

TITLES AND ABSTRACTS OF SHORT PAPERS GIVEN AT THE  
56TH MEETING OF THE BRITISH SOCIETY OF ANIMAL PRODUCTION,  
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1. REPLACING BARLEY WITH DRIED GRASS IN INTENSIVE BEEF PRODUCTION

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Intensive beef diets containing 33, 50, 66 and 100% dried-grass pellets, with the remainder as rolled, moist barley, were compared with a Rowett-type diet. The dried grass was first-cut RVP Italian Ryegrass with a digestibility value of 70, and 15% crude protein. Five British Friesian and one Hereford × British Friesian ♂ castrates were individually fed *ad libitum* on each diet, from about 120 kg at 16 weeks through to slaughter at about 390 kg when they were 12 to 15 months old. Intakes on all treatments were similar. There were no significant differences between the growth rates of animals on any of the diets containing a proportion of barley. All gained at about 1.1 kg per day, which was significantly greater ( $P < 0.01$ ) than those on the all-grass diet (0.8 kg/day). Animals on dried grass alone took 12 weeks longer to reach slaughter weight, and consequently had significantly poorer food conversion (7.9 to 1 compared with 6.1 to 1) than animals on the other treatments.

2. DIETS FOR BEEF CATTLE BASED ON BARLEY GRAIN AND GROUND BARLEY STRAW

J. Lockwood, H. Swan and B. Wilton, *University of Nottingham, School of Agriculture, Sutton Bonington, Loughborough, LE12 5RD.*

Owing to advanced lignification at harvest, long or chopped cereal straws are of limited value in rations for intensive or semi-intensive beef cattle. Such straws are of low digestibility and in these forms voluntary intake is low. Further, complete diets cannot be based on long or chopped cereal straws owing to fractionation and the subsequent selective intake practised by the animal. The grinding of barley straw within a modulus of fineness range 2.36 to 3.39, and within a modulus of uniformity range 0.5:5 to 1.7:2, allows the preparation of complete rations containing large quantities of ground straw without fractionation. The voluntary feed intake of these diets is not related to their apparent digestibility. The optimal range of particle size distribution was determined by digestibility and feeding trials. In a diet of 30% ground barley straw, 20% molasses, 45% ground barley, 2% urea and 3% mineral and vitamin supplement (12% crude protein), the optimal animal performance was obtained when straw was ground within a screen range 6.4 to 9.5 mm. The live-weight gain of animals fed these diets over a weight range 300 to 425 kg was 1.04 to 1.14 kg per day; this was comparable with the performance of animals fed a similar diet without the inclusion of ground straw. In a further experiment with a diet of similar composition (10% crude protein), the influence of physical form of grain and the nature of protein supplement was tested with animals over the weight range 300 to 450 kg. There were no differences between grinding or rolling the barley grain, nor between protein supplementation in the form of soya bean meal or urea.

## 3. INTENSIVE BEEF PRODUCTION: REPLACEMENT OF MAIZE WITH GROUND STRAW

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In earlier trials young growing ♂ castrates (steers) given unpelleted diets containing ground barley grew more rapidly and consumed less feed than steers given mixtures of ground barley containing 15 or 30% ground straw. The object of this experiment was to examine the effects on feed intake and rate of gain of replacing ground maize with ground straw in diets for growing steers. Twenty-four British Friesian steers were reared on an all-concentrate diet containing barley, and allocated to one of three diets at 250 kg. These were (A) a ground maize concentrate mixture and two further diets in which either 15% (B) or 30% (C) of the ground maize was replaced by ground straw. The steers were grown from 250 to 430 kg in individual pens with slatted floors. No long roughage was offered.

Daily dry-matter intakes (kg/day) and daily live-weight gains (kg/day) were 6.20 and 0.99, 7.37 and 1.02, 7.85 and 0.93 for steers given diets A, B and C respectively. Carcass gain (kg/day) declined from 0.61 to 0.52 and killing-out percentage from 57.9 to 55.5 between steers given diet A or diet C. The dry-matter digestibility coefficients for the diets, measured at maximal intake, were 81.8 (A), 75.9 (B) and 65.3% (C).

## 4. THE VALUE FOR BEEF CATTLE OF HIGH-MOISTURE MAIZE GRAIN WITH DRIED LUCERNE COBS

G. M. J. Horton and W. Holmes, *Wye College (University of London), Wye, Ashford, Kent.*

Two experiments were carried out to evaluate high-moisture (HM) maize grain, preserved with 1.5% propionic acid, and dehydrated lucerne cobs for beef cattle. In the first experiment, four treatments offered the same daily quantities of concentrate DM: rolled barley (2.50 kg) and decorticated groundnut meal (DGM) (0.35 kg); rolled barley (1.36 kg) and lucerne (1.49 kg); HM maize (2.40 kg) and DGM (0.45 kg); and HM maize (1.17 kg) and lucerne (1.68 kg).

These were compared in a randomized block design with 40 beef cattle of 260 kg mean live weight. A mineral and vitamin supplement was added daily, and barley straw was offered *ad libitum*. Whole maize was fed for the first 42 days, and rolled maize for the second 42 days of the experiment. Daily live-weight gains during the first period were 0.68, 0.64, 0.34 and 0.51 kg (SE 0.05 kg), and digestible organic matter (DOM) values were 62, 61, 52 and 54% (SE 1.15%), respectively. In the second period, daily live-weight gains averaged 0.56, 0.41, 0.70 and 0.61 kg (SE 0.06 kg) and DOM values were 63, 61, 63 and 62% (SE 1.10%), respectively. There was no difference in barley straw consumption (average 46g OM/kg  $W^{0.75}$ ). In the second experiment, two treatments consisting of 1.0 kg lucerne cobs, 0.8 kg barley straw and either 2.1 kg whole HM maize or 2.1 kg rolled HM maize were compared. Mean daily live-weight gains were 0.42 and 0.61 kg (SE 0.05 kg), and DOM values for the whole diets were 63 and 65% (SE 1.8%), respectively.

## 5. THE FEEDING VALUE OF ARTIFICIALLY DRIED, WHOLE CROP CEREALS AND LEGUMES

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At the present time in the 'Green-crop' drying industry no work has been documented on the feeding value of crops other than grass, clover and lucerne (with the

exception of whole-crop beans). In the first experiment 1:1 mixtures of whole-crop dried wheat or barley, with peas or beans as a nitrogen supplement, were fed to four groups of 17 6-month-old ♂ castrate sheep for a period of 42 days. The materials were finely milled, pelleted and fed *ad libitum*. Mean dry matter intakes (kg/lamb per day) for the wheat+peas, wheat+beans, barley+peas and barley+beans treatments were 1.69, 2.05, 1.80 and 1.81, and the corresponding live-weight gains (kg) were 11.0, 12.1, 11.9 and 9.5. The efficiencies of conversion of feed dry matter to live-weight gain were 6.46, 7.10, 6.37 and 7.98. In the second experiment dried pelleted whole-crop maize was fed to beef cattle in conjunction with molasses and one of three protein sources, soya bean meal, urea or whole-crop beans. The three diets were fed *ad libitum* to three groups of 8 12-month-old British Friesian ♂ castrates for a period of 90 days. The mean dry-matter intakes (kg/day) for the maize+soya, maize+urea and maize+beans treatments over the period were 9.68, 9.38 and 9.72, and the corresponding live-weight gains (kg/day) were 1.26, 1.04 and 1.15. The efficiencies of feed conversion were 7.64, 9.00 and 8.54 respectively.

## 6. THE UTILIZATION OF MAIZE SILAGE FOR BEEF PRODUCTION

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Fifty-four British Friesian ♂ castrates (steers), initially 3, 6 or 9 months of age, and of similar weight for age, were individually fed for 3 months on maize silage (28% dry matter (DM), 10.6% crude protein (CP) in DM). Silage was offered either alone or supplemented with cobs of dried lucerne (22% of total DM intake). Three levels of urea (0, 1 and 2% of silage DM) were added to the silage before feeding. Silage DM intakes averaged 20.4, 20.8 and 19.4 g/kgW for the 3-, 6- and 9-month-old animals respectively. Addition of urea increased average DM intake ( $P < 0.05$ ) from 19.7 (no urea) to 20.5 g/kgW (2% urea). The response to urea was most marked in the 6-month-old group. Lucerne supplementation reduced silage intake but increased total intake ( $P < 0.001$ ). Live-weight gain (LWG) of the steers fed silage alone was highest in the oldest group. The main effect of urea was to increase LWG from an average of 0.79 (no urea) to 0.94 kg/head per day (2% urea). Addition of lucerne increased mean LWG from 0.77 to 0.99 kg/head per day, but the response declined with increasing age of animal ( $P < 0.001$ ). Inclusion of lucerne significantly reduced the response to urea ( $P < 0.05$ ). Feed conversion ratio (kgDM/kg LWG) and feed efficiency (kg LWG/100Mcal metabolizable energy intake) were 5.4 and 7.25; 5.9 and 6.24; 6.9 and 5.17 for the 3-, 6- and 9-month-old groups respectively. It was concluded that steers older than 6 months of age (180 kg) could achieve a growth rate of 1.0 kg/head per day on silage and urea, but that younger animals required lucerne supplementation to support this rate of gain.

## 7. NITROGEN AND ACIDITY AS FACTORS INFLUENCING THE VOLUNTARY INTAKE OF MAIZE SILAGE

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Twelve rumen-fistulated British Friesian ♂ castrate calves initially three months of age and 77 kg live-weight were fed, both *ad libitum* and at a restricted intake, either maize silage (26% dry matter (DM), 8.6% crude protein (CP)) alone or with 2% of urea in the silage DM added at the time of feeding. At each level of urea (0 or 2%), silage pH was left unchanged (pH 3.9) or was increased (pH 5.4) by the

addition of sodium bicarbonate. Silage pH levels were changed over within each urea level. Silage DM intake was increased by 8% ( $P < 0.05$ ) with urea, 12% ( $P < 0.01$ ) with sodium bicarbonate, and 20% with both. At restricted DM intake addition of urea increased rumen ammonia nitrogen from 3.17 to 13.41 mg/100 ml ( $P < 0.001$ ), and blood urea nitrogen from 2.20 to 10.06 mg/100 ml ( $P < 0.001$ ). There was no significant effect of silage pH on rumen pH. However, partial neutralization by sodium bicarbonate increased venous blood pH from 7.366 to 7.396 ( $P < 0.001$ ), and urine pH from 7.43 to 8.42 ( $P < 0.001$ ). It is suggested that both low nitrogen content and acidity may limit the intake of ensiled maize, and that the effect of silage pH may be metabolic rather than ruminal.

