of nutrition, therefore, may be influenced by age of the animal.

Land (1971) studied the PPI of other breeds of winter-lambing ewes. The percentage of Finn, Dorset and Finn x Dorset ewes nursing single or twin lambs that had PPI less than 56 days was 100 and 100%, 60 and 83%, and 50 and 70%, respectively. The following year, the Finn x Dorset crossbred ewes were studied again and only 17% with singles and 26% with twins had PPI of less than 56 days.

Using Finn x Dorset crossbred ewes, Shevah et al. (1974) questioned the concept that

![Figure 1. The effect of plane of nutrition (high = 110% and low = 60% of NRC, 1968 for lambing and nonlactating ewes), lactation and season of lambing on PPI of Merino ewes. Drawn from data presented by Hunter and van Aarde (1973).](image)
nutrition was more important than lactation. Only 3% of suckled ewes showed estrus by 21 days postpartum compared with 47% of the nonlactating ewes. In both groups, weight gains of the ewes that failed to show estrus were similar to weight gains of ewes that did show estrus.

The following conclusions are warranted:

1. The effects of lactation on the length of the PPI differ between breeds.

2. In fall-lambing ewes, more primiparous than multiparous ewes remain anestrous if weight loss occurs during lactation.

A fruitful area for future research would be to investigate the effects of undernutrition before lambing on length of the PPI. As will be shown later in this review, undernutrition prepartum increases the length of the PPI in suckled beef cows. As shown by Hunter and Lishman (1967) and Lishman et al. (1974), the interval from parturition to ovulation was inversely related to the weight of the ewe 3 days postpartum. Therefore, if undernutrition during the last trimester of gestation caused ewes to lose weight, it would follow that they should have a longer interval from parturition to ovulation.

**PPI of the Sow.** Sows exhibit complete lactational (suckling) anestrus (see review by Edgerton, 1980). Moreover, the length of lactation influences the interval from weaning until FPPE. In general, weaning pigs after 24 days of suckling produced an interval from weaning until FPPE of 4 to 7 days (Self and Grummer, 1958; Svaigr et al., 1974; Cole et al., 1975; Hays et al., 1978). The interval from weaning until FPPE increased as the duration of suckling decreased, thus, the interval was about 10 days in sows that suckled piglets for only 2 days (Svaigr et al., 1974). The length of the PPI in the sow, therefore, is the sum of the suckling period and the interval from weaning to FPPE.

The length of the interval from weaning to estrus is of less importance to swine producers than is failure of sows to show estrus following weaning (see review by Rasbech, 1969). As shown by Britt and Levis (1978) only 49% of sows weaned in June and July showed estrus by 10 days after weaning and only 79% by 30 days after weaning. Several other authors have reported that sows fail to show estrus following weaning during summer months (see review by Christensen, 1980).

Many attempts have been made to decrease the interval from weaning to estrus and to reduce the percentage of anestrous sows by manipulating feed levels following weaning. Doubling the daily feed intake from 1.8 to 3.6 kg/day shortened the interval from weaning to estrus (22 vs 9 days) in primiparous sows following a 42-day lactation (Brooks and Cole, 1972). Not only did increasing the feed level shorten the interval from weaning to estrus, but it also decreased the percentage of anestrous sows from 36 to 0%. When these studies were repeated in multiparous sows, increasing the feed level from 1.8 to 4.5 kg/day had no effect on either the interval from weaning to estrus or the percentage of anestrous sows (Brooks et al., 1975). On the other hand, Fahmy and Dufour (1976) found a higher incidence of anestrous sows (12 vs 2%) in those fed 2.7 kg/day compared to those with ad libitum feed intake following weaning. Inconsistent results have also been observed in primiparous sows. Allrich et al. (1979) showed that fasting for 0, 2, 3 or 4 days following either 21- or 30-day lactations did not affect either the length of the interval from weaning to estrus or the percentage of anestrous sows.

It seems likely that not only season (Christensen, 1980) but also breed may affect both the interval from weaning to estrus and the percentage of anestrous sows. In Canada, increasing the postweaning feed level had no effect on the length of the interval from weaning to estrus or the percentage of anestrous sows (Dyck, 1972). There were marked differences in these two parameters, however, between Yorkshire and Lacombe sows.

