

TITLES AND ABSTRACTS OF SHORT PAPERS GIVEN AT THE  
58TH MEETING OF THE BRITISH SOCIETY OF ANIMAL PRODUCTION,  
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1. THE PARTITION OF FAT IN THE BOVINE CARCASS

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Classification of beef carcasses for fatness depends on the assumption that the amount of subcutaneous fat is a reliable indicator of the amount of intermuscular fat. This assumption was investigated in three groups of purebred beef and dairy steers consisting of: (1) 17 Herefords and 19 Friesians reared together from birth to 24 months, with serial slaughter at 6-monthly intervals; (2) 10 Herefords and 12 Friesians also reared together, but on different levels of feeding, and again with slaughter at 6-monthly intervals; (3) 57 Herefords, 16 Devons, 10 Lincoln Reds, 17 South Devons, 29 Friesians and 15 Jerseys, all commercial cattle within the weight range 209 to 495 kg carcass weight. The left side of every carcass was dissected and the relationships among the different fat depots examined. The relationship between weights of subcutaneous and intermuscular fat is breed dependent, as is the relationship between subcutaneous and kidney fat. These relationships are characterized by a greater ratio of subcutaneous to intermuscular fat and of subcutaneous to kidney fat in the beef breeds compared with the dairy breeds. However, when the subcutaneous and kidney fats are combined, this difference between breed types is greatly diminished, and it is concluded that for an accurate assessment of intermuscular fat the assessor should be able to see both the subcutaneous and kidney fats.

2. PREDICTION OF BEEF CARCASS COMPOSITION BY SAMPLE JOINT DISSECTION

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Dissection data for the left sides of 419 carcasses, comprising 8 breed type and production system groups, were analyzed to determine the relative value of the standard MLC joints for predicting carcass composition. Mean lean percentage in the side for the groups ranged from 55.2 (Aberdeen Angus crosses) to 65.7 (semi-intensive Friesians); considerable variation existed within groups, the pooled within-group standard deviation being 3.53%. Tissue percentages and ratios in each joint were examined as predictors of their corresponding values in the side. The ranking of joints for the precision of predicting tissue percentages was fairly consistent from group to group. The coast and pony gave the most precise predictions of side lean percentage over groups; the pooled within group correlation was 0.94, with a standard deviation about the regression of  $\pm 1.20$  for both joints. The top piece and fore rib were marginally inferior ( $r = 0.92$  for both joints). The ranking of joints for the precision of predicting lean to bone ratio in the side was more variable between groups. Again the top piece, pony and coast were the best predictors over groups, the pooled correlations being 0.82, 0.82 and 0.79 respectively, with standard deviations about the regressions of  $\pm 0.18$ ,  $\pm 0.18$  and

$\pm 0.19\%$  respectively. In most cases, the regression relationships between joint and side values differed significantly between groups, presenting problems in the selection of prediction equations for general application.

### 3. PREDICTION OF PIG CARCASS COMPOSITION BY SAMPLE JOINT DISSECTION AND FAT THICKNESS MEASUREMENTS

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Data for the left sides of 534 male castrates and gilts from combined test groups, dissected between 1969 and 1972, have been analyzed to evaluate predictors of carcass composition. The results confirmed the superiority of caliper fat thickness measured over the eye muscle (C and K) compared with that along the mid-dorsal line (shoulder, mid back and loin) for predicting carcass leanness. The SD of percentage carcass lean for breeds, sexes, testing stations and years pooled was 2.64, and the residual standard deviations (RSD) 2.01, 2.02, 2.35, 2.42 and 2.20% respectively. There was little difference in the precision with which carcass lean percentage was predicted by lean percentage in the ribback (RSD = 1.17), rumpback (1.31), streak (1.21) and ham (1.36%); the hand and collar joints were inferior (RSD = 1.65% for both joints). The addition of C and K to lean percentage in a joint improved prediction for the hand and collar (RSD = 1.28 and 1.40% respectively) but produced little change for other joints. Used thus, each joint predicts carcass leanness with similar precision, and selection depends on the labour cost, carcass depreciation and the precision of prediction of other factors. The hand offers the best compromise, combining very low cost, relatively easy dissection and moderately precise prediction of intermuscular fat (SD of intermuscular fat in the side was 0.60, and the RSD was 0.44%).

### 4. THE GROWTH AND BODY COMPOSITION OF PIGS OF TWO GENOTYPES ON DIFFERENT NUTRITIONAL REGIMES

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The extent and nature of differences in the nutritional responses of pigs of two genotypes were examined in a factorial experiment which included 120 pigs, half of predominantly fat-type Duroc parentage (D), and half of predominantly lean-type Landrace parentage (L). One block of 5 male castrates and one of 5 gilts was allocated to each of six dietary treatments, comprising three protein regimes (18-16, 16-13 and 14-10% CP) at each of two levels of feed intake (110 and 130 g/kgW<sup>0.73</sup> per day). The pigs were individually fed from 20 kg and were slaughtered and dissected at 10 kg intervals from 70 to 110 kg. At any slaughter weight D pigs had less muscle (mean difference 3.7%,  $P < 0.001$ ) and more fat (mean difference 6.3%,  $P < 0.001$ ) than the L pigs. Increasing feed intake decreased the percentage of muscle in the L pigs by 2.4%, but by only 0.2% in the D pigs (interaction  $P < 0.05$ ). Feed intake had a similar differential effect on the *longissimus dorsi* area in the two genotypes (interaction  $P < 0.05$ ). The average backfat thickness of the L pigs changed by 4.0 mm between the extreme protein treatments, that of the D pigs by only 1.8 mm (interaction  $P < 0.05$ ). The growth rates of muscle in the two genotypes were not significantly different, but in the D pigs the rate of fat deposition was significantly higher, giving an improved daily gain ( $P < 0.001$ ) and feed conversion ( $P < 0.05$ ). This suggests that in the D pigs the energy costs either of maintenance or of tissue synthesis were less than in the L pigs.

## 5. FORM AND FUNCTIONAL DEVELOPMENT IN FARM ANIMALS

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There is abundant evidence that the deposition of protein in the animal body is fairly rigidly controlled. The large variation in body fat suggests less strict control. In the mid-nineteenth century, however, Lawes and Gilbert observed that in beef cattle fat deposition was greater subcutaneously than internally, whereas in dairy cattle the reverse applied. We have examined this proposition further to take into account subcutaneous, intra- and intermuscular fat, and kidney and associated fat. The results show that the same general patterns of fat deposition can be observed in cattle, sheep and pigs, and that the pattern may be changed by changes in level of feeding and by experimentally induced or natural variations in metabolism such as are encountered from one breed of animal to another. The breed-to-breed variation is associated with differences in thyroid function between animals. A hypothesis is presented that breed variations in the extent of deposition and pattern of fat distribution represent different ways of providing for survival, reproduction and lactation.

## 6. FEEDING LEVELS FOR SINGLE SUCKLER COWS IN LATE PREGNANCY AND EARLY LACTATION

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Twenty in-wintered North Devon  $\times$  British Friesian cows were group-fed on a daily ration of either 30.4 kg/head, on average, of grass silage of 23% mean DM content (l), or 31.5 kg/head of the same silage plus 1.36 kg of rolled barley (h), from mid-December until their South Devon cross calves were born in February and March 1972. The same rations (L and H) were fed from calving until the cows were turned out to grass in early May, but half of them were transferred to the alternative ration at calving. All cows grazed together at approximately 0.40 ha/cow and calf until late August, when the herd was divided into two matched groups so that some calves could be creep-fed a cereal supplement of 13.5% DCP. Cow weight loss between mid-December and one day post partum was 27.7 and 59.4 kg for the h and l treatments respectively, but mean calf birth weight was the same (35.5 kg). The higher level of feeding in early lactation was associated ( $P < 0.001$ ) with faster growing calves (0.72 v. 0.60 kg/day) and a lower cow weight loss (40.4 v. 53.1 kg) between calving and turn-out. Mean daily DM intakes over the whole winter were 8.03 and 7.17 kg for the higher and lower levels respectively. Interaction of the effects of levels of pre- and post-calving feeding resulted in the significantly higher growth rate ( $P < 0.01$ ) of hH calves (1.04 kg/day) from birth to 150 days. In late August the cow weight changes from the previous December were +0.4, -10.0, -5.9 and -6.4 kg for hH, hL, lH and lL respectively. Creep feeding did not affect the calf or cow weight changes but intakes averaged only 0.57 kg/head per day.

## 7. MILK PRODUCTION OF SUCKLER COWS AND CALF PERFORMANCE IN RELATION TO FEEDING IN LATE PREGNANCY AND BREED OF CALF

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Twelve winter calving crossbred cows were used in nutritional studies during the winter months for 3 consecutive years. All calves were sired by a single Aberdeen

Angus bull in years 1 and 2, though four bulls were used in year 3. In year 1 six animals were in their first lactation and six were in-calf heifers. During the first 28 days post partum, calves removed 55 and 78% of the milk produced by the cows and heifers respectively. During year 2 the cows were housed during the final 2 to 3 months of pregnancy and subjected to feeding levels of either 1.8 or 1.2 times maintenance; after calving all cows received 1.2 times maintenance. These pregnancy treatments significantly affected the weights of maternal tissue plus calf, which had mean values of 60.5 and 37.8 kg ( $P < 0.05$ ). Comparison between values for years 1 and 2 with respect to percentage of milk removed showed that this was an individual characteristic of cows and not, as previously thought, related to the lactation number. In year 3 six of the cows were grazed on poor hill and six on good lowland pasture; calves were sired by Hereford, Limousin, Charolais and Simmental bulls. Cows on good pasture weighed 80 kg more after calving than they did at the same stage in year 2 whilst those on poor grazing were only 5 kg heavier. In the third year the percentage of milk removed was confounded by breed of calf with the larger breeds consuming all or most of the milk. The milk consumed in kg/kg weight gain of calf amounted to 10.8, 9.9, 10.2 and 8.9 for Hereford, Limousin, Charolais and Simmental respectively.

8. EFFECT OF PLANE OF NUTRITION FOR BEEF COWS DURING LATE PREGNANCY ON SUBSEQUENT COW AND CALF PERFORMANCE

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In two experiments, spring calving cows (500 kg live weight) were individually fed either silage to appetite (1) or 27.3 kg per head (2) daily during late pregnancy. In Experiment 1, for treatments 1 and 2 respectively, the number of experimental animals was 12 and 11; the daily ME intakes were 22.3 and 13.4 Mcal; the duration of the experimental treatments was  $103.3 \pm 4.9$  and  $97.5 \pm 4.7$  days; the daily weight changes to post-calving were  $0.02 \pm 0.07$  and  $-0.53 \pm 0.06$  kg ( $P < 0.001$ ). The corresponding figures for Experiment 2 were 13 and 16 animals; 15.8 and 11.2 Mcal;  $79.2 \pm 3.8$  and  $77.3 \pm 3.4$  days; and  $-0.74 \pm 0.08$  and  $-1.20 \pm 0.07$  kg ( $P < 0.001$ ). All cows received silage to appetite for 42 and 49 days post-calving in Experiments 1 and 2 respectively, and were subsequently grazed together. In Experiment 1, for treatments 1 and 2 respectively, calf birth weights were  $35.4 \pm 1.6$  and  $34.1 \pm 1.5$  kg (NS); calf weight gains to 180 days of age were  $154.3 \pm 4.7$  and  $163.3 \pm 4.9$  kg (NS); cow weight gains from calving to 180 days were  $26.2 \pm 7.0$  and  $71.9 \pm 6.7$  kg ( $P < 0.001$ ). The corresponding figures for Experiment 2 were  $37.4 \pm 0.9$  and  $37.3 \pm 0.8$  kg (NS);  $222.7 \pm 6.3$  and  $217.5 \pm 5.7$  kg to 240 days (NS); and  $69.5 \pm 6.2$  and  $95.1 \pm 5.6$  kg to 240 days ( $P < 0.01$ ). There was no significant effect of treatment on milk yield in either study.