#### 8. LAMB GROWTH ON GRASS AND CLOVER DIETS

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The growth rates of hill lambs usually decline steadily from the peak of lactation to weaning. This work was carried out to examine the growth rates of hill lambs during the late lactation period on grass of both hill and lowland origin, with and without White Clover. Re-growths of *Agrostis-Festuca* herbage, S23 Ryegrass and White Clover were harvested and cold stored. Sixty Border Cheviot ♂ castrate lambs were weaned when 9 weeks old and randomly allocated to five groups of 12 by live weight. One group was slaughtered and four groups were individually penned indoors. Each group was fed one of the following herbage: Ryegrass (RG), Ryegrass + Clover (RG/Cl), *Agrostis-Festuca* (AF), *Agrostis-Festuca* + Clover (AF/Cl). The mixed herbage contained equal amounts of clover and grass dry matter. Lambs were fed *ad libitum* to 20% excess daily. Organic matter digestibility was determined on two occasions. Live weights were recorded once weekly; all lambs were slaughtered after 9 weeks. Mean daily live-weight gains (LWG) (g/head per day) ( $\pm$  SE) were: RG/Cl 183  $\pm$  8, RG 149  $\pm$  12, AF/Cl 107  $\pm$  9, AF 59  $\pm$  3. Organic matter intakes (OMI) (g/head per day) were: RG/Cl 780  $\pm$  28, RG 642  $\pm$  30, AF/Cl 563  $\pm$  20, AF 464  $\pm$  17. Digestible organic matter intakes (DOMI) were: RG/Cl 612  $\pm$  22, RG 499  $\pm$  23, AF/Cl 428  $\pm$  15, AF 340  $\pm$  13. Clover increased DOMI on both grasses by approximately 24%; this was largely due to increases in OMI. LWG was related to DOMI/kg  $W^{0.73}$  by the equation: LWG =  $-148 + 5.4 \text{ DOMI/kg } W^{0.73}$  (residual standard deviation  $\pm 22$ ) OMI/kg  $W^{0.73}$  was positively related to organic matter digestibility and negatively to 'neutral detergent fibre'.

#### 9. THE FOOD INTAKE AND GROWTH OF LAMBS GIVEN CHOPPED AND/OR PELLETED DRIED GRASS

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From a survey of the literature it appeared that although the pelleting of dried grass for sheep would increase intake considerably in short-term, changeover experiments, the increase might be smaller in the long term. Four groups of eight castrated male lambs, weighing initially about 37 kg, were accustomed to both chopped and pelleted grass and then fed *ad libitum* for 18 weeks on: C, chopped throughout; P, pelleted throughout; C/P (or P/C), the two forms alternated every 3 weeks; or C+P, both forms on offer. Daily dry matter intake is expressed throughout as g/kg metabolic live weight ( $W^{0.75}$ ). Intake for C was 58.2 and for P, 81.4 (SE of difference  $\pm 2.9$ ); thus the 'long-term' difference, 100

(P—C)/C, was 40%. For treatment C/P intakes of C and P were 51.1 and 84.6, and the 'short-term' difference was therefore 66%. Overall daily intake for C/P (67.9) was close to the mean of treatments C and P (69.8). For treatment C+P, intakes were 9.3 g C and 75.6 g P; total intake (84.9) was slightly but not significantly greater than that for treatment P. Dry-matter digestibility coefficients were 74.0% for treatment C, 61.4% for P and 62.0% for C+P. At slaughter, total gut fill (% of live weight) was C, 16.0; P, 10.1; P/C, 13.8; C/P, 11.5; C+P, 11.3. Mean empty weight gains (g/day) were C, 112; P, 181; C/P (or P/C), 126; C+P, 195 (SE of differences  $\pm 12$ ).

#### 10. THE EFFECT OF PROCESSING ON THE UTILIZATION OF CEREALS BY YOUNG LAMBS

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A trial was conducted with 36 female lambs in which the effects of methods of cereal processing on growth and digestibility were compared. The treatments compared were barley rolled and pelleted (RP), barley pelleted without rolling (WP) and whole unprocessed grain (W).

Digestibility of organic matter for RP, WP and W was 80.8, 79.3 and 81% respectively, and corresponding growth rates to 35 kg live weight were 260, 270 and 260 g/day. Dry matter required per kg live-weight gain was 3.20, 3.20 and 3.00 kg and the killing-out percentages were 49.6, 50.2 and 49.3 respectively. Only the difference in food conversion between the processed and unprocessed barley was significant.

A second trial was carried out with 64 early-weaned lambs using maize, barley, wheat and oats, given whole and unprocessed or roughly milled and pelleted. A protein supplement was given as a pellet with the whole grain or incorporated into the pellets for the lambs receiving processed cereals.

Feed was given *ad libitum* and slaughter was at 35 kg live weight. The growth rates (g/d) for the whole and pelleted diets were 345 and 346, 340 and 347, 297 and 323, and 241 and 238 for the respective cereals. The corresponding food conversion ratios (kg dry matter/kg gain) were 2.52 and 2.62 for maize, 2.75 and 2.79 for barley, 2.97 and 2.56 for wheat and 3.07 and 3.33 for oats.

#### 11. THE USE OF DRIED GRASS AS A COMPONENT OF CONCENTRATE MIXTURES FOR LACTATING DAIRY COWS

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Twenty-four cows were used in a randomized block, continuous feeding trial to examine the effects of level of dried grass inclusion in a supplement given to cows receiving grass silage *ad libitum*. The levels of dried grass inclusion were 0, 25 and 50% of the supplement. The remainder of the supplements was mainly barley, but soya bean meal was included as necessary to maintain a crude protein content of 15% in all supplements. All three supplements were given at the rate of 0.4 kg/kg of milk. The treatments were imposed for a 6-week period after a preliminary feeding period of 4 weeks. At the beginning of the experiment the cows were on average 39 days calved. The mean intakes of silage dry matter were 7.60, 8.28 and 8.39 kg/day for the supplements containing 0, 25 and 50% dried grass respectively. The inclusion of dried grass, both at the 25% and 50% level, significantly increased

the intake of silage ( $P < 0.05$ ). The mean milk yields of 19.7, 18.5 and 19.6 kg/day for the three levels respectively, were not significantly different. Body-weight change and milk composition were not significantly different for the treatments. Organic matter digestibilities of the total diet were 73.2, 72.6 and 70.9 when the supplements contained 0, 25 and 50% dried grass respectively, and were not significantly different.

#### 12. THE EFFECT OF VARYING PROTEIN LEVEL IN A COMPOUND DIET FED IN CONJUNCTION WITH GRASS SILAGE

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An experiment was conducted during the winter 1971/2 employing 48 British Friesian cows in a changeover design of four periods each of 4 weeks. Four experimental compound diets were compared, similar in respect of oil, energy, Ca, P and other micro-ingredients, but varying in the crude protein level in steps of 2 units between 10 and 16% crude protein. Silage was fed on a 'simulated *ad libitum*' basis with actual silage intakes being measured for each cow. Compound consumption and milk yield were measured daily.

Milk yield increased with increasing level of crude protein in the compound diet and thus with total crude protein in feed intake. Cows were blocked for milk yield in the experimental design. This response was significant for both the high and low yielding blocks, with indications of greater response to protein level with the higher yielding cows ( $P < 0.001$ ).

Calculations have been made on the economic response to the extra crude protein fed, and show that the value of the extra milk yield more than compensated for the extra cost of the highest crude protein diet.

These results are discussed in the context of the protein requirements for high yielding (over 5000 litres) cows, and also in connection with the balancing of grass silage by compound diets for milk production.

#### 13. DRIED POULTRY WASTE IN DAIRY RATIONS

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Dried poultry waste (DPW) was included in the ration of 86 dairy cows in three experiments to test its value as a protein substitute. In experiment 1, DPW was substituted for the vegetable proteins in a dairy ration and fed at 2.0 kg (calculated starch equivalent (SE) 63), compared with a control ration fed at 1.8 kg (SE 70) per 4.5 kg of milk. There was a significantly lower mean yield from the cows fed DPW (75 kg milk per week) compared with the control ration (81 kg milk per week) ( $SE \pm 1.8$ ). In experiment 2, the energy value of DPW was investigated using three concentrate rations:

- A Control (SE 70, 16% crude protein) fed at 1.8 kg per 4.5 kg milk;
- B Control four parts + DPW one part, fed at 1.8 kg per 4.5 kg;
- C Control four parts + DPW one part, fed at 2.3 kg per 4.5 kg.

There was a tendency for increased yields, higher milk quality and lower live-weight losses from ration C, but there were no significant differences. In experiment 3, using two levels of fixed rate feeding, three rations were compared:



- I Control;
- II Dairy cake containing 10% DPW;
- III Dairy cake containing 20% DPW.

There were no significant differences in milk quality between treatments. Overall mean total milk yields for weeks 3 to 24 were 2562 kg, 2671 kg and 2512 kg respectively ( $SE \pm 43.0$ ).

#### 14. EFFECT OF HERBAGE SELECTION ON PERFORMANCE OF GRAZING COWS

K. A. E. Archibald, R. C. Campling and W. Holmes, *Wye College (University of London), Ashford, Kent.*

The effect of herbage selection on the performance of milking cows was examined in two grazing seasons. Three groups each of 14 cows, balanced for stage of lactation and potential milk yield, were kept either on treatment C—control, grazing within a rigid 28-day rotational system, or on a leader (A) and follower (B) grazing system, operated within a similar rigid grazing schedule. The stocking rate of treatment C at 5.76 cows/ha was equal to the overall stocking rate of treatments A and B. In 1971 a 10-week continuous type experiment was conducted following a 4-week uniformity trial; in 1972 a  $3 \times 3$  Latin square design was adopted, with periods of 4 weeks. Although the cows on treatment A (leaders) were offered twice the area of herbage of those in treatment C, mean milk yield increased only slightly (5%) but the mean performance of cows in treatment B (followers) fell significantly below (–12%) that of the other treatments. The increase in milk yield of high-yielding cows offered extra opportunity for selection of herbage (treatment A) was small and less than the fall in yield observed in high-yielding cows on treatment B (followers). The low-yielding cows showed little response in milk yield to treatment A but milk yield declined appreciably on treatment B. The results were discussed in relation to the effect of selection on yield of early and late lactation cows, and to the potential value of a leader and follower grazing system.