The results on the effect of feed level following weaning are not consistent either in primi- or multiparous sows. Since anestrus is a problem, especially during the summer months, future research should be directed towards examining the effects of temperature, photoperiod, breed and nutrition on the occurrence of estrus following weaning.

**PPI of the Dairy Cow.** The PPI of dairy cows ranged from 30 to 72 days in 18 studies reviewed by Casida et al. (1968). In order to maintain a calving interval of 365 days or less, a cow must conceive by 80 days after parturition; thus, the PPI of most dairy cows falls within this limit. Moreover, there are some recent arguments concerning the advisability, because of economic considerations, of maintaining a 365-day calving interval versus somewhat longer intervals (Shafer and Henderson, 1972; Gill and Allaire, 1976; Olds et al., 1979; H. E. Shaffer, personal communication). Low conception rates probably extend...
the calving intervals of dairy cows more often than do long PPI.

Because of more intensive management practices and because heavy feeding prior to calving was, until recently, an accepted management practice (Etgen and Reaves, 1978), few studies have examined the effects of nutrition on the length of the PPI of dairy cattle. The PPI of primiparous dairy heifers was increased about 21 days (88 vs 67 days) by underfeeding during gestation (Joubert, 1954). On the other hand, overfeeding during gestation did not shorten the PPI compared with feeding recommended levels (Gardner, 1969). Cows fed grain in increasing amounts (grain increased from 1.8 to 9.1 kg/day during the last 21 days of pregnancy) with ad libitum intakes of corn silage had PPI similar to cows fed grain in constant amounts (0 to 2.7 kg/day) during the entire dry period (Morrow et al., 1969).

Wagner (1974) suggested that the incidence of postpartum infertility may increase in intensive dairy operations, especially in high producing cows. In a recent survey of 9,750 Holstein cows in 125 herds in New York, the interval from parturition to conception was 37 days longer in high producing cows (at least 907 kg more milk than their herd mates) than in low producing cows (Spalding et al., 1975). Thus, it appears that the reproductive performance of high producing cows was less than that of lower producing cows. Since high producing cows often lose weight early in lactation, inadequate nutrition may be associated with the decrease in fertility.

The effects of varying the protein content of diets during lactation for high producing dairy cows has recently attracted much attention. Feeding high protein levels (19.3% crude protein) to high producing cows (30 kg milk/day at the peak of the previous lactation) shortened the PPI by 18 and 9 days compared with the cows receiving 18.3% and 12.7% crude protein diets (Jordan and Swanson, 1979). In the United Kingdom, cows fed 75% of the recommended protein requirement for 8 weeks prior to and 8 weeks following parturition had PPI 11 days longer (46 vs 35 days) than cows fed the recommended level of protein (Treacher et al., 1976). In both studies, however, the interval from parturition to conception was shorter in the cows fed the lower levels of protein. Feeding as much as 290 g urea/cow/day in 14.5% crude protein lactation diets did not affect the length of the PPI although urea feeding increased the calving interval in one trial (Erb et al., 1976).

Dairy cows present a markedly different situation than do beef cows. They are maintained on a high plane of nutrition in order to maintain a high level of milk production. Moreover, milk production is measured frequently, not yearly as is the calf production of beef cows. The dairyman soon realizes when a cow is decreasing in production and can make appropriate ration adjustments. Consequently, we believe that problems with undernutrition of dairy cows are less frequent than in beef cows. An alternative is that the PPI of the milked (dairy) cow is less sensitive to pre- or postpartum weight losses than is that of the suckled (beef) cow (Oxenreider and Wagner, 1971).

The studies reviewed show that the PPI of milked dairy cows are within acceptable limits. At least two factors seem to produce shorter PPI in dairy cows compared with beef cows: First, they are milked, usually only twice daily, instead of suckled ad libitum. Secondly, they are usually on a high plane of nutrition because of the demands of lactation.

