

TITLES AND ABSTRACTS OF SHORT PAPERS GIVEN AT THE
54TH MEETING OF THE BRITISH SOCIETY OF ANIMAL PRODUCTION,
COVENTRY, 27, 28 AND 29 MARCH 1972

1. THE PHYSICAL AND FINANCIAL RETURNS FROM A ONCE-BRED HEIFER SYSTEM

J. P. Crowley and T. E. Darby, *An Foras Talúntais, Grange, Dunsany, Co. Meath, Ireland.*

It has been established that most beef and dairy-type heifers which are not required as herd replacements may be bred so as to produce a calf before they are slaughtered as beef animals. Various studies have shown that the meat and carcass quality of young once-bred heifers cannot be differentiated from that of maiden heifers and bullocks. Furthermore, these animals may be dried-off satisfactorily at any point in early lactation, by means of a simple abrupt weaning procedure.

These findings provide the basis for several variations of a once-bred heifer system: it may be based on calving in spring, autumn or winter, followed by weaning at any time from 1 to 16 weeks after calving.

A once-bred heifer system based on heifers purchased as weanlings in November–December, and calving as two-year-olds in February–March, has been in operation on a farm unit scale at Grange for three years. After a short period of suckling, the calves are weaned before the calved heifers are returned to pasture in early April. The calves are sold from the system as dropped calves. The once-bred heifers are ready for slaughter from May onwards and all of them have been disposed of by 30 June.

The system has yielded over 340 kg of carcass beef together with almost 2.5 calves per hectare per annum. The gross margins, exclusive of subsidy, for the three years have been £80, £97 and £100 per hectare respectively. Taking into account the payments under the Beef Incentive Scheme in Ireland during the past three years, the gross margins for those years were £105, £130 and £135 per hectare respectively.

2. BULL BEEF PRODUCTION UNDER INTENSIVE CONDITIONS

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Beef production from entire males has been a generally accepted practice on the Continent for many years, but in the United Kingdom this has not been the case. Within the last few years, the demand by the public for lean meat, coupled with the ever increasing production costs of beef animals, has made many producers turn their attention to the fattening of bulls in preference to steers. From work carried out at the East Riding College of Agriculture during the last five years, it becomes quite apparent that bull beef has indeed a place in British agriculture.

Trials comparing the performances of bulls and steers kept under similar conditions have shown favourable results from entire males. Savings in feed costs, allied to improved weight for age and daily live-weight gain, make bulls a very real proposition. The use of hormone implantation has been shown to improve both live-weight gain and feed efficiency in the male. The ability of bulls to grow to heavier weights without laying down excess fat makes them most suitable for fattening under intensive conditions; and the carcasses have been shown, by means of detailed dissections, to be suitable for the present-day meat trade.

3. GROWTH RATE, FEED CONVERSION AND CARCASS COMPOSITION AND QUALITY OF FRIESIAN MALE, CASTRATE AND FEMALE CATTLE FED AN ALL-CONCENTRATE DIET AND SLAUGHTERED AT FOUR LIVE WEIGHTS

I. J. M. Frood and E. Owen, *Department of Agriculture, The University, Reading.*

Forty-eight individually fed animals, comprising 16 per sex, were used.

Calves were given milk substitute, weaned at six weeks of age, and if necessary castrated at that time. Early-weaning concentrates and hay were offered *ad libitum* to 90 kg live weight. Thereafter, rolled barley (90%), supplemented with protein, mineral and vitamin concentrate pellets, was given *ad libitum* until slaughter at 257 (females only), 318, 379, 440 or 501 kg (males and castrates only) live weight. Four animals per sex were slaughtered at a given live weight. The left side of each carcass was jointed and dissected, and the dissection residues chemically analysed. Subjective and objective measurements of meat quality were also undertaken.

Data on growth rate, feed intake, carcass composition and meat quality, as affected by sex and slaughter weight, were presented and discussed in relation to practical recommendations regarding optimum slaughter weight for each sex.

4. COMPARISON OF DAILY ALLOWANCES AND PROTEIN CONTENTS OF CONCENTRATES FOR FRIESIAN CASTRATES KEPT INDOORS

I. A. M. Lucas, R. Flint and G. M. Davies, *Department of Agriculture, University College of North Wales, Bangor.*

Ninety-six Friesian castrates, initially 3 to 10 days of age, were used in a $3 \times 4 \times 2$ factorial experiment. They were reared on a standard early-weaning system and entered the experiment at 100 kg, after which they were tied individually until slaughtered.