#### 15. THE USE OF ONCE-BRED HEIFERS FOR WINTER MILK PRODUCTION

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In a once-bred heifer system the animals are normally dried-off shortly after calving, and then finished as beef animals. When surplus dairy-type heifers are bred so as to calve in August-September, they may be milked for a 5 to 6 month period before drying-off. Some trials were undertaken to assess the output of milk and beef attained when this procedure is operated intensively on a farm unit basis. Following two crops of silage, British Friesian heifers (in-calf) were introduced into the system from mid-August onwards. After calving in August-September these heifers grazed the silage aftermath until late October. The heifers were dried off on 1 March, and then fattened for slaughter in April-May. The milk yield and body-weight response to concentrate feeding at pasture was uneconomic. Concentrates significantly increased milk yield and live-weight gain on silage feeding; a high body weight at drying-off shortened the subsequent fattening period. When the best feeding treatments were combined, the system yielded more than 6500 kg of milk and about 4.5 calves/ha per annum. The procedure affords one means of adjusting the national milk:beef output ratio. At farm level the financial returns depend on the milk:beef price ratio and on the value of in-calf heifers relative to that of once-bred heifers.

16. DETERMINATION OF LACTATION AND LIVE-WEIGHT RESPONSE CURVES IN BLUE-GREY COWS AT FOUR LEVELS OF INTAKE

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A long-term experiment investigating lactation and live-weight response curves in autumn calving Blue-Grey (Whitebred Shorthorn ♂ × Galloway ♀) suckler cows fed four levels of intake throughout their lactation, is being undertaken in the Edinburgh School of Agriculture. Twenty-five cows were involved in the first year (1971/72) and the four treatments imposed were 90%, 125%, 175% and 225% (Treatments 1, 2, 3 and 4) of maintenance (117 kcal metabolizable energy (ME)/kg W<sup>0.75</sup> per day) based on a live weight measured 12 hr post partum. The cows were fed only silage (25% dry matter) plus a mineral-vitamin supplement until turnout. The mean ME intakes/treatment group were 11.01, 14.45, 20.37 and 20.30 Mcal/head per day for treatments 1 to 4 respectively. The proposed intakes of silage for treatment 4 were in fact above appetite, so that there was no difference in recorded intake between treatments 3 and 4. The cows were machine milked twice daily and the mean milk yields/day, and total yields for a 6-month lactation along with milk composition data, compared with lactation curves for dairy cows. The overall mean milk yield was 4.3 kg/day at 11.8% total solids and 3.6% fat. Body compositional changes were monitored by measurements of live weight, condition score and blood glucose and ketone levels. Live-weight change/day from post partum until turnout ranged from +0.25 to -0.75 kg/day and, although confounded with milk yield, mean losses of live weight per treatment during the experimental period decreased with increases in silage intake. The ability of the Blue-Grey to mobilize body reserves for lactation, and the resultant effects upon fertility were used as a basis for discussion of practical feeding recommendations for autumn calving suckler cows.

17. BODY WEIGHT IN SUCKLER COWS AND ITS RELATIONSHIP TO CALF PERFORMANCE

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Data from suckler herds recorded by the Meat and Livestock Commission in the period autumn 1969 to spring 1972 have been analysed to compare the live weights of suckler cows of different breeds and crosses in a range of farm environments. The relationship between cow weight and the weight of the weaned calf has also been studied. Records from 4931 cows in 37 lowland, 54 upland and 11 hill herds were included in the analysis. Most cows were weighed in the autumn or winter, and again in the spring. Calves were weighed at weaning. The herds included 21 breeds and crosses with Hereford × British Friesian and Blue-Grey (Whitebred Shorthorn × Galloway) cows numerically dominant. There was considerable variation in live weight within breed type, within age of cow and within herd. Mean live weights were highest on lowland farms, intermediate on upland farms and lowest on hill farms. Charolais-cross cows had the highest mean live weights (656 kg) while Aberdeen-Angus crosses were the smallest (430 kg). Differences in weight between the Hereford × Friesian (488 kg) and Blue-Grey (458 kg) were smaller than expected, and both breed types were relatively light in weight in relation to all the breeds and crosses studied. The order of ranking of different types of cow on the basis of live weight can be predicted from an examination of weight-for-age in the parent breeds. Data on calf performance were also presented.



## 18. A COMPARISON BETWEEN DIFFERENT QUALITIES OF ARTIFICIALLY DRIED GRASS AND CONCENTRATES FOR REARING BRITISH FRIESIAN STEER CALVES

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Two experiments, lasting 117 and 115 days, with calves of 60 to 65 kg mean initial live weight were described. In Experiment 1 three groups of 8 calves were offered one of three qualities (L, M and H) of autumn-cut dried grass *ad libitum*. A fourth group of calves received cereal-based concentrate *ad libitum* (AC), and a fifth group the same concentrate restricted (RC) to allow a similar mean rate of live-weight gain to calves offered medium quality dried grass (M). All calves received 250 g chopped hay daily. Experiment 2 was similar to Experiment 1 except that the three qualities of dried grass were harvested in the spring. The *in vivo* values for digestible organic matter in the dry matter, determined with wether sheep at the *ad libitum* level of feeding, were 52.9, 57.4 and 59.5% for the autumn-harvested and 51.2, 61.7 and 55.1% for the spring-harvested dried grasses. Mean daily dry-matter intakes (kg) by calves in Experiment 1 (autumn) were 3.22 (L), 3.01 (M), 2.78 (H), 2.61 (AC) and 2.03 (RC), and daily live-weight gains (kg) were 0.76, 0.78, 0.71, 1.05 and 0.80 respectively. Mean daily dry-matter intakes (kg) in Experiment 2 were 2.12 (L), 2.73 (M), 2.48 (H), 2.59 (AC) and 2.01 (RC), and the mean daily live-weight gains (kg) were 0.43, 0.72, 0.54, 0.93 and 0.72 respectively. Comparisons were made between spring and autumn dried grass, and between dried grass and concentrate. The combined results were discussed on a digestible organic matter intake basis.

## 19. THE RELATIONSHIP BETWEEN MILKING TIME AND MILK YIELD

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The prediction of mean herd machine milking time from the mean herd milk yield at a milking is of practical use in the assessment of the number of milking units needed to milk a particular number of cows per hour. The current situation was investigated by recording the machine milking time and milk yield of each of the 1934 cows in 28 commercial dairy herds at one morning milking and of the 1641 cows in 24 of these herds at the previous evening milking. All herds were milked in modern herringbone milking parlours equipped with wide ratio pulsators and rigidly mounted, calibrated recorder jars. The milking machines were operated at a vacuum of 35–38 cm Hg with pulsation rates of 58–62 cycles per min. Milk was elevated 120 to 180 cm from the udders into high-level jars in 7 parlours, and 60 to 90 cm into the 'eye level' jars in 8 parlours. In the remaining 13 parlours milk was drawn into jars 30 to 60 cm below udder level. The between herd regression for mean machine milking time per cow,  $T$  min, on mean milk yield,  $Y$  kg, for all 28 herds at morning milking was highly significant ( $P < 0.01$ ); the regression equation being  $T = 2.75 + 0.207Y$  with residual standard deviation about the line of 0.44 min. The differences between the slopes of the three regression lines when the herds were classified according to the height of the recorder jars were not significant. The substitution of a common slope, 0.234 min/kg, gave three parallel regressions with constants of 2.82 min for high level, 2.60 min for 'eye' level and 2.27 min for low level jars. Although these were significantly different the overall equation was used for prediction since the loss in accuracy was marginal.

20. DAIRY COW PRODUCTION RECORDS BASED ON INFORMATION GATHERED AT AFTERNOON MILKINGS ONLY

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Milk recording costs in Scotland, in terms of the number of gallons of milk required to pay for the official service, have increased by 250% in the last 15 years. Methods which reduce cost and inconvenience involve less frequent visits and more farmer involvement. Recording at afternoon milkings only has been investigated as a possible method on commercial farms. Preliminary investigations indicated that the inaccuracies of this method were likely to be considerable in so far as butterfat percentage was concerned. Subsequent work concentrated on milk yields. A random sample of 20 herds showed the very close relationship between milking interval and the ratio of herd morning milk yield to herd evening milk yield. The same data showed a seasonal trend in this ratio with more morning milk in winter than in summer. Cows within these herds showed a lower ratio with increasing yield level. Further work on an independent random sample of 30 herds showed the advantage of using multiplicative adjustment factors based on the current a.m.:p.m. herd yield ratio rather than general interval factors. Daily yields for 2305 cows so derived showed a mean difference of zero and a within-herd standard deviation of differences from actual daily yield of  $\pm 1.36$  kg. Variation between herd mean differences was significant but of little importance practically. A sample of 106 lactation yields derived from such daily yields was compared with officially calculated lactation yields and showed a standard deviation of the differences of  $\pm 153.7$  kg with no significant bias. The practical significance of the results is discussed.