PPI of the Beef Cow. The PPI of the suckled beef cow is of critical importance to the cow-calf operator. As shown in table 1, the average daily gain for calves between 106 and 273 days of age was nearly constant (varying only .05 kg/day from .67 to .72 kg/day). A calf born late in the calving season will be younger at weaning than a calf that is born early in the calving season. An extended PPI is a frequent cause of late calving. The length of the PPI may also affect the number of cows that become pregnant since cows with an extended PPI may fail to show estrus during the breeding season, or if they do show estrus late in the breeding season, they must conceive to a single service.

The PPI of suckled cows is affected by several factors. Heifers nursing their first calves have longer PPI than older cows (Wiltbank, 1970; Bellows and Short, 1978). Cows that experience difficult parturition have longer PPI than do cows that have normal parturition (Laster et al., 1973). Cows that are suckled frequently have longer PPI than do cows that are suckled only once daily (Randel and Welker, 1977). Cows that calve in winter have longer PPI than cows that calve in spring (Warnick, 1955; Bellows and Short, 1978). The effects of nutrition on reproductive performance of the cow have been reviewed by several authors (Reid, 1960; Wiltbank et al., 1965; Baker, 1969; Lamond, 1970; Topps,
TABLE 1. AGE AND WEANING WEIGHT FOR 20,192 WYOMING CALVES*

<table>
<thead>
<tr>
<th>Weaning age (days)</th>
<th>No. of calves</th>
<th>Weaning weight (kg)</th>
<th>Average daily gain (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 106</td>
<td>54</td>
<td>119</td>
<td>.85</td>
</tr>
<tr>
<td>106-126</td>
<td>123</td>
<td>118</td>
<td>.72</td>
</tr>
<tr>
<td>127-147</td>
<td>589</td>
<td>133</td>
<td>.72</td>
</tr>
<tr>
<td>148-168</td>
<td>2107</td>
<td>146</td>
<td>.71</td>
</tr>
<tr>
<td>169-189</td>
<td>5103</td>
<td>163</td>
<td>.72</td>
</tr>
<tr>
<td>190-210</td>
<td>6507</td>
<td>175</td>
<td>.71</td>
</tr>
<tr>
<td>211-231</td>
<td>3892</td>
<td>190</td>
<td>.71</td>
</tr>
<tr>
<td>232-252</td>
<td>1009</td>
<td>199</td>
<td>.69</td>
</tr>
<tr>
<td>253-273</td>
<td>637</td>
<td>205</td>
<td>.67</td>
</tr>
<tr>
<td>279-294</td>
<td>109</td>
<td>296</td>
<td>.62</td>
</tr>
<tr>
<td>&gt; 294</td>
<td>62</td>
<td>204</td>
<td>.57</td>
</tr>
</tbody>
</table>

*From C. O. Schoonover, unpublished data, Univ. of Wyoming.

The effects of body condition at parturition and pre- and postpartum weight changes on the length of the PPI will be further examined.

Several investigators, mostly from Dr. Wiltbank's group, the Livestock and Range Research Station at Miles City, MT and our group at the University of Wyoming, have studied the effect of both pre- and postpartum energy intake on reproductive performance of beef females. We have evaluated the combined results from these three laboratories by regression analysis. The percentage of cows that had shown estrus by 60 days postpartum was regressed onto the mean prepartum weight change for the group. Likewise, the mean length of the PPI was regressed onto the mean prepartum weight change. Separate analyses were conducted for 2-year-old heifers and for multiparous cows. The prepartum weight change was calculated by finding the difference between cow weight shortly after calving and cow weight about 100 days prior to calving. A negative prepartum weight change means that the cow utilized her body tissue stores to provide nutrients for the developing conceptus. A positive prepartum weight change indicates that the cow consumed sufficient nutrients to meet the demands of maintenance plus growth of the conceptus. In instances where postpartum weight was not presented, it was estimated by deducting 50 kg (Corah, 1974) from the weight taken within 1 week prior to parturition. The sources of data used to prepare figures 2 through 5 are shown in table 2.