9. A COMPARISON OF MILK YIELDS OF SUCKLER COWS USING THE CALF SUCKLING TECHNIQUE AND MACHINE MILKING TWICE DAILY

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A long-term experiment is being undertaken which investigates the response in terms of lactation and cow live weight to feed intake in autumn calving Hereford  $\times$  Friesian suckler cows. Two methods of determining milk yield are being employed: either machine milking twice daily, or the calf suckling technique which allows the calves to suckle four times a day during the first two weeks of life, three times

daily from 2 to 6 weeks of age and twice daily thereafter. The calves are weighed before and after suckling on two days in each week to determine milk intakes. Forty-eight cows are at present involved in the experiment and are fed in lactation on one of three treatments consisting of 90, 125 and 175% of maintenance (117 Kcal metabolisable energy/kg  $W^{0.75}$  per day). Thirty-five of the cows were first-calving heifers mated with an Aberdeen Angus bull, and the remainder were second-calving cows mated to a Charolais bull. The determinations of milk yields and patterns of milk production during the lactation resulting from these two techniques are compared, with particular emphasis on their relation to commercial practice. The effect of birth weight of the calf and the body condition of the cow at calving, in relation to milk yields determined by the calf suckling technique, are also discussed.

#### 10. THE INTAKE AND UTILIZATION OF SILAGES BY FRIESIAN STEERS

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An experiment of  $2 \times 2$  factorial design was undertaken to study the nutritional value of high quality grass conserved either as fresh or wilted material (21 and 32% DM), preserved with or without the addition of 2.25 litres/tonne of an additive containing 85% formic acid. The silages were individually fed *ad libitum* for 50 days to 36 Friesian steers (9 per treatment) of 285 kg initial liveweight. Dry-matter intake for fresh and wilted, acid and non-acid treated material were 78 and 128; 102 and 104 g/kg  $W^{0.75}$  respectively. Corresponding mean live-weight gains were 0.80 and 0.96; 0.86 and 0.91 kg/head per day. Digestibility and balance studies suggested that whilst the apparent digestibility of the silages was high, there were no significant differences between treatments in the coefficients of digestion of individual constituents (OM, 0.73; N, 0.66; Energy, 0.72). Similarly there were only small non-significant differences in the ME values of the silages (11.5 MJ/kg DM). It was concluded that the difference in liveweight performance between treatments reflected differences in intake, rather than any effects on the efficiency of utilization of dietary components.

#### 11. THE EFFECTS OF SILAGE CHOP LENGTH AND MODE OF FEEDING IN BEEF PRODUCTION

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For each of three seasons 400 tonnes of flail-foraged and meter-chopped silage has been compared for manger feeding and self feeding 40 yearling store cattle and 32 two-year-old fattening cattle. Each spring four identical bunker silos of 100 tonne capacity were simultaneously filled with 22.3 ha of mown ryegrass/clover herbage, harvested with either a simple forage- or a meter-chop harvester. All silages received 2 litres of formic acid per tonne. Similar dry-matter losses were recorded in each type of silage, but that produced by meter-chopping had a superior feeding value as determined by chemical analysis, and *in vivo* digestibility was up to 3% higher. Feeding trials comparing methods of harvesting, self- or manger-feeding, and low or moderate levels of barley supplement were of a  $2 \times 2 \times 2$  design. Yearling store cattle were supplemented with 0 or 1.4 kg barley per day for 4 months. Two year old beef cattle were supplemented with 1.8 or 3.1 kg barley over a 3-month period to slaughter. Both yearling and fattening cattle showed higher live weight and carcass weight gains respectively on meter-chopped silage. Self-feeding only matched manger-feeding when silage quality was higher and stocking density at the face relatively low, but meter-chopped silage still showed to advantage. The effects of chopping, additive use and feeding practice are discussed.

## 12. UTILIZATION OF UREA IN MIXED SILAGE AND BARLEY DIETS BY GROWING CATTLE

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Recent work with growing and lactating cattle has shown responses in animal production terms from the addition of protein supplements to mixed silage/cereal diets. The object of these experiments was to evaluate urea as a non-protein nitrogen source in mixed silage and barley diets for rapidly growing cattle using the nitrogen (N) balance technique. Data have been taken from three experiments with a total of 20 animals using Latin square changeover designs. Equicaloric diets of silage and mineralized barley (4 kg/day) with and without approximately 40 g urea per day (incorporated into the concentrate mixture) were offered to Friesian-type heifers with a mean liveweight of 380 kg. Four basal silages were used with a mean dry matter (DM) digestibility of 72% but with crude protein (CP) ranging from 9.7 to 18% of the DM. Calculated metabolizable energy (ME) intakes for each comparison were 22.4, 19.5, 19.9 and 19.1 Mcal per day, and additional N retained was 12.8 ( $\pm 2.33$ ), 9.4 ( $\pm 2.11$ ), 8.2 ( $\pm 3.68$ ) and 2.6 ( $\pm 3.68$ ) g/day. Significant increases in N retention were obtained where ME intake was high and where the digestible N intake was less than 90 g/day. These results indicate that with mixed diets of silage and cereals given at levels to support weight gains of around 1 kg/day, a response to urea is likely if the silage contains less than 12% CP in the DM.

## 13. EVALUATION OF DRIED GRASS AS A SUPPLEMENT TO GRASS SILAGE FOR FINISHING CATTLE

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Seventy Friesian-cross steers (410 kg live weight) were used to study the effects of supplementary feeding of dried grass on silage intake. In addition the dried grass was compared with ground barley as a silage supplement in terms of live-weight and carcass gain. There were six treatments and a pre-experimental slaughter group. The animals on each treatment were group fed silage *ad libitum* for 98 days. The treatments were: (1) no supplement, (2) 1.5 kg dried grass, (3) 3.0 kg dried grass, (4) 4.5 kg dried grass, (5) 1.5 kg ground barley and (6) 3.0 kg ground barley/head per day. Silage intakes were measured on 30 occasions. Mean daily silage DM intakes for the six treatments were 8.05, 7.03, 6.59, 5.77, 6.49 and 6.54 kg respectively. Thus silage DM intakes were depressed by 13, 18 and 28% when 1.5, 3.0 and 4.5 kg dried grass was fed, and by 19% with either level of barley. The mean live-weight gains for the six treatments were 0.72, 0.93, 0.97, 0.87, 0.81 and 0.94 kg ( $SE \pm 0.05$  kg)/head per day respectively. The corresponding carcass gains were 0.44, 0.57, 0.65, 0.60, 0.54 and 0.60 kg ( $SE \pm 0.03$  kg)/head per day. Differences in carcass gain between dried grass and barley supplementation at similar levels were not significant.

14. DRIED GRASS AS A DAIRY CONCENTRATE WITH SILAGE FED *AD LIBITUM*.

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The object was to evaluate dried grass or dried grass/barley mixtures as concentrates with grass silage fed *ad libitum*. Four groups of eight autumn-calving British Friesian cows were individually fed grass silage (63 to 65% digestible OM in

DM (D value), 11.6 to 14.6% crude protein in DM) at a level 10% in excess of daily intake. Each had an equal quantity of concentrate consisting of either dried grass pellets (65 D, 21% CP in DM, 0.9 modulus of fineness; treatment 1), or dried grass/barley in the ratio 66/33 (2), or 33/66 (3), or a barley/de-corticated ground nut pellet (15.5% CP in DM; treatment 4). Following a standard feed in week 3, and change-over in weeks 4 and 5, the mean quantity of concentrate fed in the treatment period, weeks 6-22 of lactation, was 6.1 kg DM/head per day. For treatments 1, 2, 3, 4 respectively, silage intake was 8.6, 8.9, 8.0 and  $7.0 \pm 0.29$  kg DM/head per day (treatments 1, 2 > 4,  $P < 0.01$ ); milk yield was 18.8, 17.8, 20.1 and  $17.8 \pm 0.89$  kg/head per day, and these did not differ significantly; milk fat was 3.9, 3.9, 3.8 and  $3.4 \pm 0.11\%$  (1, 2, 3 > 4,  $P < 0.05$ ). SNF% and live-weight changes did not differ significantly between treatments. DM digestibility of the four treatment diets was respectively 69.9, 71.6, 70.1 and  $74.2 \pm 0.78\%$  (1, 3 < 4,  $P < 0.05$ ). Equal milk production can be obtained from pellets of dried grass or dried grass/barley as from a barley/protein concentrate fed with grass silage *ad libitum* (with grass of high D value) partly as a result of a depression of 0.26 kg silage DM intake for each additional kg barley DM included in the concentrate.

15. THE EFFECT OF DRIED GRASS/CONCENTRATE RATIO ON INTAKE AND LIVE-WEIGHT GAIN BY BRITISH FRIESIAN CALVES.

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Cereal-based concentrate and milled dried grass were mixed in the following ratios and pelleted: A, 100 : 0; B, 75 : 25; C, 50 : 50; D, 25 : 75 and E, 0 : 100. Forty early-weaned British Friesian calves of 54.8 kg mean live weight were divided into two similar groups (F and R). Calves in both groups were divided into 4 blocks of 5 calves and the above diets allocated at random within blocks. Calves in Group F were offered their respective diets *ad libitum*. Group R calves were offered 1.0 kg DM of their respective diets in the first week, and the feeding level was increased by 0.125 kg/day at weekly intervals. Treatments were imposed for 20 weeks. Five calves of 84.1 kg mean initial live weight were offered the 5 diets *ad libitum* in a 5 × 5 change-over trial to obtain more data on voluntary intake of the diets. Chopped hay was offered to all calves at 10% of the amount of pelleted food offered. Mean DOM values in the DM of the complete rations were: A, 77.5; B, 72.4; C, 67.1; D, 63.2 and E, 56.1. Mean daily DM intakes of hay plus pellets by Group F calves were 3.09, 3.23, 3.64, 3.04 and 3.31 kg/day and their mean daily gains were 0.97, 1.08, 1.01, 0.73 and 0.75 kg/day. Daily DM intakes of hay plus pellets by calves in the change-over trial were 3.61, 3.77, 3.99, 3.82 and 3.88 kg/day. Mean daily DM intakes of hay plus pellets by Group R calves were 2.36, 2.38, 2.38, 2.39 and 2.38 kg/day and their corresponding mean daily gains were 0.83, 0.76, 0.72, 0.71 and 0.62 kg/day. The results were discussed with reference to recommended live-weight gains for autumn-born calves.