21. VARIATION OF APPARENT CONCEPTION RATES IN CATTLE WITH SPECIAL REFERENCE TO GENETIC FACTORS

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A population study was conducted to determine some of the more important factors influencing the apparent conception rate in cattle. This same sample has been used previously to study apparent embryonic mortality, abortion and stillbirth. The Reading Cattle Breeding Centre had recorded the fourth week non-return rates for 384 736 fresh semen and 61 851 frozen semen first inseminations, by 100 bulls of 5 dairy and 3 beef breeds over a period of 8 years. The fourth week non-return rate is used as a measure of the apparent conception rate. Significant differences in apparent conception rates between breeds of bull were found with fresh semen first inseminations. The Ayrshire breed had the lowest and the Shorthorn the highest apparent conception rate. There were also significant differences between bulls within the British Friesian, Ayrshire and Aberdeen-Angus breeds. These results support the view that there are genetic factors affecting conception rate in cattle. The apparent conception rate with fresh semen was higher than with frozen semen for any corresponding insemination up to the fourth, but there was no difference between fresh and frozen semen in the rates of decrease of apparent conception with higher numbers of insemination. There was also a small significant decrease in conception rate between 1-day, 2-day and 3-day-old fresh semen inseminations.

## 22. THE USE OF COOKED POTATO FLAKE IN PIGLET DIETS

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An examination was made of the nutritive value for piglets of a cooked potato flake (CPF) provided by the Products Research Station of the Potato Marketing Board. The average composition of the product was 0.92% dry matter (DM), 1.72 MJ gross energy (GE), 1.52 g N/100 g DM, and 5.3 g lysine/16 g N. Digestibility coefficients, for ground flakes, determined with 40 kg pigs were  $0.96 \pm 0.003$  for GE and  $0.89 \pm 0.013$  for N. Digestibilities determined with 20 kg pigs for a diet of 1.73 MJ GE and 2.91 g N/100 g DM, comprising 0.78 CPF, 0.10 extracted soya bean, and 0.10 fish meal, were found to be  $0.95 \pm 0.006$  for GE and  $0.90 \pm 0.009$  for N. Twenty piglets weighing 6.5 kg which were weaned into individual cages at 23 days of age were used to compare the performance of pigs fed either this diet or a proprietary diet containing 1.87 MJ GE and 4.27 g N/100 g DM. Daily intakes per piglet from 23 to 51 days were 596 g and  $601 \text{ g} \pm 14.7$  (NS), and the daily live-weight gains were 393 g and  $460 \text{ g} \pm 16.1$  ( $P < 0.05$ ) for the potato and proprietary diets respectively. Estimated feed costs per kg gain were 13% lower for the potato based diet. A similar efficiency of CPF utilization occurred when 17 weaned piglets were offered a diet of 0.73 CPF, 0.10 dried skimmed milk and 0.15 fish meal from 24 to 52 days, and attained a live-weight gain of  $251 \pm 26.0$  g/day from an intake of  $396 \pm 34.4$  g diet. A number of diets containing up to 0.78 CPF have been found acceptable to suckling piglets offered a choice between potato and mixed cereal creep diets. It is concluded that CPF has many of the qualities required of an ingredient of piglet diets.

## 23. THE MEASUREMENT OF MILK INTAKE OF PIGLETS BY DEUTERIUM OXIDE

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A total of 12 early-weaned piglets was used to test the applicability of body water turnover measurements for the estimation of milk intake of individual piglets. Each piglet housed individually in an incubator was given a precisely metered quantity of a synthetic milk diet. A range of body water turnover rates was achieved by allocating piglets to one of four treatments according to a  $2 \times 2$  factorial design: there were two concentrations of dry matter (DM) in the milk (0.18 and 0.24 g DM/g milk) and two feeding levels (2.0 and  $3.0 \times$  maintenance). Body water turnover was determined by measuring the concentration of deuterium oxide in the blood at the start and end of each 5-day balance period, and the relationship of the actual and the predicted milk intakes was examined for three separate 5-day periods. The overall correlation between the two variables was close ( $r = 0.98$ ) but was associated with a high degree of variability; the residual variability for predicted milk intake at the mean intake was approximately 6% (mean intake per piglet per period =  $4409 \pm 347$  g). The regression equations were not significantly affected by either level of feeding or dietary dry matter concentration. The advantages of this method over conventional methods in estimating milk intakes of groups of piglets, as in intensive studies with lactating sows, are discussed.

24. AN APPARENT INTERACTION BETWEEN DRY-MATTER CONTENT OF THE FEED AND AGE AT WEANING OF BABY PIGS

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A 3<sup>4</sup> factorial experiment is being completed, with the object of examining the possibility of the existence of simple interactions between four factors affecting the performance of baby pigs. Feed was prepared at dry-matter (DM) contents of 17% and 30% (liquid) and 90% (pelleted), and fed to pigs weaned at 6 hours, 2 days or 6 days of age. Frequency of feeding was 3, 8 or 24 times daily and the plane of nutrition was 4.2, 5.6 or 7.0 g DM per 100 g live weight. Data were collected up to 28 days of age and the experiment was replicated once, litters being partially confounded with second order interactions. A single diet based on skim milk powder, maize oil and sucrose, to give a crude protein content of 25% and a gross energy of 4.79 Mcals/kg, was fed throughout. The most important interaction was between dry-matter content of the feed and age at weaning. Growth rates of pigs weaned at 6 days were similar at all three dry-matter contents. Growth rates of pigs weaned at 6 hours and 2 days were poorer on the pelleted than on the liquid diets. Growth rates were similar between the two liquid feeds at all ages of weaning. The significance of these results was discussed.

25. STUDIES ON THE INTAKE AND UTILIZATION OF WET FEED BY CALVES

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Twelve British Friesian calves were used in a trial of Latin square design, with three periods of 3 weeks, to measure dry-matter intake, live-weight gain and water intake on all-concentrate diets given *ad libitum* in wet form, and which contained 30% (B), 20% (C) or 15% (D) dry matter. Six calves were given the same diet in dry pelleted form (A) throughout the experimental period. Digestibility and nitrogen balance were measured on four calves on each treatment at the end of the experimental period. In addition, two Ayrshire calves, each fitted with permanent abomasal cannulae, were used to study the site of digestion of the feed when given in dry or wet form. The mean dry-matter intake for the calves given the wet and dry feed was 80.8 and 75.5 g/day per kg W<sup>0.75</sup> and daily live-weight gains were the same (849 g). The mean dry-matter intakes for calves given the different wet diets were 80.9 (B), 81.2 (C) and 75.5 (D) g/day per kg W<sup>0.75</sup>. The corresponding daily live-weight gains were 857 (B), 879 (C) and 812 (D). The differences in water intake between treatments were highly significant, but there were no differences in the dry-matter digestibility of the diets nor in the nitrogen retained by the calves. On all treatments approximately 6% of the dietary starch passed through the abomasum.

26. RETARDED GROWTH IN HAMPSHIRE PIGLETS

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Imported Hampshire pigs were observed to have low weights at weaning. To investigate this problem a series of cross-fostering experiments was carried out

between Hampshire and British Saddleback females, the latter breed being characterized by heavy weaning weight. An initial cross-fostering experiment involved 10 pairs of gilts of the two breeds and used a simple creep ration. This showed that the low weaning weights of the Hampshire piglet were essentially a characteristic of the piglet and not the sow. Least squares estimates of the weight of Hampshire and Saddleback piglets at 50 days of age were  $10.6 \pm 0.2$  and  $13.4 \pm 0.2$  kg respectively. A similar result was obtained in a second series of fosterings with 5 pairs of sows of the two breeds. To investigate the suggestion that the low weight of the Hampshire piglets might be due to their particular nutritional requirements, a third series of cross-fosterings was carried out with 8 pairs of females allowing the piglets access to a more sophisticated creep feed with higher protein and energy content. The breed difference in piglet weight was not significantly reduced in these altered circumstances.

#### 27. CROSSBREEDING STUDIES WITH POLAND CHINA BOARS

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The main characteristics of the Poland China breed, namely a high carcass lean content and large cross-sectional area of eye muscle but low reproductive performance, favour its use as the male parent in a crossbreeding programme. In this respect two Poland China boars were mated with 12 Large White females, while for comparison two Large White boars were used on the same number of females of similar background. In the post-weaning period a trial was conducted to compare the performance, carcass and muscle quality characteristics of crossbred and purebred females and male castrates given a growers diet throughout (28 to 66 kg live weight) on an *ad libitum* scale of feeding. Breed of boar had no significant effect on litter size or body weight at birth or weaning. In comparison with purebred pigs the progeny of Poland China boars grew more slowly to slaughter (10%) but with equal efficiency of gain. Crossbreds had higher carcass yields (4%), shorter (3%) and deeper (2%) carcasses, lower depths of mid-line and internal fat (11%) and larger eye muscle areas (22%). Breed of boar had little influence on joint proportions and no effect on carcass cut-out value. The eye muscles of crossbred carcasses were paler in colour and had higher transmission values than those of the purebreds but the water binding capacity of the meat was not different.

#### 28. STUDIES OF GENETIC AND PHENOTYPIC PARAMETERS IN 'ON FARM' PERFORMANCE TESTED PIGS

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Data were analysed from 59 350 pigs performance tested within the 'on farm' testing scheme of the Meat and Livestock Commission during the period May 1969 to January 1971. These provided means and standard deviations for weight at test, age at test, shoulder, loin, C, K, C+K measurements, Index score and daily live-weight gain for all pigs and for each sex, each breed and each of nine herd classes. The phenotypic correlations between these variables were calculated. During November 1971 to May 1972, some 16 000 pigs of known parentage were tested and their data analysed to provide estimates of the heritability and genetic correlations of the above traits using full and half-sib relationships. Estimates were also made of some of the major sources of between- and within-farm variation in pig

performance. A constant sample of farms was used to estimate changes in pig performance over the period 1969–1972.

29. THE MERIT AND PROGRESS OF HERDS IN THE PIG IMPROVEMENT SCHEME OF THE MEAT AND LIVESTOCK COMMISSION

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Purebred pigs from commercial herds have been purchased by the Meat and Livestock Commission from 1966 onwards. The pigs have been compared with the purebred pigs in the Commission's Pig Improvement Scheme. The results of both Large White and British Landrace pigs (previously reported until 1970) have been up-dated and economic values attached to the differences between the two types of stock. Progress from the scheme can only be estimated by the use of control herd pigs. Three control herds are used, those at Bangor and Newcastle being of Large White pigs, and that at Wye College of Norwegian Landrace pigs. Significant regressions of control performance on time indicate progress in the Scheme for food conversion, eye muscle area, percentage lean in rump back, C and Index points. Attaching the normally used economic values to these regressions shows annual progress between 16.9 and 51.7p, with the pooled Large White estimate being 25.4p per annum. These estimates of progress are discussed in terms of the number of pigs which need to be influenced by the Scheme in order for it to be cost effective.