Based upon the regression analysis for multiparous cows, 91% of cows that have 0 prepartum weight change will show estrus by 60 days postpartum (figure 2, r = .76, P<.01). For each kilogram of negative prepartum weight change, the percentage of cows that show estrus by 60 days postpartum decreases by .5%. Thus, for cows that lost 120 kg, only 30% would be expected to show estrus by 60 days postpartum. The relationship between the length of the PPI and prepartum weight change was negative (figure 3, r = —.56, P<.05). Using the regression equation (figure 3) the predicted length of the PPI was 47 days for cows that had 0 prepartum weight change.

The same relationships were examined for first-calf, 2-year-old heifers. Sixty-four percent of the heifers with 0 prepartum weight change were predicted to show estrus by 60 days postpartum (figure 4, r = .38, P<.05). As in the multiparous cows, the relationship between the length of the PPI and prepartum weight change was negative (figure 5, r = —.56, P<.05). Therefore, 2-year-old, first-calf heifers with 0 prepartum weight change would be

TABLE 2. SOURCES OF DATA FOR FIGURES 2, 3, 4 and 5

<table>
<thead>
<tr>
<th>Mature cows</th>
<th>Postpartum interval (figure 3)</th>
<th>2-year-old heifers</th>
<th>Postpartum interval (figure 5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent in estrus by 60 days (figure 2)</td>
<td>Dunn, 1964</td>
<td>Dunn, 1964</td>
<td></td>
</tr>
<tr>
<td>Wiltbank et al., 1962</td>
<td>Wiltbank et al., 1962</td>
<td>Dunn, 1964</td>
<td></td>
</tr>
<tr>
<td>Wiltbank et al., 1964</td>
<td>Wiltbank et al., 1964</td>
<td>Dunn et al., 1969</td>
<td></td>
</tr>
<tr>
<td>Corah, 1974</td>
<td>Corah, 1974</td>
<td>Corah et al., 1975</td>
<td></td>
</tr>
<tr>
<td>Clemente, 1978</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
after calving. Records from 686 Hereford and Angus females were used in the study. Data from primiparous and multiparous cows were combined. In his original report, Whitman classified cows into four groups according to weight gains before and after parturition: 1)
gained before and after, 2) gained before and lost after, 3) lost before and gained after, and 4) lost before and after. Within each of the four groups, he further subdivided cows into those in thin, moderate and good body condition at parturition. Unfortunately, Whitman used weights taken immediately before instead of immediately after parturition to calculate increased to 45 and 47% in thin cows that lost weight prior to calving but gained weight after calving. In spite of thin body condition at parturition and weight loss after parturition, 67% of the thin cows that gained weight prior to calving had shown estrus by 60 days postpartum.

Cows that fail to show estrus by 80 days

![Graph](image)

**Figure 6.** The effect of body condition at parturition, prepartum weight change and postpartum weight change on percentage of cows that had shown estrus by 60 days postpartum. Body condition was subjectively scored from 1 to 9 with 1 being thinnest and 9 being fattest. Cows with scores of 1 to 3, 4 to 6 and 7 to 9 were designated in thin, moderate and good condition, respectively. Drawn from data presented by Whitman (1975).

prepartum weight changes. To allow for losses at parturition, we subtracted 50 kg (Corah, 1974) from the group average prepartum weight changes he calculated. When this was done, the group of thin cows that gained weight before and after calving became a group of thin cows that lost weight before and gained after calving (figure 6).

A high percentage of cows in good body condition at parturition had shown estrus by 60 days postpartum regardless of weight changes either before or after parturition (figure 6). Prepartum weight change exerted more effect than did postpartum weight change for cows in moderate body condition. Sixty-nine and 74% of cows in moderate body condition that gained weight prior to parturition had shown estrus by 60 days postpartum compared with 51 and 48% of those that lost weight prior to parturition. Only 25% of the thin cows that lost weight both before and after calving had shown estrus by 60 days postpartum. This was postpartum cannot maintain a 365-day calving interval. As shown in table 3, more cows that were thin at calving failed to show estrus by 80 days postpartum compared with cows in moderate or good body condition.

The response to prepartum weight change seems to depend upon the body condition of the cow at parturition. Cows that are in good body condition at calving are affected little by either pre- or postpartum weight changes. More cows in moderate or thin body condition will have PPI of 60 days or less if they gain weight prior to calving. Postpartum weight gains are essential for cows that are thin at calving if they lost weight before calving.