16. THE GRAZING BEHAVIOUR AND HERBAGE INTAKE OF FRIESIAN STEER CALVES

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The ability of an animal to modify its grazing behaviour (time spent grazing and/or rate of biting during grazing) can exert an important influence upon the amount of herbage eaten under conditions of pasture restriction. The results of an

experiment designed to investigate the effect of the amount of herbage on offer to grazing calves upon their grazing behaviour and herbage intake are reported in this paper. Twelve spring-born British Friesian steer calves were strip-grazed on paddocks of S24 perennial ryegrass in August and September. There were three levels of herbage present before grazing (4100, 2600 and 3600 kg DM/ha, measured to ground level) in successive 2-week periods, and three levels of herbage allowance per day (3, 6 and 9 kg grass DM per 100 kg live weight). Measurements of grazing behaviour over 24 hours and herbage intake were made in each fortnightly period. Grazing time decreased by 6.3% as herbage allowance was reduced from 9 to 3 kg DM/100 kg LW and the rate of biting decreased by 10%. As a result herbage intake fell by 16.8%. There was no clear relationship between pre-grazing herbage yield and herbage intake. The behavioural responses observed are in conflict with the results of earlier studies with sheep and cattle, in which grazing time was reported to increase as the amount of herbage on offer declined, though not necessarily at a rate sufficient to maintain herbage intake. It is suggested that the influence of pasture restriction upon grazing behaviour and herbage intake will vary with the class of stock and the method of grazing management used.

17. A SIMPLE TWO-AREA SYSTEM OF GRASSLAND MANAGEMENT FOR SEMI-INTENSIVE BEEF PRODUCTION FROM AUTUMN-BORN CALVES

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Two groups of 8 autumn-born British Friesian steers weighing an average of 201 kg/head when turned out in April, were grazed during the three summers of 1971 to 1973, under two systems of management. 1. A 7- to 10-paddock grazing layout, comprising 4 to 5 small paddocks for early season grazing and 3 to 5 large paddocks for conservation and late season grazing. 2. A simple 2-area system with no subdivision comprising  $\frac{1}{3}$  for early season grazing and  $\frac{2}{3}$  for conservation and late season grazing. The grassland was stocked at an overall rate of 3.71 steers/ha, and provided both summer grazing and conserved fodder to rear and fatten the animals at an average age of 18 months with only a limited supplement of concentrates. Both grazing systems produced a similar and high level of liveweight gain during the grazing season (0.94 kg/head per day) but an additional 130 kg/head of forage dry matter (DM) was conserved for winter feeding under the paddock grazing management. In 1971 and 1972 an additional 200 kg of DM/head conserved under paddock grazing gave a saving of 40 kg/head in the amount of concentrates required for fattening. It also enabled a slightly heavier carcass to be produced. These two factors led to a higher economic margin/ha from paddock grazing. However, the simplicity of management and savings in watering and fencing costs offered by the two-area system must be considered.

18. LENGTH OF GRAZING ROTATION AND LIVEWEIGHT GAINS IN DAIRY REPLACEMENTS

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Plot experiments have shown that the longer the rest period between harvests, the greater is the quantity of herbage produced over the whole season. An experiment was carried out to test whether under grazing conditions animal production could be increased by lengthening the grazing rotation. A comparison was made during two grazing seasons between a 21- and 35-day rotation for Friesian calves



and heifers grazed in a leader-follower system. The two lengths of rotation were each examined at low (3 calves+3 heifers/ha) and high (4 calves+4 heifers/ha) stocking rates. The mean liveweight gains (kg/day) at low and high stocking rates respectively were 0.78 and 0.73 for calves, and 0.84 and 0.69 for heifers, on the 21-day rotation; 0.81 and 0.75 for calves, and 0.90 and 0.75 for heifers on the 35-day rotation. Live-weight gains/ha were 5% greater on the 35- than on the 21-day rotation, and 17% greater at the high than at the low stocking rate. Estimated herbage dry-matter production was 18% greater in the first than in the second year, but differences between treatments in both years were small.

#### 19. THE EFFECTS OF LACTATION LENGTH ON THE SUBSEQUENT REPRODUCTIVE PERFORMANCE OF THE SOW

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Forty sows (British Landrace × Large White) were subjected to a range of lactation lengths from 4 to 42 days, at two-day intervals. A significantly ( $P < 0.001$ ) negative curvilinear relationship was observed between lactation length and the interval from weaning to oestrus, and is given by the equation  $\log Y_1 = 0.9475 - 0.0086X$  (where  $Y_1$  = interval from weaning to remating, and  $X$  = lactation length) and  $r = -0.60$ . The relationship between lactation length and the service period (interval from farrowing to remating) was positive and linear over the whole range of observations, and could be described by the linear regression equation  $Y_2 = 8.37 + 0.89X$  ( $P < 0.001$ ) (where  $Y_2$  = service period) and  $r = +0.98$ . Very short lactations were associated with reduced litter sizes in the next parity. Sows weaned at lactation lengths between 4 and 21 days had an average litter size of 9.6 piglets born in the next parity, whereas sows weaned following lactation lengths of between 21 and 42 days had an average litter size of 12.7 piglets. Hence very early weaning is likely to reduce the farrowing interval linearly, but the advantages of this in terms of potential annual sow productivity appear to be offset by the effect of lactation length on the sow's subsequent litter size.

#### 20. SOWS MATED DURING LACTATION: OBSERVATIONS FROM A COMMERCIAL UNIT

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A restriction is placed on sow productivity by an apparent anoestrus state existing throughout lactation. Observations and data collection are being conducted on a single, commercial, hybrid multiplier unit where a management system is employed which enables sows to be served during lactation. The system involves grouping between 3 and 8 sows together with their litters at around day 20 post partum. The sows are fed *ad libitum* from grouping, and the piglets have ready access to creep food. After a day a boar is introduced to the group. No exogenous hormone therapy is used. Results from the 24 groups comprising 110 sows so far monitored, suggest that sows kept under these conditions will show oestrus, and conceive during lactation, with a high degree of predictability. Oestrus was shown by all 110 sows and conception to first service was 98.2%. The time taken for oestrus to be exhibited, represented as the number of days between grouping and oestrus, and parturition and oestrus, was  $10.97 \pm 0.37$  and  $34.10 \pm 0.54$  respectively.

Records available from 88 animals mated whilst lactating gave the following performance. Number of live births:  $11.14 \pm 0.29$ ; birth weight:  $1.51 \pm 0.01$  kg; 8 week weight:  $18.06 \pm 0.09$  kg. The system has recently been established experimentally on the University of Reading Pig Unit using Camborough hybrid sows. From 42 sows the percentage showing oestrus during lactation was 88% of which 92% conceived to first service. The number of days taken for oestrus to be shown was  $11.95 \pm 0.66$  from grouping, and  $32.00 \pm 0.65$  from parturition.

## 21. THE UTILIZATION OF GRASS JUICE BY GROWING PIGS

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Grass juice was extracted from mainly Italian ryegrass by passing through a screw press, and was evaluated in an experiment involving 96 pigs in the live-weight range 65 to 95 kg. One of 4 liquid diets of approximately 20% dry matter (DM) was given to pens of 6 pigs. There were 4 pens of pigs to each diet. The amount of dry matter given was increased weekly on a scale based on live weight. The diets which were given with different ratios of water were: barley/water in the ratio 1 : 3 (A); barley/grass juice/water in the ratio 1 : 1.9 : 1.6 (B); barley/grass juice/water in the ratio 1 : 2.8 : 0.95 (C); and barley/fish meal/water in the ratio 1 : 3 (D). The mean dry matter of the grass juice was 6% and the protein content in dry matter 18.4%. Diets B and D provided the same amount of crude protein (approximately 14%) and C and D the same amount of total lysine (0.59%). The live-weight gains (g/day) were 727 (B) and 739 (C) which were significantly greater than 671 (A) but less than 857 (D). The conversion of dry matter to live-weight gain was most efficient on D (2.94) and least efficient on A (3.83). The conversions of dry matter for the pigs on B (3.21) and C (3.14) were significantly better than A. The data relating to specific gravity indicated that A gave the fattest carcasses (1.0404) and D the leanest carcasses (1.0478) with B and C giving intermediate values of 1.0449 and 1.0450 respectively. The differences in specific gravity of the pigs on B and D were not significant.

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

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The addition of hydrochloric acid (HCl, 1½%) and sodium metabisulphite (MBS, 1.4 g/l) to freshly produced lucerne or grass juice significantly reduced the rate of decline in true protein nitrogen (PN) during storage. In an experiment with growing pigs (20 to 60 kg live weight), all the N supplied by the 3½% white fish meal (WFM) in a 'marginal' protein control diet, was replaced, on a PN basis, by either lucerne juice or grass juice to which these two preservatives were added. There were no significant differences in performance between the controls and the animals fed lucerne juice or grass juice. Laboratory tests confirmed that the initial rapid changes in the protein component of the lucerne juice were largely due to enzymic action, and could be prevented by mild heat treatment of the juice, to approximately 85°C by steam injection for 10 sec, immediately after production. A feeding trial was undertaken to assess the nutritive value of such heat-treated lucerne juice preserved with HCl (to reduce pH to 3.0) and MBS. The treated juice replaced, on a PN basis, all the WFM N in either a standard 7% WFM diet or in the 3½% WFM 'marginal' protein diet. The experiment involved 48 individually fed pigs (12 on

each of the four treatments) and covered the period from 20 to 60 kg live weight. The performance of the juice-fed pigs was at least as good as those receiving fish meal.

23. AN INVESTIGATION INTO TECHNIQUES FOR SHEEP ARTIFICIAL INSEMINATION IN THE FIELD

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Trials involving 969 ewes on eight farms were carried out in 1972 to determine whether artificial insemination could be applied satisfactorily in conjunction with oestrous synchronization of ewes. The ewes were treated with medroxyprogesterone acetate-impregnated intra-vaginal pessaries for 13½ days, and injected intramuscularly with 750 IU follicle stimulating hormone at pessary withdrawal. The overall conception rate (CR) for ewes inseminated by the French 'straw' technique at 50 and 64 hours after pessary withdrawal was 52%, with a lambing rate of 1.92 lambs born per ewe lambled. Where good handling facilities were available, 50 ewes per hour could be inseminated without undue difficulty by an inseminator and two assistants. Introduction of vasectomised rams from the time of first insemination had no effect on the overall CR and lambing rate. Similarly, marking of ewes by a vasectomised ram did not have any effect on fertility, the same CR (49%) and lambing rate (1.90) being obtained for 317 marked and 126 non-marked ewes. The CR for 483 ewes inseminated with semen diluted in a reconstituted milk powder was 59%, compared with 42% for 478 ewes inseminated with semen diluted in egg yolk, glucose and citrate ( $P < 0.01$ ). The French 'straw' insemination technique was considered to be superior to the pipette and ampoule method used previously, as it allowed better control of semen temperature and volume, and facilitated semen handling.