30. WINTER WEATHER AND THE GROWTH OF YOUNG BEEF CATTLE

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Previous workers have reported that 'no interaction on live-weight gain was found between plane of nutrition and winter environment'. Comparison here of animal performance over intervals when the weather could be held to be the same for the three types of accommodation studied (viz. roofless sawdust pads, wind sheltered pads, conventional roofed housing) requires that 'winter environment' be interpreted as relative shelter. Data from these workers' experiments were used to compare performance over successive intervals. Weather was taken as a primary variable and 'winter environment' interpreted as the thermal environment. For the class of stock studied, i.e. 9-month-old British Friesian steers at around 200 kg, fed to appetite on poor to medium quality hay, a Critical Temperature was inferred for the individual of a group in the farm situation, of 4.8°C to 5.3°C at wind speeds of 4 to 6 m/s. This Critical Temperature, when used as a predictor of performance on the previous data demonstrates an interaction between live-weight gain, plane of nutrition and 'winter environment'. The occurrence of air temperatures in the British Isles below the Critical Temperature has been examined.

31. EFFICIENCY OF FEED CONVERSION AND CARCASS QUALITY OF BRITISH FRIESIAN MALE, CASTRATE AND FEMALE BEEF CATTLE REARED SEMI-INTENSIVELY AND SERIALLY SLAUGHTERED

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A total of 56 individually fed animals was used, comprising 20 males, 20 castrates and 16 females. Calves were given milk substitute, weaned at 6 weeks of age,



and if necessary castrated at that time. Concentrates and hay were offered *ad libitum* to 90 kg live weight. Thereafter to slaughter, a complete diet (70% concentrates, 30% chopped barley straw) was given in amounts such that the average rate of live-weight gain was 0.87 kg/day. Four animals per sex were slaughtered at 318, 379, 440, 501 and 562 kg (males and castrates only) live weight. Males were 13 and 20% more efficient than castrates and females respectively, in converting dietary energy into live-weight gain. Males had significantly lower killing-out percentages than castrates, and castrates than females. Carcasses were assessed for subcutaneous fat and conformation score, and the left sides completely dissected. Over all slaughter weights, the mean side compositions were found to be 66.5, 58.2 and 56.8% lean, and 14.3, 23.6 and 27.5% fat, for males, castrates and females respectively. Taste panel assessment of texture showed no significant differences between the sexes. The results are discussed in relation to optimum slaughter weights for the different sexes on a semi-intensive beef system.

### 32. ENERGY AND NITROGEN RETENTION BY GROWING CATTLE

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The Agricultural Research Council system for assessing the energy requirements of growing cattle is based on measurements of fasting metabolism, which declines during growth from about 600 to 400 kJ/kg  $W^{0.75}$  per 24 hr, and on measurements of the intake and the net availability of the diet for maintenance ( $k_m$ ) and for fattening ( $k_f$ ). This system was tested in a series of energy and nitrogen balance trials conducted in respiration chambers on 4 British Friesian and 4 Aberdeen-Angus steers at weights from 60 to 460 kg. They were fed a barley-based diet at two levels calculated to produce overall efficiencies of retention of metabolizable energy of 15 and 25%. Basal metabolism, estimated by extrapolation from observations in fed animals, assuming  $k_m$  and  $k_f$  to be constant functions of the metabolizability of the diet, was constant during growth at about 450 kJ/kg  $W^{0.75}$  per 24 hr. Occasional direct measurements of fasting metabolism in these animals agreed with ARC values. Nitrogen retention declined during growth from about 800 to 400 mg/kg  $W^{0.75}$  per 24 hr. There were marked individual, rather than breed, differences in N retention and in estimated basal metabolism, and the two were positively correlated. These results suggest that the basal energy requirement of the growing steer is not the same as fasting metabolism and/or that  $k_f$  varies according to the partition of retained energy between protein and fat.

### 33. SEMI-INTENSIVE BEEF PRODUCTION FROM BULLS

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Results are presented on the comparative performance of 178 bulls and 164 steers reared in eight commercial semi-intensive beef units recorded by the Meat and Livestock Commission. The British Friesian and Hereford  $\times$  Friesian calves used in the investigation were born in the autumn of 1970 and slaughtered in the spring of 1972. On all cooperating units bulls had higher live-weight gains than steers. Daily gains were 5.3% higher in bulls than in steers during the rearing winter, 9.0% higher during grazing and 16.5% higher during the yard finishing winter. These differences were all statistically significant. Producers elected to slaughter bulls at live weights 8.3% higher than for steers. No insurmountable management problems were reported in bulls. However, there were distinctive differences in behaviour

between bulls and steers, whether they were grouped together or managed separately. During grazing, bulls appeared to herd less closely than steers. A visual evaluation of carcasses gave bulls a lower fat score than steers but a similar overall conformation score. Carcasses from 26 bulls and 19 steers were dissected. Bulls had a lower percentage of fat and a higher percentage of lean (68.7% v. 62.9%) but there were no differences in bone percentage. The proportion of high priced cuts was slightly lower in bulls (42.6%) than in steers (44.0%).

#### 34. DRIED POULTRY WASTE IN RATIONS FOR INTENSIVE BEEF CATTLE

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With the object of reducing feed costs, dried poultry waste was substituted for the more traditional protein constituents in an intensive beef ration. The experiment was carried out over 3 years using purebred autumn-born British Friesian ♂ castrates. Each year 8 animals on each treatment were fed in two groups of 4 from approximately 150 kg live weight to slaughter at 400 kg. Treatments comprised either total or half replacement of the protein fraction (soya and fish meals in the control) by poultry waste, on an isonitrogenous basis. In the first year only deep litter waste was used, but in the subsequent two years the experiment was enlarged to include a laying battery waste treatment. In the first two years, the inclusion rate of poultry waste was dependent on crude protein analysis of the material ( $N \times 6.25$ ). In the last year both types of waste were included at a standard rate, and the crude protein in the treatment rations was balanced by the addition of small quantities of urea. Results showed that the material is a suitable protein source although there are problems in ration formulation due to its low energy value. When ration energy was maintained at a satisfactory level, live-weight gains were satisfactory and there was a substantial increase in the profit margin per animal compared with the controls.

#### 35. THE EFFECT OF PLANE OF NUTRITION OF THE EWE DURING THE FIRST AND SECOND MONTHS OF LACTATION ON THE GROWTH RATE OF TWIN LAMBS

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Information is very limited on the effect of variation of the pattern of energy intake of the ewe during lactation on the growth rate of the lamb. Twenty-four Border Leicester  $\times$  Cheviot ewes with twin lambs were allocated to a factorial arrangement of treatments in which two feeding levels, 6.47 (H) and 3.84 Mcal metabolizable energy/day (L), were applied in each of two consecutive periods of 28 days (initial period, 1–28 days and final period 29–56 days post-lambing).

Concentrate creep feed was fed *ad libitum* to the lambs in the final period. The mean intakes (g/day) were (HH) 302, (HL) 396, (LH) 150 and (LL) 214, and these were significantly affected by feeding level of the ewe in both periods.

Lamb growth rates (g/day) in the initial period were (H) 247 and (L) 198. Thus the response to feeding level of the ewe was 25%. In the final period growth rates (g/day) were (HH) 371, (HL) 306, (LH) 283, and (LL) 220 indicating a response of 35% to the residual effect of feeding level of the ewe in the initial period, and a 24% response to feeding level of the ewe in the final period.

Live-weight changes (g/day) of the ewes were (HH) –45 and –24, (HL) –2 and –322, (LH) –342 and +125, and (LL) –252 and –180 in the initial and final periods, respectively.

### 36. FACTORS INFLUENCING THE INCIDENCE OF SUCCESSFUL PREGNANCY IN YOUNG SHEEP

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The paper gives results of mating nearly 2000 female Clun Forest sheep (ewe lambs) at from 6 to 9 months of age in the Cockle Park flock of the University of Newcastle upon Tyne, over a 14-year period. Evidence is presented from overall analyses, and from specific experiments in three of the years, on many of the possible causes of the low reproductive performance of these animals. The average percentage lambing was 56 with a range of 36–77 between years. Eighty-nine per cent achieved puberty before the end of their first mating season (mid-December), and in two years the average age at first oestrus among these sheep was close to 230 days. The mean length of single cycles was 16 days, but 15% of all cycles were of abnormal length, suggesting a high occurrence of silent heats. There was no apparent increase in reproductive success with increased cycling experience before the first mating with fertile rams. The mean gestation length was 145 days. No evidence was found for significant effects of individual rams on the percentage of ewe lambs producing full-term progeny. In two out of three years some groups of ewe lambs were offered concentrate supplements at pasture, and some were housed, before, during and after mating. The results suggested that the percentage of successful pregnancies was least in unsupplemented sheep left outside for several weeks after mating, and that this was in part due to early embryonic losses.

### 37. EFFECTS OF CROSSING FINNISH LANDRACE AND GALWAY SHEEP

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The ability of the Finnish Landrace breed to increase the productivity of Galway sheep has been evaluated. Animals with half-Finn and half-Galway ancestry are termed Fingalway. Litter sizes, averaged over two years, for 2-, 3-, and 4-year-old Fingalway ewes were 1.95, 2.07, and 1.92, respectively. Corresponding figures for Galway ewes were 1.30, 1.40 and 1.54, while Finnish Landrace ewes averaged 2.26, 2.51 and 2.99. The results suggest heterosis in the pattern of litter size change with ewe age. Significant ( $P < 0.01$ ) heterosis was observed in the proportion of barren ewes; 2.1% of Fingalway ewes were barren versus 10.8 and 7.7% for Finnish Landrace and Galway ewes, respectively. Thirty rams, comprising 10 Galway, 10 Finnish Landrace and 10 Fingalway were progeny tested on Galway ewes. The data yielded an estimate of  $-2.0$  kg for the effect of the Finnish breed on weaning weight compared with the Galway. This result, combined with data on Galway and Fingalway ewes mated with Galway rams, gave an estimate of 0.4 kg for the superiority in maternal performance of Galway ewes relative to the Fingalway. Analysis of lamb mortality showed no effect of Finnish genes either directly or via maternal effects. Detailed carcass analysis of the progeny of Finnish Landrace, Galway and Fingalway rams by Galway ewes is presented.