The mechanism by which nutrition influences the length of the PPI is elusive and will likely remain so until the factor or factors which trigger the onset of the FPPE are determined. Both nutrition and suckling play important roles in determining the length of the PPI. It also seems likely that the two factors...
may interact to affect the duration of the PPI. The recent report by Kaiser (1975) presented some interesting information on the effect of combinations of suckling and milking on the length of the PPI in Jersey cows. In this study, cows were suckled by three calves for 6, 9 or 12 weeks. The calves were then weaned and the cows were milked twice daily. Control cows were milked twice daily from parturition. The length of the PPI was directly related to the length of the suckling period (37, 53, 79 and 98 days for control cows and cows suckled 6, 9 and 12 weeks, respectively). The intervals from weaning to estrus were similar for all of the suckled cows (11, 16 and 14 days for cows suckled 6, 9 and 12 weeks, respectively). The milked cows lost the least weight from calving to 12 weeks postpartum. Cows suckled for 6 weeks and then milked lost more weight than either of the other two suckled groups of cows but had the shortest PPI of all of the suckled cows.

Other investigators have shown that lactational status produces a differential response to a given nutritional treatment. Oxenreider and Wagner (1971) reported that the interval from parturition to ovulation was not affected by postpartum energy intake in nonlactating or milked cows. In suckled cows, however, only those cows on the high energy intake ovulated by 56 days postpartum. The milked cows had the greatest postpartum weight loss which suggests that the PPI of milked or nonlactating cows may be less sensitive to nutritional manipulations. Further support of the concept that lactational status affects response to a given nutritional treatment was provided by Randel and Welker (1977) who studied 2-year-old Brahman crossbred heifers. In spite of a high plane of nutrition both before and after calving, heifers that were suckled *ad libitum* had a 124-day PPI, and 5 of 17 heifers did not show estrus during the 180-day suckling period. Allowing calves to nurse only once daily decreased the length of the PPI to 32 days and all heifers showed estrus. Even once-daily suckled heifers on a low plane of nutrition had a shorter PPI than *ad libitum* suckled heifers on a high plane of nutrition (71 vs 124 days) and more heifers showed estrus (14 of 16 vs 12 of 17).

In one of our studies, it appeared that prepartum weight changes did not interact with lactational status (Clemente, 1978). Cows that gained weight prior to calving had shorter PPI than cows that lost weight prior to calving whether calves were weaned at 10 days of age or allowed to suckle *ad libitum* (table 4). However, when we examined the serum concentrations of luteinizing hormone (LH) and progesterone of the early weaned cows, we found that six (one that gained and five that lost weight prepartum) of 15 cows had an LH surge an average of 13.5 days before FPPE. This LH surge was followed by 12.5 days of increased serum progesterone concentrations and then the FPPE. We assumed that the cows with these endocrine profiles ovulated after the initial LH surge. When the intervals from calving to the assumed ovulation were calculated, the prepartum ration was not a significant source of variation in the length of the interval from parturition to first ovula-

### TABLE 3. EFFECT OF BODY CONDITION AT PARTURITION AND WEIGHT CHANGES BEFORE AND AFTER PARTURITION ON PERCENTAGE OF COWS THAT FAILED TO SHOW ESTRUS BY 80 DAYS POSTPARTUM*

<table>
<thead>
<tr>
<th>Weight change Before parturition</th>
<th>Weight change After parturition</th>
<th>Body condition at parturition</th>
<th>Good</th>
<th>Moderate</th>
<th>Thin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gained</td>
<td>Gained</td>
<td>Good</td>
<td>7</td>
<td>7</td>
<td>33</td>
</tr>
<tr>
<td>Gained</td>
<td>Lost</td>
<td>Moderate</td>
<td>0</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Lost</td>
<td>Gained</td>
<td>Thin</td>
<td>0</td>
<td>20</td>
<td>22</td>
</tr>
<tr>
<td>Lost</td>
<td>Lost</td>
<td></td>
<td>0</td>
<td>10</td>
<td>75</td>
</tr>
</tbody>
</table>

*From Whitman (1975).