24. FERTILITY AND SURVIVAL IN HILL SHEEP IN RELATION TO THEIR HAEMOGLOBIN TYPE

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All animals in a closed flock of 2800 Scottish Blackface ewes and lambs kept under fairly severe hill conditions were blood typed in 1958 and in 1971. Analysis of field records collected over 20 years showed an association between performance and haemoglobin type (HbA and HbB). Ewes with Hb type B produced about 10% more lambs on average than those with Hb type A. However, the survival of HbB sheep was generally poorer than HbA sheep. These effects varied with age and with season but were sufficient to maintain a balanced polymorphism with the frequency of HbB at around 0.25. The findings indicate that under some circumstances lamb production might be increased by selecting Hb type B sheep

25. THE INFLUENCE OF THE TIMING OF RED CLOVER GRAZING ON OVULATION AND CONCEPTION IN SCOTTISH BLACKFACE EWES

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Ewes grazing red clover during the autumn mating season may exhibit a lowered conception rate due to an oestrogenic effect. An experiment was carried out in

1972 to locate an interval between the end of red clover grazing and the beginning of mating which would eliminate or minimise this effect. Seventy-five draft-for-age hill ewes were divided at random into five groups of 15. Ewes on treatment 1 grazed red clover (variety Hungaropoly) for one 28-day period immediately before mating and remained there during mating. Ewes on treatments 2, 3 and 4 grazed for 28-day periods ending 0, 14 and 28 days respectively before mating, while ewes on Treatment 5 remained on grass throughout the experiment. When not on red clover, the ewes on treatments 1-4 grazed with those on treatment 5. The ewes were examined post mortem for the presence of corpora lutea and embryos 50 days after mating commenced. The overall average corpus luteum and embryo counts were 1.66 and 1.39 with standard errors of 0.074 and 0.069 respectively. There were no significant differences between treatment means. Analysis showed that formononetin and biochanin A were present to the extent of 12 to 29 and 7 to 13 mg/100 g of fresh material (20% DM) respectively. It was visually apparent that the level of diadzen increased over the period. These results suggest that breeding ewes can graze red clover for short periods before mating without loss of fertility. The experiment was repeated in the autumn of 1973.

26. REPRODUCTIVE RESPONSE TO VARIATION IN BODY CONDITION AT MATING IN THREE BREEDS OF HILL SHEEP

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Apparent breed differences in lamb production are frequently observed on hill farms. It has been largely assumed that these are due to differences both in genetic potential and in standards of management. In a series of experiments over several years, the reproductive responses of Scottish Blackface (BF), South Country Cheviot (SCC) and North Country Cheviot (NCC) ewes to various controlled management procedures have enabled genotypic differences to be categorized. Comparison of ovulatory response to two definable levels of body condition at mating has shown little difference between breeds at a low level (Grade 2: BF = 1.30, NCC = 1.25 and SCC = 1.20) but considerable difference at a high level (Grade 3: BF = 2.11, NCC = 1.81 and SCC = 1.45). Breed differences in embryonic mortality were also apparent, with SCC ewes in high body condition losing more, and SCC ewes in low condition losing less than the other two breeds. This resulted in a different pattern of potential lambing rate from that of ovulation rate. Information on breed differences in response to current nutritional state at mating, and on the interactions with body condition, is not yet available, but possible differences and the effect of source, origin or rearing treatment of each genotype make extrapolation of results to other genotypes of limited value. Choice of breed for a given management system or, alternatively, choice of management objectives for a given breed and level of performance, must therefore depend on knowledge of breed potential and its response to a variety of known variables.

27. OVULATION RATE AND RESPONSE TO SELECTION IN GALWAY SHEEP

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A flock of Galway sheep has been under selection for litter size since 1964. In addition a control flock has been maintained. Ovulation rate has been measured in females of the selection (S) and control (C) lines at 1½ years of age (hoggets).

The mean ovulation rates were 1.33 and 1.59 for 70 S and 34 C hoggets respectively. The line difference is significant ( $P < 0.05$ ). Mean body weights for the lines were 52.7 and 54.3 kg for S and C hoggets respectively. The regression of ovulation rate on body weight was negative and non-significant in both lines. Hence, the difference between control and selection lines cannot be explained by body-weight differences. Mean hogget litter sizes for the years 1971, 1972 and 1973 were 1.29, 1.32 and 1.26 for S hoggets and 1.18, 1.39 and 1.26 for C hoggets. Repeatability of ovulation rate was 0.32. It is apparent that selection has not increased litter size at this age. The possibilities of selection for ovulation rate were discussed.

## 28. COMMERCIAL VALUE OF TESTED BOARS

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Previous reports have been given of the progress of the Pig Improvement Scheme, including an analysis of the old PIDA records to evaluate tested boars under farm conditions. This had the disadvantage that many of the tested boars were of high points being compared with highly selected boars used in pedigree herds. Arrangements were made to assist producers to purchase a boar normally in the 110 to 125-point range and to provide information on the age to slaughter, dead weight and grade of his progeny, in comparison with progeny from non-tested boars used at the same time. Within-farm comparisons were restricted to boars of the same breed. Similar information has also been collected to assess the value of AI boars under commercial conditions. Collection of information continues, but analysis to date shows that for 21 within-farm comparisons the tested boars (natural service) (weighted average points 116) had progeny averaging 1.82 days less to 68 kg dead weight and worth 17.3 pence per pig more than those from non-tested sires. Sample size was 2958 pigs by 39 non-tested sires compared with 2518 pigs by 23 tested sires. Thirteen within-farm-breed comparisons, a total sample of 2981 pigs by 55 non-tested sires and 2020 by 64 AI sires, gave results of 2.17 days and 42.3 pence per pig in favour of AI sires, for pigs slaughtered at 68 kg dead weight. Insufficient results were available from farms selling pigs to pork weights to make a meaningful analysis.

## 29. A PRELIMINARY STUDY OF THE RELATIONSHIP BETWEEN CENTRAL TESTING AND 'ON-FARM' PERFORMANCE TESTING OF PIGS

P. R. Bampton, M. K. Curran and R. E. Kempson, *Wye College (University of London), Wye, Ashford, Kent.*

Performance test scores from the Meat and Livestock Commission's 'on-farm' testing scheme were available for 11 050 gilts tested between December 1971 and November 1972. Mean scores of a sire's progeny tested on-farm were paired with scores from centrally tested progeny. Nine hundred and eighty-six pairs of records were obtained when each progeny test on a sire was regarded as an independent assessment of that sire. A nested design was used, partitioning the total variance into between-quarter (3 months), between-herds within-quarters and residual (between sire) components. Variation due to herd differences was highly significant ( $P < 0.01$ ). Correlation coefficients calculated from the residual components were 0.15, 0.21, 0.19, 0.26, 0.27, 0.42 and 0.48 respectively for samples containing at least 1, 5, 10, 15, 20, 25 and 30 progeny per sire 'on-farm'. These correlations were significantly different from zero ( $P < 0.01$ ) but not from each other. Correlations

from the between-herd components varied from 0.15 to 0.40. Regression coefficients were little influenced by the number of progeny and were of the order of 0.05 units of farm score per unit of central test score. These preliminary results were discussed in relation to the efficacy of 'on-farm' performance testing.

30. A COMPARISON OF TWO FARROWING AND REARING SYSTEMS FOR PIGLETS

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Since 1970 2 different types of farrowing system and 2 systems of rearing piglets from 3 weeks to weaning at 6 weeks of age have been in contemporary use at Terrington. In one farrowing system the sow occupies a combined farrowing and rearing pen with a temporary crate where she is closely confined only during farrowing and for 24 hours afterwards. The sow and litter remain in this pen until weaning at 6 weeks of age. Under the other system sows are confined in crates at from 4 to 5 days before farrowing until the piglets are 3 weeks of age, when sows and litters move to follow-on accommodation. Piglet mortality for both systems has been recorded over a 2½ year period; losses from birth to 3 weeks of age were 14.9% in the combined farrowing and rearing pens but only 10% in the crates. From 3 to 6 weeks of age piglets are housed either in the combined farrowing and rearing pens or in groups of 4 sows and litters in multiple occupation pens. Piglet mortality over the 2½-year period was 2.8% in the single litter pens and 3.2% in the multiple litter pens.

31. APPLICATION OF PIG SLURRY TO PASTURE: THE EFFECT ON SHEEP OF HERBAGE COPPER

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Winter application of slurry from a pig fattening enterprise caused high copper levels in the spring herbage. Further dressings in the summer maintained these high copper levels throughout the grazing season. Ewes with their lambs were grazed on plots which had received 250 000 l/ha slurry, with a copper content of 3.88 mg/l, and on which the Cu content of the spring herbage was 65 p.p.m.

In a subsequent experiment, ewes with their lambs were grazed on plots which had received 250 000 l/ha slurry over winter and a further 250 000 l/ha in 4 dressings over the grazing period. On these plots herbage copper content was maintained at 36.0 p.p.m. during the grazing period (April-September). Monthly blood samples were taken from ewes and lambs but blood copper content did not differ from that of control groups. Levels of the enzymes glutamic oxalacetate transaminase, sorbitol dehydrogenase and glutamate dehydrogenase in the blood of ewes grazing the slurried plots were significantly higher than those of the control group. The level of these enzymes was indicative of liver damage and this damage was confirmed histologically. Summer application of slurry with a copper content more than 3.88 p.p.m. could cause the condition of chronic copper poisoning in sheep grazing such pastures for long periods.

32. THE EFFECT OF QUALITY AND QUANTITY OF MILK PROTEIN ON FEED DIGESTIBILITY, GROWTH RATE AND NITROGEN RETENTION IN LAMBS GIVEN MILK SUBSTITUTES

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Milk substitutes with low levels of non-casein nitrogen (NCN) (expressed as the percentage of total N that is present as NCN) have been shown adversely to affect the performance of calves. Twenty-four lambs were given milk substitutes with two levels of protein (20 or 30% of the gross energy supplied by protein) and three levels of NCN (6, 11 or 17%) at each protein level. All animals received a daily allowance of 7950 kJ (approximately 350 g milk powder DM) for 21 days. The apparent digestibility of the dry matter was improved by both increasing protein level (95.1 v. 97.3%) and NCN level (94.9, 96.8 and 96.8%). The digestibility coefficients for CP and ash followed this pattern, whereas those for fat and energy only responded to an increase in the protein level. Live-weight gain and feed conversion efficiency (kg LWG/kg DMI) were improved by increasing protein (271 v. 308 g/day and 0.79 v. 0.89) and NCN levels (273, 290 and 306 g/day and 0.80, 0.84 and 0.89) in the diet, as were the gains of water and nitrogen in the whole body. The gains of fat and ash were only affected by protein level. The percentage of dietary nitrogen retained rose with NCN level but fell with protein level. The results indicate that live-weight gain and food conversion efficiency can be affected as much by protein quality (as represented by the percentage NCN) as by protein quantity in the diet, within the limits used in this experiment.