### 38. THE INFLUENCE OF MATING BEHAVIOUR IN THE SHEEP ON FERTILITY AT A PROGESTAGEN-SYNCHRONIZED OESTRUS

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Previous studies have suggested that the decrease in fertility at a synchronized oestrus might be due in part to incomplete mating of oestrous ewes in a flock situation. The experiments reported here have attempted to look more closely at the

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influence of mating behaviour on fertility after progestagen treatment. Sixteen 2-year-old Suffolk rams of common genetic and environmental background, and previously ranked for relative sexual ability, were used in a factorial experiment investigating the influence of the ram : ewe ratio on fertility. Four ram : ewe ratios of 1 ram to either 6, 12, 18 or 30 synchronized ewes were mated in four batches, each ewe : ram ratio represented per batch. The 16 rams used were allocated to treatment according to high or low 'libido'. The rams were introduced to the ewes 24 hr after progesterone sponge removal, and sexual behaviour was recorded for the following 3 days. The conception rates were 86.5%, 72.9%, 63.0% and 56.5% for 6, 12, 18 and 30 ewes respectively. As the ram : ewe ratio increased so did the mean total number of services achieved for the 3-day period (41.3, 64.5, 69.0 and 89.9 for 6, 12, 18 and 30 ewes respectively). The rate of semen depletion was investigated in 8 Suffolk rams subject to a service load of either 90 or 45 ejaculations over a 3-day period in a cross-over design experiment. Preliminary analysis indicates that depletion was very rapid over the first 20 to 30 ejaculations but even after 90 ejaculations a sperm fraction was still evident. A third experiment based on the conclusions of the previous work looked at behaviour and fertility when the ram was introduced to a flock of 22 synchronized ewes at the conventional 24 hr compared with 48 hr after sponge withdrawal.

39. A METHOD FOR COMPARING LAMB STRAINS OF DIFFERENT MATURE SIZE FOR COMMERCIAL MEAT PRODUCTION

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Two experiments designed to evaluate a method of testing and comparing animals of different growth patterns for their meat-producing capacity have been carried out. The design allowed for the determination of the optimal point of feed efficiency for muscle production, and for comparisons to be made over similar ranges of maturity as well as over equal weight ranges. Muscle weight was taken as the criterion of maturity. In experiment 1, 96 Cheviot and 96 Border Leicester  $\times$  Cheviot male castrate lambs (mean initial weights 19.4 kg and 22.5 kg respectively) were allocated at random to one of 16 dietary treatments. These treatments were four levels of metabolizable energy (1.62, 2.05, 2.43 and 2.73 Mcal daily) each in combination with four levels of digestible crude protein (DCP) (65, 85, 105 and 125 g DCP daily). Each dietary treatment comprised six lambs from each strain grouped into pairs. The lambs were slaughtered over a range of live weights (36.3, 43.1 and 49.9 kg and 40.9, 49.9 and 59.0 kg for Cheviot and Border Leicester  $\times$  Cheviot strains respectively). An initial slaughter group was used to assess the carcass composition at the start of the experiment, and a further group was taken to maturity to ascertain the composition of the mature animal. At slaughter, all live body components were weighed and sampled for chemical analysis. The left side of each carcass was jointed and dissected and the dissection residues chemically analysed. In the following year, slight modifications in the design for experiment 2 were made. The lambs received an allowance for increasing maintenance requirement where previously a constant level had been fed throughout. Lamb numbers were reduced by examining three levels of protein only, and the two strains studied were Suffolk  $\times$  (Border Leicester  $\times$  Cheviot) and Cheviot. Four slaughter points were used. Selected results are presented to illustrate the method of identifying the differences between the strains for their efficiency of commercial meat production.

#### 40. LAMB GROWTH, EFFICIENCY OF FOOD UTILIZATION AND BODY FAT AT FOUR STAGES OF MATURITY IN FOUR BREEDS OF DIFFERENT MATURE BODY WEIGHT

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The breeds represented in this study were the Soay, Southdown, Finnish Landrace and Oxford Down. The estimated mature body weights of females were 21, 50, 52 and 90 kg respectively, with males taken as 130% of that of females. Each breed was represented by 8 lambs of each sex. Lambs were group reared on *ad libitum* milk substitute to 7 weeks of age then weaned, individually penned and fed a complete diet cube containing 30% straw *ad libitum*. Two lambs of each sex in each breed were slaughtered at approximately 40, 52, 64 and 76% of their estimated mature body weight. The Soays were first to reach the four stages of maturity and the Oxfords last. Differences between breeds in weekly live-weight gain were highly significant, mean values being 0.60 kg for Soays and 2.00 kg for Oxfords. When growth rate was considered as a percentage of mature body weight all significant breed differences were removed. Efficiency of food utilization did not differ between breeds over the range of maturity investigated. At each stage of maturity the percentage fat in the fleece free empty body (FFEB) was lowest in the Soay and greatest in the Oxford, with the Finnish Landrace and Southdown having values nearer to that of the Oxford. The Soay had the greatest increase in percentage chemical fat per unit increase in FFEB weight, and the Oxford the lowest. However, when FFEB weight was expressed as a percentage of mature body weight, the rate of chemical fat deposition was similar for all breeds from weaning to 76% maturity.

#### 41. PERFORMANCE TESTING RAM LAMBS

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A study was made of artificial rearing as a means of providing a standard rearing procedure on which to base selection of ram lambs. Suffolk, Ile de France, Hampshire, Oxford and Dorset Down rams born as twins were included. One from each set of twins was taken off the ewe at 2 days of age. Each was separately penned and given a standard allowance of milk replacer up to 30 days of age. Thereafter they were given *ad libitum* access to a complete diet based on barley and coarsely ground straw. The method proved to be a practicable one. From 40 to 100 days, the mean rates of gain for breed groups ranged from 0.3 to 0.39 kg/day, and the within breed CV from 6 to 17%. Efficiency (gain/feed) similarly ranged from 0.29 to 0.34 with CV 8 to 34%. Three Suffolk rams which were the best, the average and the worst in terms of growth rate in a performance test, were selected to provide ram progeny for performance testing. The value of tritiated water as a means of detecting *in vivo* differences in carcass composition at the end of test was studied. After slaughter, one side of the carcass was separated into lean, fat and bone, and the other side ground and sampled for chemical analysis. The results showed that the dilution of tritiated water was not useful in predicting carcass composition in lambs of similar live weight; the correlation with dissected fat content was only +0.10. The correlation between the content of dissected fat and chemical fat was +0.90, and between dissected lean and crude protein +0.45.



## 42. COMPARISON OF EWES OF FOUR PARENTAL BREEDS AND THEIR CROSSES FOR LAMB PRODUCTION

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Crossbreeding as a means of exploiting non-additive genetic variation to increase productivity is a long-established practice in sheep production. In order to measure the extent of any hybrid advantage a flock of crossbred ewes and their parent breeds was set up in 1965, and their performance was compared in the same environment. The four breeds were Border Leicester (BL), Galway (G), Scottish Blackface (BF), and Cheviot (CH); rams of the first two breeds were mated to ewes of the two latter breeds to produce the four crossbreds. Reciprocal crosses were not made. Crossbred ewes were brought into the flock at 6 months of age over a five-year period 1965–69. Preliminary analysis of five years' data (1966–70) which include 1907 mated ewe records and 1643 lambing records, indicates that in terms of litter size born and weaned, Blackface-crossbreds were equal to or better than the mid-parental value, while Cheviot-crossbreds were lower; none of the differences was significant. The litter size born was 1.52, 1.45, 1.66, 1.60, 1.44, 1.64, 1.41 and 1.68 for G × BF, G × CH, BL × BF, BL × CH, G, BL, BF and CH respectively. Cheviot ewes weaned the greatest weight of lamb per ewe mated (32.7 kg), while the Galways produced the least (23.8 kg); this was primarily due to a large difference in barrenness, 8.8 v. 23.7%, in addition to the difference in litter size. Blackface-crossbred ewes weaned a significantly heavier weight of lamb than the mid-parent value, while the weight of lamb weaned by Cheviot-crossbreds was lighter than the mid-parent value.

## 43. THE EFFECT OF DIETARY CRUDE PROTEIN INTAKE AND STAGE OF WEANING ON EWE MILK PRODUCTION AND LAMB CREEP FEED INTAKE

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Results from a previous experiment suggested that the concentration of crude protein in the diet of the lactating ewe influenced the partition of dietary energy between milk and body tissue. The effect was further examined in an experiment in which 27 ewes suckling twins were each offered one of three dried grass/concentrate diets containing 10, 13 or 16% crude protein (CP) and 2.4 Mcal metabolizable energy (ME)/kg. Each ewe received daily a basal ME intake of 95 kcal/kg  $W^{0.75}$  and a production intake of 3.5 Mcal. Within each protein treatment group the lambs were weaned at 25, 33 or 41 days. There were no significant effects of diet on milk composition, and no significant interactions between diet and stage of weaning on milk yield and ewe body-weight change. Increasing the crude protein concentration of the diet resulted in a significant increase ( $P < 0.05$ ) in both milk production and ewe body-weight loss; the mean values for milk production were 2.4, 2.9 and 3.1 kg/day (SE of mean  $\pm 0.16$ ) for the 10, 13 and 16% CP diets respectively. The corresponding values for ewe weight loss were 118, 170 and 265 g/day respectively (SE of mean  $\pm 31$ ). The differences in creep feed dry-matter consumption between the 10 and 13% CP diets were 42, 138 and 315 g per lamb for 25, 33 and 41 days of weaning respectively. There were no differences when the 13 and 16% CP diets were given. The results will be used as a basis for predicting dietary crude protein concentrations for lactating ewes in an intensive system.