### TABLE 4. THE EFFECT OF PREPARTUM WEIGHT CHANGE ON THE PPI OF SUCKLED OR NONLACTATING COWS*

<table>
<thead>
<tr>
<th>Weight change before parturition</th>
<th>Lactational status</th>
<th>Nonlactating (days)</th>
<th>Suckled (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gained</td>
<td></td>
<td>15</td>
<td>42</td>
</tr>
<tr>
<td>Lost</td>
<td></td>
<td>27</td>
<td>70</td>
</tr>
</tbody>
</table>

*From Clemente (1978).
tion for the nonlactating cows but was for the suckled cows.

To summarize, body condition at calving and prepartum weight changes are important factors that affect the length of the PPI of beef cows. Postpartum weight gains are essential for cows that are thin at calving and that lost weight prior to calving.

When designing future research projects to study the effects of nutrition on the length of the PPI, one must remember that many factors affect the length of the PPI in the ewe, sow and cow and these factors probably interact with the nutritional status of the animal.

Economic Importance of the PPI. The economic importance of the length of the PPI of the ewe depends upon the management system that is employed. In extensive range operations with breeding in late fall or early winter and late spring lambing, the length of the PPI is of little importance. In intensely managed farm flocks, especially those managed for more than one lamb crop per year, the length of the PPI becomes quite important.

The length of the interval from weaning to estrus is probably of less importance to the swine producer than the failure of sows to show estrus following weaning. In summer months, a significant percentage of sows may be anestrous and therefore infertile.

The importance of the length of the PPI of dairy cows is debatable. Most dairy cows do not have infertility problems because of PPI of greater than 80 days. In suckled beef cows, the PPI is often extended beyond 80 days, which means that a cow cannot maintain a 365-day calving interval. A calf born to a cow with an extended PPI will thus be younger and hence weigh less at weaning. In extreme situations cows may not show estrus during the entire breeding season and will thus fail to become pregnant, or if they do show estrus late in the breeding season, they must then conceive to a single service.

Literature Cited


Self, H. L. and R. H. Grummer. 1958. The rate and economy of pig gains and the reproductive behaviour in sows when litters are weaned at 10 days, 21 days, or 56 days of age. J. Anim. Sci. 17:862.


DISCUSSION

Question: Dr. Bellows

I think it is very interesting the way that you pooled the different studies together and the amount of scatter you had in terms of linear response. It is very interesting when we look at those original means that were something like 45 or 90 kg on the average. Did you look at this in terms of a curvilinear effect?

Dr. Dunn: No I did not. It certainly appears that percentage of females in estrus by 60 days postpartum and the length of the postpartum interval may have a nonlinear relationship with prepartum weight change, especially in mature cows.

Question: A Questioner

Concerning your final conclusion about the effect of nutrition and lactation on the postpartum interval of the ewe, would you be willing to go out on a limb and say these factors are not affecting the postpartum interval of the ewe?

Dr. Dunn: Mr. Gary Sides, one of our graduate students, has experiments in progress to hopefully answer this question.

Question: A Questioner

There are some data that would indicate that nutritional stress lowers progesterone levels. Would you care to comment?

Dr. Dunn: The results in cattle are somewhat contradictory. Decreases in plasma concentrations of progesterone during undernutrition were observed in dairy (Gombe and Hansel, 1973. J. Anim. Sci. 37:728) and beef (Hill et al., 1970. Biol. Reprod. 2:78) heifers. In our laboratory, Janice Rone (M.S. Thesis, Univ. of Wyoming, 1975) found increased plasma concentrations of progesterone during undernutrition of mature Hereford cows. This apparent contradiction may be explained by the duration of the period of undernutrition since there is some evidence (Donaldson et al., 1970, J. Endocrinol. 48:599) that progesterone levels initially increase in response to undernutrition and then decrease.

We also measured plasma concentrations of FSH in Rone's study and it appeared that undernutrition suppressed FSH levels. I think this is interesting in view of the recent work at Iowa State (L. L. Anderson, personal communication) in which inanition of pregnant gilts produced ovaries devoid of follicles but with functional corpora lutea. The failure of follicular growth may be related to a deficiency of FSH caused by inanition.