33. THE PERFORMANCE OF EARLY-WEANED LAMBS GIVEN CONCENTRATES CONTAINING WHOLE OR PROCESSED CEREAL GRAINS

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Conventional soya bean/barley diets for early-weaned lambs have been found to produce an undesirable softness in the fat. Experiments were conducted to measure the effects of whole, rolled and ground barley on performance and carcass quality. Two successive groups of 40 early-weaned lambs were each divided into 10 blocks and the following 4 diets were offered *ad libitum* from 4 weeks of age to slaughter at 37 kg live weight: (A) ground barley with soya bean; (B) ground barley with fish meal; (C) rolled barley with fish meal; and (D) whole barley with fish meal. A mineral/vitamin supplement was included with each diet. Diets A and B were pelleted, while C and D were offered as 10% of a pelleted fish meal/mineral supplement mixed with 90% barley at the time of feeding. There was some selection of barley in diets C and D with the result that the mean percentage of supplement consumed was 7.8 in these diets. The percentage crude protein in the diets consumed was (A) 17.7, (B) 15.1, (C) 13.5 and (D) 13.3. Values for organic matter digestibility were 81.9, 82.6, 80.6 and 81.5%. Mean daily DM intakes were 863, 746, 772 and 722 g respectively, and mean daily live-weight gains were 289, 251, 269 and 275 g. Conversion ratio on the ground barley/soya bean diet at 3.08 was considerably higher than on the whole barley/fish meal diet at 2.68. Results were discussed in relation to carcass quality.

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34. GROWTH RATE, FEED CONVERSION RATE AND SLAUGHTER PERFORMANCE OF MALE AND FEMALE SUFFOLK × CLUN FOREST LAMBS REARED INTENSIVELY AND SERIALY SLAUGHTERED

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Twenty-five male and 20 female Suffolk × Clun Forest lambs which had been artificially reared and weaned at four weeks of age were used. From 16.0 kg live weight (age 52 days), animals were fed individually and *ad libitum* on a diet of 79% rolled barley and 21% protein, with a mineral and vitamin supplement, and slaughtered at 28, 34, 40, 46 or 52 kg live weight. Five lambs of each sex were slaughtered at each weight, but females were not slaughtered at 52 kg. Carcasses were assessed for fat cover and conformation. Overall, mean growth rates from 16.0 kg live weight were 364 and 311 g/day for males and females respectively; similarly, feed conversion rates were 3.52 and 3.90 kg feed per kg live-weight gain. Feed conversion rates deteriorated with increasing live weight and were 4.01 and 4.30 for males and females respectively during the live-weight range from 28 to 34 kg, 4.30 and 5.31 from 34 to 40 kg, 5.78 and 6.21 from 40 to 46 kg and 5.68 for males from 46 to 52 kg live weight. Overall, the killing-out percentage of males was 2.1 units lower than females. Fat and conformation scores for both sexes improved with slaughter weight until 40 kg and remained constant thereafter, but females had consistently higher scores than males. Five animals (males slaughtered at 28 and 34 kg) were rejected for Ministry Certification because of lack of finish and poor conformation. The results were discussed in relation to optimum slaughter weight. It would appear that in the absence of carcass price differences reflecting variation in finish, the margin of carcass value over feed costs increases with slaughter weight, and differences between sexes are small.

35. FEEDING PRE-RUMINANT CALVES WITH MILK-REPLACER POWDERS CONTAINING ANIMAL AND VEGETABLE PROTEIN IN PLACE OF MILK SOLIDS

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The rising cost of conventional milk-replacer powders for calf rearing has stimulated the production of powders based upon proteins of animal and vegetable origin which replace skim milk powder. The new powders, manufactured in France and Holland, became available through British agents together with a prototype British powder. In the winter and spring of 1972/73, trials were carried out with 220 calves at six centres, using British, Dutch and French powders fed to both home-reared and bought-in calves of dairy and beef type and of both sexes. Calves were successfully reared on all powders on one or two daily feeds, and on both warm and cold feeding systems. Calf health was good throughout the trials except at one centre. Some centres reported poorer appearance in calves reared on the new powders, although they were not different in live weight at weaning. Results to 84 days showed no significant differences in live-weight gain amongst calves on all treatments, and savings in cost of from 50 to 95p per calf were recorded for the new powders compared with conventional milk replacers.



36. THE EFFECT OF LEVEL OF MILK CONSUMPTION ON THE HERBAGE INTAKE AND LIVE-WEIGHT CHANGE OF CALVES.

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Thirty Hereford × Friesian castrate male calves were used to investigate the importance of milk in the diet of calves during the first eight months of life and its effects on herbage intake and live-weight change. Typical lactation curves were followed in the feeding of five levels of reconstituted milk substitute (1900, 1600, 1300, 1000, 700 kg) over a 240-day period. Calves were individually penned and fed milk twice daily so that consumption was precisely controlled. They were housed individually from purchase in mid-February, at approximately 7 to 10 days of age, until they were turned out to grazing at 10 weeks of age. At pasture the calves were strip grazed on S24 perennial ryegrass and given a daily allowance equivalent to 6% of total body weight as herbage dry matter (measured from ground level). Herbage intake was measured over six 5-day periods at 28-day intervals during the grazing season. The mean herbage organic matter intake (HOMI) (g/day) was 1433, 1822, 2303, 2178, 3516 and 4220 ± 42.4 g for periods I-VI respectively. There was no significant within-period effect of milk treatment on HOMI per head. When HOMI was calculated as intake per unit live weight there was a significant milk treatment × period interaction ( $P < 0.05$ ). These data are discussed in relation to the effect of milk on the live-weight gain and grazing behaviour of the calf.

37. MILK CONSUMPTION AND GROWTH OF SUCKLED CALVES

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An experiment has been undertaken to examine the effects of level of feeding of the cow, and of single- versus double-suckling on milk intake and growth of the calf. Twelve crossbred cows in their first or second lactation were divided into groups of three according to calving date, and an animal in each group was either adequately fed on winter rations and given two or one calves to rear (groups HDS and HSS respectively) or underfed with a single calf (group LSS). The four additional calves for group HDS were Friesians obtained locally. All calves were allowed hay *ad libitum*, and milk consumption and weight gains were measured from the 29th day of lactation. Spring grazing was simulated by giving chopped dried grass *ad libitum* to all cows on the same date when they were in either mid- or late lactation. During the period of winter feeding the average daily yields of the cows in groups HDS, HSS and LSS were 12.25, 9.57 and 7.57 kg respectively and the corresponding mean daily growth rates of the calves were 1.35 (two calves), 0.91 and 0.73 kg. For both yield and growth rate the differences between HDS and the other two groups were significant ( $P < 0.05$  or 0.01). There was a highly significant correlation ( $r = 0.87$ ) between rate of gain and milk consumption. When dried grass was fed the daily yields of the cows were 13.06, 9.37 and 7.30 kg, and the daily growth rates of the calves were 1.79, 0.95 and 0.88 kg for groups HDS, HSS and LSS respectively. The correlation between milk consumption and weight gain was less ( $r = 0.53$ ) but still significant.

## 38. LIQUID FEEDING FOR BEEF CATTLE

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Twenty Friesian steers weighing 170 kg were individually penned on slats and used in a growth trial to measure the effects on feed intake and weight gain of offering a diet containing predominantly barley in either dry form (D) or mixed with water to provide a liquid feed containing 26% dry matter (L). Hay was offered to all steers to provide 5% of total intake, but in spite of this bloat occurred in some animals on both treatments. Dry matter intakes (kg/day) from 170 to 350 kg were 6.0 for steers on treatment D and 4.3 for steers on treatment L. Live-weight gains were 1.19 and 0.78 kg/day for steers on treatments D and L respectively. At 350 kg 3% crude fibre (on a dry basis) was added to the mixture for steers given the liquid feed, and from 350 kg to slaughter at 430 kg daily dry-matter intakes were 8.60 kg for D and 7.5 kg for L. Live-weight gains were 1.16 and 1.35 kg/day for steers on treatments D and L respectively. In a second trial 14 younger steers were offered the liquid feed containing added fibre and grown from 100 to 250 kg. They consumed 5.6 kg dry matter daily and gained at 1.26 kg/day compared with steers given dry feed when the dry matter intake was 4.9 kg and daily gain 1.20 kg.

## 39. DIGESTIBILITY OF WHOLE MAIZE GRAIN IN CATTLE

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It has recently been claimed that under certain conditions cattle are capable of efficiently digesting whole maize grain. Two experiments were conducted to determine some of the factors affecting the digestibility of whole maize grains by cattle. In the first experiment four cows and four steers (15 months old) were given high moisture maize (50% DM) preserved with propionic acid, with two levels of hay: supplying 40 and 15% of total dry matter intake. Digestibility of organic matter of maize was higher in the steers (71.3% OMD) than in cows (63.3% OMD) irrespective of level of hay. The lower level of hay in the diet improved the digestibility of maize in the steers but not in the cows. In a second experiment, with four yearling steers, a 4 × 4 Latin Square was used to determine the influence on digestibility of amount of whole dried maize in the diet and of the physical form of the forage. Medium quality dried grass provided forage in the long, or in the ground and pelleted form. The possibility of using whole maize grain in diets for cattle was discussed together with the importance of chewing for efficient digestion of whole grain and of the time of retention of grain in the gut.

## 40. THE VOLUNTARY INTAKE OF MAIZE SILAGE TREATED WITH AMMONIA

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Previous work at the Institute has demonstrated that both the low nitrogen (N) content and the acidic nature of maize silage limits the level of voluntary intake by young calves. In the present experiment, ammonia was added to ensiled whole-crop maize (23.2% dry matter (DM) 11.3% crude protein (N × 6.25) in DM) to elevate simultaneously both the N content and pH of the material. Eight British Friesian ♂ castrate calves, of which four were fitted with rumen fistulae,

initially 3½ months of age and 122 kg live weight, were fed in two replicates of a 4 × 4 Latin Square design on maize silage offered *ad libitum* which was treated with different amounts of ammonia (NH<sub>3</sub>) prior to feeding. The quantities of NH<sub>3</sub>, added in aqueous solutions at a rate of 250 ml solution/kg silage DM, supplied 0 (level O), 3·2 (1), 5·3 (2) and 8·0 (3) g N/kg silage DM. The pH of the four silages averaged 3·82, 3·95, 4·27 and 4·60. Addition of NH<sub>3</sub> increased DM intake by 1·3, 7·5 and 13·3% at levels 1, 2 and 3 respectively (P < 0·01). There were no significant effects of addition of NH<sub>3</sub> on time spent eating or ruminating (per kg of silage DM) on rumen pH, concentration of total rumen volatile fatty acids (VFA) or on the molar proportions of VFA. Increasing levels of NH<sub>3</sub> were reflected in elevations in both rumen NH<sub>3</sub>-N content and blood urea-N content. It is suggested that the responses in voluntary intake to addition of NH<sub>3</sub> were probably metabolic in origin. Application of NH<sub>3</sub> at a rate of 8g N/kg silage DM gave elevations in voluntary intake of silage which were greater than had earlier been obtained from the addition of a similar quantity of N in the form of urea.