#### 44. OBSERVATIONS ON THE DIGESTIVE PROCESSES IN THE SMALL INTESTINE OF GROWING PIGS

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Ash re-entrant cannulae have been inserted in six pigs of about 30 kg at each of the following sites: (i) duodenum (10 cm posterior to the stomach), (ii) jejunum (250 cm posterior to the stomach) and (iii) ileum (20 cm anterior to the ileo-caecal junction). The progress of digestion of three rations during 24-hr periods has been followed: (A) a cereal diet supplemented with fishmeal, (B) a diet containing starch, sucrose and groundnut and (C) a diet containing starch, sucrose and casein as the principal ingredients. The mean percentages of the dietary intake which passed through the cannulae in 24 hr, with standard errors, for sites (i), (ii) and (iii) respectively were  $280.0 \pm 15.1$ ,  $281.0 \pm 8.9$  and  $68.4 \pm 4.6$  for diet A;  $218.4 \pm 11.7$ ,  $220.0 \pm 15.7$ , and  $63.8 \pm 7.4$  for diet B; and  $151.5 \pm 2.5$ ,  $152.3 \pm 14.9$  and  $20.1 \pm 0.01$  for diet C. The figures for dry matter were  $97.0 \pm 4.8$ ,  $79.0 \pm 2.9$  and  $26.2 \pm 1.6$  for diet A;  $94.0 \pm 3.2$ ,  $76.1 \pm 7.3$ , and  $19.5 \pm 1.6$  for diet B;  $72.4 \pm 0.0$ ,  $77.5 \pm 5.1$  and  $8.2 \pm 0.4$  for diet C. The figures for total nitrogen were  $96.0 \pm 0.9$ ,  $77.0 \pm 2.2$  and  $24.4 \pm 1.6$  for diet A;  $90.5 \pm 4.2$ ,  $91.8 \pm 6.6$  and  $19.9 \pm 2.8$  for diet B; and  $75.0 \pm 2.5$ ,  $74.2 \pm 5.1$  and  $8.6 \pm 0.3$  for diet C. Ash was measured in sites (ii) and (iii): the figures were  $211.8 \pm 5.3$  and  $74.7 \pm 5.8$  for diet A;  $135.0 \pm 8.4$  and  $69.9 \pm 5.3$  for diet B; and  $166.5 \pm 12.7$  and  $56.8 \pm 2.6$  for diet C. Samples were also analysed for pH, soluble nitrogen, amino acids, various minerals and reducing substances. It is hoped that a more detailed understanding of digestion will lead to methods of manipulating the processes with economic benefit.

#### 45. ENERGY METABOLISM STUDIES ON GROUPS OF GROWING PIGS

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Measurement of metabolizable energy intake, heat loss and N balance were made on groups of pigs, in order to study variations in body-weight gain and its composition with different temperatures and feeding levels. Eight groups of 4 castrated male pigs, 25 to 45 kg body weight, were kept for periods of 3 weeks in a calorimeter equipped as a pig pen and maintained at either 8 or 20°C. At each temperature two feeding levels were employed, 45 and 52 g/kg body weight per day at 8°C, and 39 and 45 g/kg body weight per day at 20°C. Metabolizable energy, as a percentage of gross energy was in the range 74.0 to 75.3%, and was not affected by either temperature or feeding level. Heat loss at 8°C was, on average, 16% higher than that at 20°C and independent of feeding level. At 20°C, however, heat loss was higher on the 45 g feeding level. Energy retention depended on both temperature and feeding level, being highest on the 52 g feeding level at 8°C and least on the 39 g level at 20°C. There were no significant differences in the proportion of energy retention deposited as protein at different temperatures and levels of feeding. The mean values ranged from 213 kJ/kg  $W^{0.75}$  per day on the higher feeding level at 8°C to 168 kJ/kg  $W^{0.75}$  per day on the lower feeding level at 20°C. Fat deposition, on the other hand, depended both on temperature and on feeding level. The highest deposition occurred on the 52 g feeding level at 8°C (460 kJ/kg  $W^{0.75}$  per day) and the lowest on the 39 g feeding level at 20°C (285 kJ/kg  $W^{0.75}$  per day), with an intermediate value (382 kJ/kg  $W^{0.75}$  per day) on the 45 g feeding level at 20°C. The maintenance energy requirement at 20°C was calculated to be 418 kJ/kg  $W^{0.75}$  per day.

## 46. THE INTERRELATIONSHIPS OF ENERGY MEASURES USED IN PIG NUTRITION

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In view of the shortage of data on digestible and metabolizable energy values (DE and ME) for the pig, a programme was conducted to determine energy values of a range of 19 feedstuffs used in pig feeding, including cereals, cereal by-products and protein feeds. DE values ranged from 1570 Kcal/kg dry matter (grassmeal) to 4890 Kcal/kg (BP microbial protein), while ME values ranged from 1550 to 4280 Kcal/kg dry matter. Total digestible nutrients (TDN) were more closely related to ME than DE:

$$\begin{aligned} \text{DE} &= (45 \times \text{TDN}) + 156. & r &= 0.917^{**} \\ \text{ME} &= (43 \times \text{TDN}) + 71. & r &= 0.979^{**} \end{aligned}$$

The ratio of ME to DE was significantly related to the crude protein content of the feedstuff:

$$\frac{\text{ME}}{\text{DE}} \times 100 = 99.7 - (0.189\% \text{ crude protein}). \quad r = 0.938^{**}$$

The results confirmed ME as a better measure of energy than DE. The effect of correcting ME values to zero nitrogen retention (ME(N<sub>0</sub>)) was significantly related to crude protein content of the feed:

$$\frac{\text{ME(N}_0\text{)}}{\text{ME}} \times 100 = 98.3 - (0.113\% \text{ crude protein}). \quad r = 0.805^{**}$$

It was considered that correction of ME values to a positive level of nitrogen retention (30%) was a more correct procedure than zero nitrogen correction.

## 47. THE EFFECT OF LYSINE CONCENTRATION ON THE PERFORMANCE OF PIGS GROWING FROM 60 TO 105 KG LIVE WEIGHT

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Ninety Large White × (British Landrace × Large White) pigs comprising five blocks containing nine females, and five blocks containing nine ♂ castrates, were used. The pigs were given *ad libitum* a diet containing 16.5% crude protein (CP) and 3.1 Mcal digestible energy/kg from 20 kg until they reached 60 kg live weight. Thereafter, until slaughter at 105 kg live weight, the pigs were fed individually according to a ration scale which supplied 140 g of feed/day per kg W<sup>0.75</sup>. A basal diet (0.36% available lysine) which contained 97% ground barley and 3% supplement was given, and was also used to provide eight other isocaloric diets. Progressive substitution by either white-fish meal or L-lysine HCl gave calculated available lysine concentrations of 0.44, 0.52, 0.59 and 0.67% of the diet. In the white-fish meal diets, CP concentrations were 10.5, 12.1, 13.5 and 14.9% respectively.

The results indicate that increasing the concentration of available lysine in the white-fish meal diets led to an increase in the performance of the pigs. The addition of L-lysine HCl to the basal diet improved performances, but the pigs did not respond to successive additions of synthetic lysine in the diet.

## 48. THE AMINO ACID REQUIREMENTS OF GROWING PIGS

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It is generally recognized that lysine is the first limiting amino acid in diets for growing pigs prepared from the ingredients which are most widely available in this country. There is uncertainty, however, as to which amino acids are second and third limiting. An experimental programme has been undertaken to try to define the order of limitation of amino acids, in diets composed of barley, soya bean meal and white-fish meal, as a prelude to determining requirements. The aim of the initial experiment was to identify the point at which the second limiting amino acid becomes limiting in a series of diets containing decreasing levels of crude protein, but in which lysine was adequately provided. Females and male castrates by British Landrace sires out of Large White  $\times$  British Landrace dams, were equally represented and randomly allocated to eight dietary treatments when at 25 kg live weight. The animals were slaughtered on attaining a live weight of 55 kg. The eight rations were formulated to contain from 17% down to 10% crude protein, in decrements of 1%. Synthetic L-lysine monochlorhydrate was used to maintain the level of lysine in the diets at the level contained in the 17% diet. Growth performance data showed a linear decrease in both daily live-weight gain and the efficiency of food conversion below 14% crude protein in the diet. Partial carcass dissection results produced similar trends. Sex effects were most marked for carcass composition. It is suggested that the second limiting amino acid became limiting below 14% crude protein (0.52% methionine+cystine, 0.17% tryptophan, 0.59% isoleucine and 0.52% threonine).

## 49. AN INVESTIGATION INTO THE USE OF ONCE-BRED GILTS AS MEAT ANIMALS

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Four treatment groups of 19 British Landrace  $\times$  (British Landrace  $\times$  Large White) gilts were used. One treatment group was left unmated and used as a control for carcass quality (heavy hogs). Two treatment groups had puberty stimulated by the introduction of males at 85 kg live weight, and were mated at the pubertal heat. Gilts from one of these groups were early weaned (5 to 11 days), while gilts from the other group were weaned at 35 to 42 days; both these groups were slaughtered after weaning. Animals in the fourth group had their first boar contact at 105 kg live weight, were mated at their third heat and acted as reproductive controls. There were no significant differences in reproductive performance between groups. Carcass composition and tissue distribution were determined by complete dissection of one side. A commercial evaluation was conducted on the other side. Age at weaning did not significantly affect carcass traits other than gross weight. The carcasses of gilts that had reared a litter contained significantly more lean ( $P < 0.05$ ) and significantly less fat ( $P < 0.001$ ) than carcasses of the heavy hogs. Once-bred gilts had heavier shoulders ( $P < 0.001$ ) and lighter middles ( $P < 0.001$ ) than the heavy hogs, but the percentage weight of principal joints was little different for the three groups compared.