#### 41. THE USE OF DEHYDRATED WHOLE-CROP FORAGE MAIZE IN DIETS FOR BEEF CATTLE

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The feed potential of dried, whole-crop maize was demonstrated by daily live-weight gains in steers in excess of 1 kg. The cattle were fed at a crude protein level of 11% and this may be higher than is necessary for cattle of this weight. Consequently an experiment was designed to investigate the feeding of dried maize on its own and in conjunction with urea, whole crop beans and dried grass to supply graded crude protein levels between 9 and 11%. The treatments were: A, whole-crop maize; B, whole-crop maize with urea; C, whole-crop maize with whole-crop beans; D, whole-crop maize with dried grass; E, whole-crop maize with rolled barley; and F, dried grass with rolled barley. Forty-eight Hereford × Friesian steers, weighing approximately 350 kg, were used in the experiment. The animals were randomly allocated to one of the six treatments. The diets were fed *ad libitum*. There was an acclimatization period of 14 days followed by an experimental period of 98 days. The mean dry-matter intake (kg) and mean daily live weight gain (kg) for each treatment were: A, 8·35, 0·87; B, 9·55, 1·0; C, 7·44, 0·70; D, 8·94, 1·15; E, 9·30, 1·23; and F, 9·24, 1·21. Although there was no overall significant difference in live-weight gain between all treatments, two levels of performance are apparent. These are the two barley diets and the maize-plus-grass diet, forming the higher level, and the maize only, urea and bean treatments forming the lower level.

#### 42. MULTIBREED COMPARISON OF GROWTH RATE AND FOOD EFFICIENCY IN CATTLE

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A multibreed experiment with cattle has been established at ABRO to estimate between-breed variation in productive efficiency, and to measure the inter-relationships of body size, growth rate, milk yield and feed intake across a wide range of beef and dairy breeds. The experimental design is based on 27 breeds with each breed represented by 10 to 12 females from 2 to 4 sires. Animals are housed indoors throughout and fed a complete pelleted diet *ad libitum* from weaning at 12 weeks of age until the end of their second lactation. Preliminary results are available from

9 breeds represented by a total of 26 animals from 14 sires. Live weight and food intake were measured at 2-weekly intervals from 12 to 72 weeks of age. Mean absolute growth rate (AGR) for breeds ranged in order of mature breed size from  $0.50 \pm 0.02$  to  $0.95 \pm 0.08$  kg/day. Relative growth rate (RGR) and food efficiency (FE) had no strong relationship with mature breed size. The respective ranges for RGR and FE were  $0.34 \pm 0.07$  to  $0.40 \pm 0.05$  %/day and  $8.9 \pm 0.09$  to  $10.7 \pm 1.3$  kg gain/100 kg food. The correlation between RGR and FE was high both between sires within breeds (0.96) and between breeds (0.91). The correlation between AGR and FE was high between sires within breeds (0.90) but low between breeds (0.36). RGR and AGR were moderately correlated within breeds (0.77) but not between breeds (0.05). Selection on RGR should be more effective than AGR in improving growth rate without increasing mature size, and in improving food efficiency, when selecting between breeds.

43. COMPARISON OF POSSIBLE METHODS OF EVALUATING DAIRY BULLS WHEN SELECTING FOR BOTH MILK AND MEAT PRODUCTION

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Computer programmes were run to estimate genetic improvement and to give some indication of economic benefit from three possible means of selecting dairy bulls for both meat and milk production. The three alternatives are: (a) two-stage selection on a performance test of the bulls for growth characters followed by a progeny test of the bulls' female progeny for milk characters; (b) Index selection on a progeny test of the bulls in which growth characters are measured on male progeny and milk characters on female progeny; (c) Index selection on a performance test of the bulls for growth characters followed by a progeny test of the bull's female progeny for growth and milk characters. A discounted gene flow method was used to give an economic value of the genetic improvement, and this was discussed in the context of possible costs of implementing these methods of selection. The characters to be selected are milk yield, fat percentage, growth rate and feed efficiency. The variables used in evaluating these methods were, where possible, those applicable to the Friesian population in the United Kingdom. Where no data were available a range of values was inserted and the results examined to ascertain the importance of changes in value of these variables.

44. AN INVESTIGATION INTO THE INCIDENCE OF DYSTOCIA IN FRIESIAN HEIFERS

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Many farmers are reluctant to have their Friesian heifers served with a Friesian bull because they fear difficult calvings. They use a Hereford or Aberdeen Angus to obtain easier calvings. In predominantly autumn-calving herds this practice often prevents a 2-year-old calving policy because the earlier-born calves are crossbreds and the Friesian calves are born too late in the year for autumn calving at 2 years of age. There is little published evidence on the incidence of dystocia in Friesian heifers calving to a Friesian bull, so an investigation planned to extend over several years was started in the autumn of 1972. ADAS Dairy Cattle Advisers identified herds (mostly institutional) in England and Wales where the weight of heifers at service and calving would be available, and where type of calving would

be recorded accurately. An interim analysis has been made of detailed reports of 1536 heifer calvings in 48 herds. In 548 calvings to Friesian (F) bulls 16.4% were difficult; comparable figures for Hereford (H) bulls (423 calvings) were 11.1% and for Aberdeen Angus (AA) bulls (388 calvings) 8.2%. Calf mortality was F 15.3%, H 8.8%, and AA 8.7%. The incidence in heifers of sickness was 4.4%, mortality 1.2% and veterinary assistance 4.7%. The effect of age and weight at service and calving on the incidence of dystocia and calf mortality were discussed. An indication of the range of age at calving where dystocia and calf mortality are at a minimum was given.

#### 45. SURVEYS OF CALVINGS TO LIMOUSIN AND SIMMENTAL BULLS IMPORTED INTO GREAT BRITAIN IN 1970/71

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Postal surveys conducted by the Artificial Insemination Organisations yielded data from 3187, 2138 and 845 calvings of Friesian cows to 13 German Simmental (GS), 10 Swiss Simmental (SS) and 6 Limousin (L) bulls respectively. In addition there were 218 GS, 144 SS and 323 L calving records from Friesian heifers and 1061 GS, 279 SS and 128 L from Ayrshire cows. Breed and individual bull means were calculated for calf mortality, seriously difficult calvings and gestation lengths. With Friesian cows perinatal mortality percentages averaged 4.0 for GS, 4.8 for SS and 3.2 for L. Comparable figures for Charolais (Ch) and Hereford (H) bulls were 5.5 and 2.7 respectively. From Friesian heifers mortality was 6.4% for GS, 19.4% for SS, 11.8% for L and 5.0% for H. Mortality from Ayrshire cows was consistently 1.5% higher than from Friesian cows. The percentage incidence of seriously difficult calvings in Friesian cows was 3.3 GS, 3.7 SS, 2.4 L, 5.4 Ch and 0.9 for H. For Friesian heifers the figures were 5.5 GS, 13.9 SS, 7.7 L and 2.5 for H; and for Ayrshire cows 4.3 GS, 2.5 SS and 0.8 L. Gestations for normal calvings of all crossbreds, from Friesian cows, were longer than the usual 281 days for pure Friesians, 285 GS, 286 SS, 287 L, 285 Ch and 282 H days.

#### 46. ADVANCES IN COMPUTERIZED DAIRY MANAGEMENT AIDS

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Computers have been utilized in the UK Agricultural Industry for almost two decades, but in farming practice the most rapid development in computerized aids and services for farmers has been in the last few years. This development has been in the 'enterprise forecasting, costing and monitoring' area, particularly for dairy farmers. Because planning ahead was viewed as more productive than merely examining historic facts and past achievements, the UK has been in the forefront in developing forecasting techniques as a tool to assist dairy herd management and ultimately herd profitability. The essential part of management aids and services is that they should provide information which leads to decision taking or direct action. Furthermore, the information must improve profitability if the services or aids are to be of real value. Two computerized dairy management aids were discussed, highlighting forecasting techniques for individual cow milk output, concentrate feed input and the financial implications. The effects of adopting management disciplines of this nature were evaluated by comparing financial

performance of farms before and after adopting the technique, with appropriate adjustment for the progress achieved during the same period on farms not using this system.

47. THE EFFECT OF SEX HORMONES GIVEN ORALLY ON LEAN TISSUE ANABOLISM IN GROWING FEMALE AND CASTRATED MALE PIGS

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The synthetic steroid  $17\alpha$ -ethynylloestradiol (EE) is a potent oestrogen which, because it closely resembles the natural ones in chemical structure, may be more ethically acceptable in animal production than is the widely used non-steroidal oestrogen diethylstilboestrol (DES). Both compounds were examined with and without the androgen,  $17\alpha$ -methyltestosterone (MT), in a growth trial involving 32 female and an equal number of castrated male pigs. The diets contained EE at concentrations of 0 (control), 0.5, 2.0 and 8.0 p.p.m., or DES at the one level, 2.0 p.p.m. Half the pigs in each of the above groups (including the control group) received 4.0 p.p.m. of MT in the diet. Hormone treatment started at 30 kg live weight and was suspended after 11 weeks, one week prior to slaughter. The diet contained 16% CP and was fed to a scale related to time. The rate of growth of lean tissues (estimated from specific gravity determinations on the carcass) was improved by 3% by DES when given alone, but by 11% when MT was given. These improvements were exceeded by EE, when given at its most effective concentration which was 2.0 p.p.m.; comparable values were 9% for EE by itself and 17% for EE+MT. The improvement from MT alone was 5%. Measures of the development of secondary sex characters showed a number of significant differences between treatment groups, but these were considered to be of little economic importance.

48. THE EFFECT OF SUBSTITUTING SWEDES FOR BARLEY IN DIETS FOR PIGS GROWING FROM 50 KG LIVE WEIGHT

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An experiment was undertaken to examine the performance of pigs given swedes as a replacement for barley in the diet, when dry matter (DM) was used as the basis for the substitution. One hundred pigs of about 50 kg initial live weight were randomly distributed to three experimental treatments. They were placed in pens in groups and offered one of three diets according to a scale of rationing which provided 2 kg DM/day when the pigs weighed 50 kg live weight. The amount of DM offered was increased each week by 125 g/day. Pigs weighing approximately 90 kg were given 3 kg DM/day. The control diet contained, on a DM basis, 89% ground barley, 9% soya bean meal and 2% mineral and vitamin supplement. In the other two diets either 20% or 40% of the DM supplied by the barley in the control diet was replaced by DM from swedes. The crude protein and available lysine concentrations in the DM of the diets were calculated to be 14.2, 13.7 and 13.3, and 0.54, 0.56 and 0.58% respectively. There were no significant differences between the treatments in live-weight gain or in feed DM: gain ratio. The carcass gain per unit of DM given was reduced ( $P < 0.05$ ) by each increment of swede DM used. It was calculated that 1.5 or 1.6 kg of swede DM were equivalent to 1 kg of barley DM for carcass production, when 20 or 40% respectively of the barley DM was replaced.

## 49. THE USE OF RAPESEED MEAL IN PIG DIETS

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Two experiments were carried out to compare a diet containing 10% rapeseed meal (R) with one of similar nutrient content containing soya bean meal (S) in place of the rapeseed meal. A third diet with 10% mustardseed meal (M) in place of rapeseed meal was included in the second experiment. The diets were formulated to provide levels of all nutrients that would meet the requirements of the animals being fed, whether growing, reproducing or lactating. In the first experiment gilts were reared, 6 on the control S diet and 12 on the R diet, from 20 weeks of age (64 kg live weight) and served at first oestrus. The gilts were killed when all had been served. There was no significant treatment effect on age or live weight at first oestrus, nor on ovulation rate. In the second experiment 7 gilts were allocated to each of the diets, S, R, and M. These treatments were introduced when the pigs were 10 weeks of age (22 kg live weight) and continued until the end of the first lactation. There were no significant treatment effects on growth rate or feed conversion ratio to 90 kg live weight, nor on carcass fat thickness measured ultrasonically. There was a high incidence of sub-oestrus in gilts fed R or M, and 2 of 6 rapeseed gilts (1 was discarded) and 3 of 7 mustardseed gilts did not farrow. Among those that farrowed there were no significant treatment effects on number of piglets reared per gilt (7.3 S, 9.0 R and 9.3 M) nor on mean weight per piglet (kg) at three weeks (5.42 S, 5.07 R and 4.93 M).

## 50. VALUE OF SOUR AND OF SWEET WHEY FED IN RESTRICTED AMOUNTS AS A SOURCE OF ENERGY FOR GROWING PIGS

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In an earlier experiment reported in 1971 the performance of pigs given either sour or sweet whey (preserved with 0.1% formalin) was identical, but there was a suggestion that the latter might produce carcasses of superior commercial quality. In view of this unexpected result a further feeding trial was carried out which was identical in all respects to the earlier one, except that a third group of pigs given a standard all-meal diet was included. The amounts of whey given were again those needed to replace, on a DM basis, 30% of the normal Shinfield scale allowance of meal given to pigs fed all-meal diets. The composition of the basal meal fed with whey was such that the daily intakes of crude protein, vitamins and major minerals were comparable for all the three groups of pigs. There was again no difference in performance between the pigs given sour or sweet whey, nor, in contrast to the previous trial, were there any differences in carcass measurements. There were no significant differences either in performance or carcass quality between the pigs fed whey and the all-meal fed controls. On the basis of these results, examples of the potential for reducing feed costs by whey feeding were presented. Results were also given of a metabolic trial in which 6 pairs of littermate castrates, given either sour and sweet whey, were on N balance for six 5-day periods conducted at regular intervals during the growing period from 20 to 90 kg live weight.

## 51. DIGESTIBILITY FOR GROWING PIGS OF PROTEIN IN DIETS CONTAINING RAW POTATO

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Digestibility trials were undertaken with 25 pigs weighing 40 kg, to determine apparent digestibility coefficients for crude protein (CP). The digestibility coefficients for cereal based diets containing raw ware potato, greened potato, sprouted potato and cooked potato, each at the rate of 50% of the dry matter, were respectively 0.81, 0.80, 0.79 and  $0.88 \pm 0.016$  ( $P < 0.01$ ). Enzyme assay for protease inhibitor activity showed that in the presence of raw ware potato and of de-watered potato the rate of *in vitro* protein digestion was reduced by 35 and 16% respectively; in the presence of cooked potato no such reduction was detected. Digestibility coefficients for CP, when the potatoes were fed alone, were 0.70, 0.28 and  $0.86 \pm 0.048$  ( $P < 0.001$ ) for raw, de-watered and cooked potato respectively. It was concluded that as a result of protease inhibitor activity the feeding of raw potato or de-watered potato was likely to reduce the dietary protein available for growth; the inhibitor activity could be removed by cooking.

## 52. THE RESPONSES OF EWES OF FOUR GENOTYPES TO ABRUPT DECREASES IN DAYLENGTH APPLIED AT TWO TIMES OF YEAR

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The experiment involved 64 ewes (16 per genotype). Finnish Landrace  $\times$  Dorset Horn (Finn-Dorset), Polled Dorset Horn, Clun Forest and Border Leicester  $\times$  Welsh Mountain ewes were subjected to 2 daylength treatments. An abrupt decrease of 6 hours from natural daylength was given on 17 February (L1: 11.5 to 5.5 hours) or 18 April (L2: 14.3 to 8.3 hours) to 2 groups of 8 ewes of each breed in similar physiological states (6 weeks before lambing). Ewes were further allocated to four feeding regimes and were either suckled or not suckled. Mean dates of onset of oestrus for the four breeds were 1, 24, 26 and 26 July respectively, following treatment L1 and 4, 21, 10 and 21 August following treatment L2. Finn-Dorset ewes showed oestrus significantly earlier than the other three breeds on both treatments ( $P < 0.01$ ). The interval from the point of decrease in daylength to onset of oestrus was longer for all four breeds on treatment L1 than on treatment L2 ( $P < 0.001$ ). The effects of feeding treatment and suckling were not significant. It was concluded that the Finn-Dorsets respond more rapidly to an artificial daylength stimulus than the other three genotypes, but the time of year at which the decrease was applied modified the response of all types of ewe.

## 53. ELEVEN YEARS OF INTENSIVE SHEEP MONOCULTURE WITH COMPARISONS OF EWE AND BREED TYPE

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Ewes and lambs have been kept continuously for 11 years on a high rainfall, upland site of 16.6 hectares. The aim was to explore the problems of sheep monoculture where stocking rate was steadily increased. Initially a comparison was made between the output from a small ewe (draft-for-age Welsh Mountain) stocked



at 12.4 ewes/ha or a medium sized ewe (Border Leicester × Welsh Mountain) stocked at 7.4 ewes/ha. The output of lamb/ha from the Welsh ewes rose from 139 kg to 223 kg/ha as stocking rate increased to 18.5 ewes/ha. The output of lamb from the larger crossbred ewe increased from 161 kg to 220 kg/ha as stocking rate increased to 12.4 ewes/ha. In most years a higher gross margin per hectare was achieved from the crossbred ewe but the gross margin per £100 working capital favoured the smaller ewe. More recently a comparison has been made between crossbred ewes out of Welsh, Exmoor Horn and Devon Closewool dams and stocking rate has increased to 13.6 ewes/ha. The weight of lamb sold per ewe was similar for all three crossbreds at 49 kg/ewe per year, but those out of Welsh dams gave a lower yield of wool, 2.28 v. 3.13 kg/ewe. With the integration of a forage crop area onto the site it has proved possible to keep individual ewe and lamb performance at a high level despite the increase in stocking rate. The management, mortality and disease controls involved were described.

54. REPRODUCTIVE PERFORMANCE AND FOOD UTILIZATION IN LATE PREGNANCY OF FINNISH LANDRACE × DORSET HORN EWES MATED IN THEIR FIRST YEAR OF LIFE

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Thirty-six Finnish Landrace × Polled Dorset Horn ewes with a mean age at mating of 294 days were penned individually from 60 days of gestation. Each ewe was offered one of two diets containing 9.6 MJ ME/kg and 11.8 (P1) or 16.4 (P2) % CP in DM at daily intakes of 1.0 (L1), 1.25 (L2) or 1.5 (L3) kg DM. Nitrogen balances were carried out on four ewes from each treatment during the latter half of pregnancy. The mean lambing percentage was 178. Daily live-weight gain increased from 143 on L1 to 207 g on L3 and was 171 and 191 g for P1 and P2 respectively. The mean birth weight of twin lambs on L1 was 10.5% higher than on L2, and was not affected by dietary CP concentration. Mean daily N retention increased from 3.3 on L1 to 4.2 on L3 and from 2.9 on P1 to 4.9 on P2. There was an increase in daily N retention on all treatments from mid-gestation to just prior to parturition, the increase being 2.1, 3.3 and 3.1 g for L1, L2 and L3 respectively, and 2.1 and 3.0 for P1 and P2 respectively. The results indicate that a daily ME intake during the latter half of gestation of 10 MJ, from a diet with a CP (g) to ME (MJ) ratio of 12.5 to 1, is adequate for the maintenance of maternal body weight and for the attainment of normal foetal growth in the highly prolific ewe mated in her first year of life.

55. EFFECTS OF BODY CONDITION, PLANE OF NUTRITION AND DOSE LEVEL OF PMS ON THE RESPONSE OF EWES TO PROGESTAGEN-PMS TREATMENT IN ANOESTRUS

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In experiment 1 fat and thin ewes were either full fed or restricted for 3 weeks prior to breeding following progestagen-PMS treatment. Thin ewes on restricted feed showed delayed onset of heat ( $P < 0.05$ ). Ovulation rate (1.72 v. 1.39,  $P < 0.05$ ) favoured the full-fed animals. In experiment 2, two groups of ewes were either full fed or restricted, and hormone treated as before. A higher proportion of the full-fed ewes exhibited oestrus (85 v. 67%) and became pregnant (79 v. 65%). Ovulation rate (2.22 v. 1.58,  $P < 0.05$ ) and litter size (1.95 v. 1.54) favoured the full-fed ewes. The number of lambs per ewe treated in the full-fed animals was double that in the restricted group (1.30 v. 0.65,  $P < 0.05$ ). In experiment 3, full-fed and restricted

ewes received either 800 IU or 400 IU PMS at the time of pessary removal. Restricted ewes showed delayed onset of oestrus ( $P < 0.05$ ) which was more marked at the lower PMS level. A difference in ovulation rate existed between the two PMS levels (2.36 v. 1.65,  $P < 0.05$ ) but the difference between the two feeding levels was non-significant. The results indicate that nutritive status immediately prior to and during progestagen treatment affects oestrous response, time of oestrous occurrence, ovulation rate and fertility in hormone-treated anoestrous ewes.

56. PROTEIN REQUIREMENTS OF PREGNANT AND LACTATING SOWS: A CO-ORDINATED TRIAL

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In a trial begun with gilts at seven centres, diets containing 9, 11, 13 or 15% protein were given during pregnancy, and 13 or 17% in lactation. The diets were based on barley and a supplement containing equal parts of soya bean meal and fish meal. The pigs were fed individually, on 2 kg feed per day in pregnancy and 5.7 kg per day in lactation ( $\pm 0.4$  kg per piglet more or less than 10). Data were obtained for 141, 127, 102 and 78 litters in parities 1 to 4 respectively. Sows given more protein in pregnancy gained more weight then, but lost more in the following lactation. Similarly, the higher protein concentration in lactation caused a smaller weight loss then, but a smaller gain in the following pregnancy. Thus at the end of the fourth lactation the range between treatment means for sow weight was only 12 kg. In parity 1, 9% protein in pregnancy gave one pig less per litter than the other treatments, but in later parities there were no significant differences in this parameter. The treatments given in pregnancy had no consistent effects on the weights of the piglets at birth or weaning (at 6 weeks), but the offspring of sows receiving more protein in lactation were consistently 0.5 kg heavier at weaning. The milk yields of the Rowett sows in their third lactation were significantly higher when the diet contained 17% protein. The interval from weaning to mating was not significantly affected by the treatments.

57. THE EFFECT OF GRADED LEVELS OF DIETARY LYSINE ON THE CONCENTRATION OF PLASMA FREE AMINO ACIDS AND BLOOD UREA IN LACTATING SOWS

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An experiment was conducted to investigate the effect of dietary lysine on the levels of plasma amino acids and blood urea. Four lactating Landrace  $\times$  (Large White  $\times$  Landrace) sows were offered a basal diet composed mainly of ground barley and ground wheat in equal amounts, containing 12.63% crude protein (dry-matter basis). The basal diet was supplemented with synthetic lysine to achieve six levels of dietary lysine: 0.37, 0.57, 0.77, 0.97, 1.17, and 1.37% (dry-matter basis) which resulted in daily lysine intakes of 14.59, 22.50, 30.45, 38.40, 46.35 and 54.28 g respectively. Each treatment was offered for a period of three days; blood samples were collected at 1 and 4 hours post feeding on day three of each treatment. The plasma lysine level was significantly affected ( $P < 0.001$ ) by the dietary treatments: the response curve remained at a low level up to 0.97% dietary lysine and then increased sharply. Plasma lysine concentration varied significantly with time of

sampling ( $P < 0.01$ ), whereas the between-animal variation and the interactions between treatment and sampling time were not significant. Blood urea levels were affected ( $P < 0.05$ ) by dietary lysine: urea levels fell as the dietary lysine content was raised to 0.97% and then increased at higher lysine concentrations. Both plasma lysine and blood urea levels indicated that dietary lysine above 0.97% (38.4 g/day) was probably in excess of the requirement of the lactating sow.