## 50. REPRODUCTIVE PERFORMANCE AND CARCASS QUALITY OF GILTS MATED AT PUBERTY

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Eighty gilts weighing 30 kg when 84 days old were grown along a standard growth curve to 90 kg (182 days old). Forty of the gilts were mated at puberty (group A), 20 at 2nd oestrus (group B) and 20 at 3rd oestrus (group C). A further 12 gilts were fed *ad libitum* from weaning until mating at puberty (group D). Vasectomized boars, housed adjacent to the gilts, were penned with them for 1 hr daily to detect oestrus. Groups A, B and C reached puberty at  $187 \pm 2.2$  days old ( $\pm$  SE of mean) at a weight of  $89 \pm 1.8$  kg. Animals in group D were  $206 \pm 5.2$  days old and weighed  $124 \pm 4.2$  kg at puberty. All animals received 2.2 kg daily of a diet containing 3.0 Mcal digestible energy and 14% crude protein during pregnancy. Numbers born from the first parity were  $7.9 \pm 0.4$ ,  $9.7 \pm 0.5$ ,  $11.0 \pm 0.9$  and  $10.2 \pm 0.8$  with a litter weight of  $10.1 \pm 0.5$ ,  $11.9 \pm 0.6$ ,  $13.1 \pm 1.2$  and  $12.4 \pm 0.9$  kg for groups A, B, C and D respectively. Net gain of the gilts during pregnancy was  $49.2 \pm 1.0$ ,  $44.9 \pm 1.5$ ,  $37.0 \pm 2.3$  and  $41.4 \pm 2.3$  kg, with litter gains over a 6-week lactation of  $67 \pm 4$ ,  $76 \pm 4$ ,  $80 \pm 6$  and  $71 \pm 7$  kg (A, B, C and D respectively). There were no significant differences in numbers born, litter weight at birth or litter weight gain in the second parity. Twenty gilts from group A were weaned within 48 hr of parturition and killed 14 days later. Mean backfat thickness (shoulder, midback and loin) was 39 mm and carcass specific gravity was 1.048.

## 51. PROTEIN AND FAT DEPOSITION IN PIETRAIN AND LARGE WHITE PIGS

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The deposition of protein and fat has been examined in Large White and Pietrain pigs over the live-weight range 20 to 45 kg. The composition of the fat deposited in terms of its triglyceride fatty acids has also been investigated. The results show that Pietrains deposit lean tissue at approximately the same rate as Large Whites when both are fed *ad libitum* but they grow more slowly because they eat less and deposit less fat. Pietrains have softer fat due to a greater unsaturation of constituent fatty acids. Data are also presented which suggest that: (1) the utilization of amino acids for protein deposition is similar between the breeds; (2) the fatty acid composition of backfat is determined by fundamental differences in the pattern of fat deposition, as well as by differences in the growth rate of the two breeds.

## 52. THE INTERRELATIONSHIP OF TISSUE DEVELOPMENT AND MEAT QUALITY IN PIETRAIN AND LARGE WHITE PIGS

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The controlled stimulation of the metabolism of anaesthetized Large White and Pietrain pigs with dinitrophenol has been investigated in relation to the control of meat quality. With this technique a common mechanism has been identified by which the range of pork quality from the pale, soft and exudative (PSE) to the dark, firm and dry (DFD) condition may be produced in either breed. The primary

control mechanism appears to be related to the availability and utilization of thyroid hormones which differ from one breed to another according to their muscularity. It is suggested that the physiological mechanisms which control muscularity both between and within breeds of pigs, also control the general variation in meat quality. It is further suggested that this mechanism does not operate by enhancing the deposition of protein but rather by reducing the deposition of fat. The central role of the thyroid in this is discussed.

53. MECHANICAL DEWATERING OF FORAGES PRIOR TO HIGH TEMPERATURE ARTIFICIAL DRYING

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The mechanical dewatering of lucerne is being studied at the National Institute for Research in Dairying with leaf protein extraction equipment designed at the Rothamsted Experimental Station. The equipment consists of: (1) a 37 kilowatt pulper, 60 cm in diameter and 90 cm in length, with 64 fixed hammers on a hub rotating at 1083 revolutions/min; and (2) a 1.5 kilowatt belt press in which pulped lucerne is squeezed at a pressure of about 2 kg/cm<sup>2</sup>, between a tensioned belt and a perforated drum for several seconds. Pulping and pressing reduced the moisture content of the lucerne by about 5%, which increased the hourly wafer output from a Taarup Unidry rotary drum drier by some 25%, and decreased fuel consumption per tonne of wafers by about 30%. However, some 18.0% of the crop dry matter was expressed in the juice which on average accounted for 32.2% by weight of the direct cut lucerne. The lucerne juice, on average 11.3% dry matter but ranging from 6.9 to 14.4% for different batches, plus 1% by weight of propionic acid, was investigated as a source of protein in pig feeding trials. Results from a preliminary study of the *in vitro* nutritive value of the pulped pressed fibre wafers indicated no large depression compared with the original crop. Technically the mechanical dewatering of forages is potentially a valuable pre-treatment within a green crop drying enterprise, but clearly many factors apart from the nutritive value of the juice and fibre must be considered in arriving at an overall economic assessment.

54. THE VALUE OF LUCERNE JUICE AS A SOURCE OF NITROGEN FOR GROWING PIGS

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Three experiments with growing pigs of 20 kg initial weight were completed in which five batches of lucerne juice were used; the range of dry-matter content was 6.9 to 12.3%. The composition of the dry matter ranged as follows: total nitrogen (TN) 5.2 to 6.3%; true protein nitrogen (PN) 3.2 to 4.5%; non-protein nitrogen (NPN) 1.4 to 2.5%. Each batch of juice was preserved with 1% propionic acid. Changes during storage in dry matter and TN content were small, but the PN:NPN ratio fell markedly. In the first experiment, lucerne juice replaced on a TN basis either all, or part of, the 7% fish meal included in a cereal-based control diet. Results of this four treatment experiment with 12 pigs per treatment indicated that a proportion of the TN in the juice was not utilized by the pigs. In the second experiment with six pigs per treatment the basal diet was fed alone, or supplemented with either 3.5% fish meal or with lucerne juice in amounts which replaced the fish

meal either on a TN or PN basis. In the third experiment, six pigs were given the basal cereal diet supplemented with lucerne juice, and were kept on a continuous balance test with the object of determining the effect on nitrogen retention of the fall in the PN:NPN ratio that occurred in the juice during storage.

55. THE RELATIONSHIP BETWEEN PROTEIN INTAKE IN PREGNANCY AND LACTATION AND PRODUCTIVITY OF SOWS

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The requirements published by the Agricultural Research Council indicate that sows need diets containing 14.5% crude protein (CP) in pregnancy and 16.5% CP in lactation. An experiment is described which supports the view that these estimates are excessively high. Thirty-eight females (sows) were given diets in their first pregnancy formulated to contain 7, 10 or 13% CP and during lactation either 12.5 or 16.0% CP. The diets were formulated so that the quality of the protein factor was similar for all diets. Sows received 6 Mcal digestible energy (DE)/day in pregnancy and 15.3 Mcal DE/day when they were suckling 8 piglets for the 42-day lactation. As far as possible sows remained on the same dietary regimes for three successive parities. The difference in protein intake in pregnancy resulted in significant ( $P < 0.001$ ) differences in nitrogen retention by the pregnant sows, but analysis of pigs slaughtered immediately at birth indicated no significant differences in chemical composition. There were no significant interactions between intake of protein in pregnancy and lactation with respect to milk yield or sow productivity. The pregnancy treatments significantly affected live-weight gain ( $P < 0.001$ ), but had no effect on any measure of sow productivity. Increasing the level of protein intake in lactation increased milk yield and average weight of the piglets at weaning, but the increases were small. A model relating protein intake to productivity is presented which indicates that national savings in protein concentrates fed to sows could be justified.

56. A COMPARISON OF THE VOLUNTARY FEED INTAKES OF BOARS, GILTS AND CASTRATES

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Ninety Large White  $\times$  British Landrace pigs were used to investigate the appetites of pigs over the live-weight range 25 kg to 105 kg, when fed diets of differing protein concentration. The design was a  $3 \times 3$  factorial; 3 types of pig, intact males (boars), females (gilts) and castrate males, and 3 dietary protein concentrations (10%, 16% and 22% crude protein (CP) in the air-dry diet). There were 9 pigs/block, and each treatment was replicated 10 times. Pigs from the same litter (2 males + 1 female) were allocated to the same dietary treatment. During the growing period, weekly feed intakes and live-weight gains were measured and, after slaughter, backfat measurements were taken at the shoulder, midback and loin, and at 3 cm, 6 cm and 9 cm from the midline opposite the edge of the last rib. The specific gravity of both carcass sides was also measured. Results indicated that the boars had a 7% lower feed intake/kg of metabolic body weight ( $W^{0.75}$ ) than the gilts and 12% lower than the castrates. Boars converted their feed about 7% more efficiently than either the gilts or castrates, and made 8% greater live-weight gains. The specific gravities of the carcasses of the boars were 15% greater than the gilts and



25% greater than the castrates. The effect of protein concentration in the diet was such that from 10% CP to 16% CP feed conversion ratios were reduced, while daily live-weight gains and carcass leanness were increased; from 16% CP to 22% CP responses in these criteria were only small.

57. CALORIMETRIC STUDIES ON GROWING PIGS—ADAPTATION TO CHANGES IN ENVIRONMENTAL TEMPERATURE

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The adaptation of singly caged pigs of approximately 25 kg to a change in environmental temperature was studied using a closed-circuit respiration chamber. Three groups of three littermate ♂ castrates were kept at an environmental temperature of 22°C and fed an amount equivalent to maintenance + 9500 kJ during a 10-day pre-experimental period. After an initial 22-hour period in the chamber at 22°C one pig from each litter was placed in an environmental temperature of 15°C, 22°C or 29°C. The heat production of each pig was determined at 3-day intervals during the next 3 weeks. Total daily heat production of all pigs increased during the experimental period, but the heat production per unit metabolic body size of pigs at 22°C and 29°C tended to decline linearly. The heat production per kg body weight<sup>0.56</sup> of the pigs kept at 15°C increased by 10% during the first 10 days. Using an average value for efficiency of utilization of metabolizable energy for production it was possible to calculate the maintenance requirement. In the case of the pigs kept at 22°C and 29°C this remained constant, the average value being 960 kJ/kg W<sup>0.56</sup> whereas the maintenance requirement of the pigs at 15°C increased curvilinearly to a value of approximately 1350 kJ/kg W<sup>0.56</sup>.