#### 58. THE EFFECT OF DIETARY PROTEIN ON PLASMA INSULIN IN THE GROWING PIG

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Studies on several animal species have shown that plasma insulin level rises in response to either intravenously- or orally-administered free amino acids. The effects of dietary protein level and type were examined to see if diets used commercially influenced the response of this hormone in the pig. Thirty pigs, two barrows, two gilts and two boars from each of five litters were divided into six groups on the basis of sex. One group of each sex was given a barley-based diet containing fish meal to raise the protein level to 19.7%; the other groups were given a diet of 13.7% crude protein containing sorghum and soya bean meal. The plasma glucose, basic amino acids and insulin levels of each pig were measured on three occasions during the growing period from 20 to 50 kg, samples being taken before, and 1 h and 3 h after, the morning feed. Significant differences in plasma insulin between diets were observed 1 h after feeding on all three occasions. The correlation between glucose and insulin was significant ( $r = 0.74^{***}$ ) only during the first period, but significant correlations with plasma free amino acids, notably arginine, were found throughout. No important sex differences were observed, but the carcasses of pigs that showed small insulin responses tended to be fatter than those which had marked responses. When the insulin level of pigs given 16% crude protein diets, based on barley and fish meal or barley and groundnuts, were compared 1 h after feeding, the fish meal diet was found to cause higher ( $P < 0.01$ ) insulin levels ( $70 \mu \text{U/ml}$ ) than groundnut ( $40 \mu \text{U/ml}$ ).

#### 59. THE AMINO ACID REQUIREMENTS OF THE GROWING PIG

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A previous experiment showed 14.5% crude protein (air-dry diet) to be the threshold of limitation of one or more amino acids when crude protein was progressively reduced in lysine-supplemented diets composed of barley, soya bean meal and white-fish meal. In order to identify which amino acids had become deficient, a basal diet formulated to contain 12.5% crude protein and 0.9% lysine was supplemented with the following combinations of synthetic amino acids: (a) 0.1% DL-methionine + 0.025% L-tryptophan + 0.2% DL-isoleucine; (b) 0.2% DL-threonine + 0.1% DL-methionine + 0.2% DL-isoleucine; (c) 0.2% DL-threonine + 0.025% L-tryptophan + 0.2% DL-isoleucine, and (d) 0.2% DL-threonine + 0.025% L-tryptophan + 0.1% DL-methionine. Such additions brought the levels of these essential amino acids to slightly above those supplied by a 14.5% crude protein control diet containing 0.9% lysine. The diets were fed to 60 cross-bred gilts, from 25 to 55 kg live weight, with or without 1.7% glycine, to test the adequacy of the non-essential nitrogen component. Growth performance data

showed threonine to be the second limiting amino acid in the basal diet. The combination of threonine, methionine and tryptophan gave the best average daily gains, equalling the mean for the control diet, that is  $705 \pm 12$  g/day. This value was significantly ( $P < 0.001$ ) higher than that for the basal diet. Carcass dissection results only indicated a significant ( $P < 0.05$ ) response to threonine addition in terms of lean content when synthetic methionine was also provided. This trend was reflected by blood urea analysis. Supplementation with either isoleucine or glycine appeared to have no significant effect on performance.

60. IMPOSED CHANGES IN MILK OUTPUT AS A BASIS FOR IDENTIFYING THE LYSINE REQUIREMENT OF LACTATING SOWS

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Existing recommendations on protein quality for lactating sows do not specify levels of individual essential amino acids. An experiment was designed to provide estimates of the utilization, for milk production, of barley protein supplemented with synthetic lysine and tryptophan. Fifteen sows were fed one of 5 diets which each supplied 550 g barley protein per day (9% CP on air-dry basis). The diets were supplemented with 0, 6, 12 and 18 g lysine daily. A fifth diet did not contain any synthetic amino acids and was included as a negative control. A wide range of milk outputs was obtained by starting each sow in lactation with 11 pigs and successively removing some at intervals of 5 days until, at final weaning, only 4 pigs remained. Nitrogen balance measurements were made over each of seven 5-day periods: milk output was evaluated by measuring body water turnover in a sample of pigs of the litter. The milk produced by each sow when there was no net change in the body pool of nitrogen was estimated from the wide range of milk outputs. The sows utilized the diets with efficiencies, expressed in terms of biological value (BV), of 56, 64, 59 and 62 ( $SE \approx 1.4$ ). The efficiency for the negative control diet was 55. Addition of lysine improved utilization significantly ( $P < 0.01$ ) but the improvement was greatest for the first increment. It is suggested that this technique has a considerable potential for the estimation of the amino-acid requirements of the lactating sow, and the results indicate that in lactation the requirement for total lysine does not exceed 4.8% of the protein.

61. EVALUATION OF HAYS AS FEED FOR PREGNANT EWES

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The feed value of a range of hay qualities for the ewe in late pregnancy has been examined by concurrent studies of energy balances and voluntary intakes for individual ewes, and by the voluntary intakes and performances of groups of ewes. During the winters of 1971/72 and 1972/73 a total of 550 pregnancies of Border Leicester  $\times$  Cheviot ewes has provided information on 4 hays of estimated ME values of 1.50, 1.85, 2.10 and 2.45 M cal per kg DM. During the last 56 days of pregnancy ewes were offered one of the hays to appetite, and a total of either 0, 10, 20 or 30 kg of a standard cereal-based concentrate over the 56-day period. The concentrate was supplied on a rising plane, so that on a diet of hay and 30 kg of concentrate a ewe received 150 g/day for 17 days, 450 g/day for the next 17 days and 600 g/day for the final 22 days of pregnancy. Data are presented for the feed intakes, parturition success, lamb birth weight, ewe body condition score, ewe weight change, blood

ketones and free fatty acid levels of the ewes. The quantities of concentrate, and the stage of pregnancy at which concentrate feeding should begin to maintain blood ketone levels below 4 mg per cent, have been calculated for each hay. For example, for a 70 to 80 kg ewe to produce strong, viable twin lambs, which then have satisfactory daily live-weight gains, it is estimated that the energy requirements on a daily basis in the last 56 days pregnancy are: 2.2 Mcal from day 56 to day 40; 2.8 Mcal from day 39 to day 23, and 3.5 Mcal from day 22 to parturition.

62. THE EFFECT OF PREVIOUS NUTRITION ON THE *ad libitum* INTAKE BY SHEEP OF ROUGHAGES OF DIFFERENT QUALITIES

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Individual *ad libitum* intakes by mature ewes offered one of three roughage feeds were measured for 8 weeks. On any one diet 10 of the 16 sheep had previously been fed one of the other diets for 33 weeks while the remaining 6 had been on the same diet throughout. *In vitro* dry-matter digestibilities for hay 1, hay 2 and dried grass were 57.5, 60.6 and 76.0 respectively, and mean dry-matter (DM) intakes for hay 1 were  $815 \pm 32$ ,  $992 \pm 55$  and  $543 \pm 30$  g/day by sheep previously on hay 1, hay 2 and dried grass respectively. The equivalent figures for hay 2 were  $1074 \pm 38$ ,  $1186 \pm 30$  and  $658 \pm 29$  g/day and for dried grass were  $1463 \pm 83$ ,  $1621 \pm 54$  and  $1190 \pm 34$  g/day. Within each diet there were significant effects of the previous diet on intake, with the exception of the intakes of dried grass by sheep previously on the two hays. Differences between intakes of the other two roughages by animals previously on hay diets could be explained in terms of their differences in live weight; DM intakes expressed as g/kgW<sup>0.75</sup> were similar. The highest between-sheep variation in intake (CV 35%) was observed on hay 1. Intakes of dried grass by sheep which had previously been offered hay 1 had a similar CV. However, this was not due to between-sheep variation but to slow adaptation to the diet; mean daily DM intakes were less than 700 g in the first week, and more than 1800 g later in the experiment. Efficiency of use of ingested food differed between groups.

63. THE VALUE OF GRASS PULP FOR RUMINANTS

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Grass pulp prepared by passing mainly S24 ryegrass through a screw press was ensiled in concrete silos after spraying with 2% propionic acid. The pulp came from 5 cuts of grass made over the growing season, May to October. Material was prepared from grass which had received either 250 (A) or 500 kg N/ha (B). Losses of dry matter through ensiling were 7.8 and 9.5% for A and B respectively. Six male Suffolk × North Country Cheviot lambs were used to determine intake and digestibility of the ensiled material. Materials were offered *ad libitum* for 42 days. During the first 21-day period half of the lambs received A and half B. In the second period of 21 days the treatments were reversed. There were no significant differences between the effect of the treatments. Dry-matter intakes (g/kg W<sup>0.75</sup>) were 73.6 and 71.4 for A and B, and dry-matter digestibility (%) was 74.1 and 75.7. The digestibility of dried grass rather than pulp was determined in another experiment and was 74.1 (A) and 75.7 (B). In a preliminary trial, 8 Friesian steers weighing initially 400 kg were offered fresh pulp *ad libitum* (C) and a further 8 fresh grass (D). Intakes measured over a 27-day period were (kg dry matter/day) 7.82 (C) and 8.16 (D).

64. THE EFFECT OF SUPPLEMENTS BASED ON WHOLE OR PELLETTED BARLEY ON THE VOLUNTARY INTAKE OF DRIED GRASS BY LAMBS

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Ten early weaned lambs were allocated to five treatments according to a Latin square design. The lambs were given dried grass *ad libitum* and the effect on intake of giving either 21 or 42 g DM/kg  $W^{0.75}$  of either whole barley or pelleted barley was investigated. Each period consisted of 21 days, during the last 8 days of which the faeces were collected for digestibility determination. The daily intakes of dry matter from dried grass were 67, 53, 43, 55 and 32 g DM/kg  $W^{0.75}$  for the control, the low and high levels of whole barley and low and high levels of pelleted barley supplementation respectively; the approximate SE of the difference between two means was 3.1 g. The respective daily intakes of digestible organic matter were 41, 49, 57, 51 and 52 g/kg  $W^{0.75}$ . At the high level of supplementation the intake of dried grass was reduced by 34% when whole barley was given, and by 52% with the pelleted barley supplement. The greater reduction in the intake of dried grass with pelleted barley led to an increase in the total consumption of digestible organic matter of only 26%, while it was increased by about 39% when whole barley was fed. If the digestibility of dried grass was assumed to be constant (69%), the digestibility of whole barley as a supplement to dried grass was estimated to be lower (72%) than that of pelleted barley (77%). The pH of the rumen liquor was lowest when the dried grass was supplemented with pelleted barley.