Concentrates were given either to appetite from hoppers, or at 75% or 55% of appetite. At the start, the concentrates contained either 11, 13.5, 16.5 or 19% crude protein, but for cattle of over 250 kg each level was reduced by 2 to 3%. In addition, barley straw was offered to appetite. Within each treatment cattle were slaughtered at either 400 or 500 kg.

Lowering the daily concentrate allowance caused greater reduction in daily gain in younger than in older cattle, a reduction in concentrates eaten per kg gain, especially in older cattle, reduced killing-out percentage, and reduced carcass fat.

Performance from 100 to 250 kg was improved by raising the protein level from 11.0 to 13.5%, and from 250 to 400 kg by raising it to 16.5%; but financially there was no advantage in giving more than 11% to the heavier animals. Protein level did not affect killing-out percentage or carcass measurements.

5. BRITISH CATTLE OF THE PAST

Barbara Noddle, *Department of Anatomy, University College, Cardiff.*

The deliberations of the BSAP are more frequently concerned with tomorrow than yesterday. However, quantities of animals' bones are produced from archaeological excavations and in order to compare these with each other it was decided to determine whether any of their dimensions could be correlated with body weight. As fat is the most variable constituent of the carcass, bones from modern dissected carcasses were measured and the measurements compared with the fat-free carcass weight. Some degree of correlation was found in several bones, mainly in the hind limb, though it was unfortunately not close enough for the method to have much application to modern carcass studies. However, when an average value is used an interesting range of body weight is revealed from prehistoric times to the 18th

century, and also a range of values is found for the same period in different parts of the country, revealing that the same regions of good grazing found today existed even as long ago as the Roman occupation.

6. THE EFFECT OF INCLUSION OF UREA IN THE CONCENTRATE RATION OF THE FRIESIAN COW, EITHER PRE- OR POST-PARTUM, ON THE SUBSEQUENT MILK YIELD AND COMPOSITION

P. Jackson, *ICI Agricultural Division, Jealott's Hill Research Station, Bracknell, Berks.*

7. 'STAREA' OR GELATINIZED BARLEY PLUS UREA AS REPLACEMENTS FOR VEGETABLE PROTEIN IN DIETS FOR DAIRY COWS

A. W. A. Burt, C. R. Dunton, W. Atkinson, T. J. Bush, I. Thomson, A. A. Durran, K. B. Whiteley, L. J. Aspinall, *Unilever Research Laboratory, Colworth House, Sharnbrook, Bedford, and BOCM Silcock Ltd.*

Subjecting mixtures of ground cereals and urea to a cooking and extrusion process which gelatinizes part of the cereal starch has been claimed to improve the utilization of urea by dairy cows (British Patent 1,127,198). Eighty-eight cows on three farms were used to examine these claims in a changeover experiment with five 28-day periods.

Hay and rolled barley were fed for maintenance with 11 experimental concentrates for production. The treatments were designed to measure the effects of

- (a) replacement of soya bean meal by 2½% urea and additional barley,
- (b) replacement of part of the barley by gelatinized barley in the diet containing soya bean meal,
- (c) the relative effect of 4 different levels of gelatinized barley either gelatinized and then mixed with 2½% urea, or gelatinized after admixture according to the patented process ('Starea'). These treatments were a 2 × 4 factorial.

Milk yield was depressed by the inclusion of urea and raised with increasing inclusion of gelatinized barley. There was no difference between the response of milk yield to gelatinized barley plus urea and response to the equivalent 'Starea'. The results were compared with those obtained in experiments on 'Starea' carried out in the USA.

8. A COMPARISON OF THE VALUE FOR MILK PRODUCTION OF LUCERNE AND RYEGRASS COBS

E. F. Thomson and R. C. Campling, *Wye College (University of London), Ashford, Kent.*

A change-over experiment was used to compare the values for milk production of two levels of lucerne and ryegrass cobs given to 16 milking cows. A daily ration of 6 kg hay and 1 kg dairy concentrate was given in addition to the artificially dried forages. Both forages were from primary growth and harvested in late May; the modulus of fineness of the lucerne was 3.4 and of ryegrass 2.9. Chromic oxide was given to the cows to estimate the digestibility of the cobs; lucerne cobs were found to be less digestible than the ryegrass cobs. The milk yields of cows given quantities of lucerne and ryegrass cobs which provided the same intake of digestible organic matter were similar, but when the cobs were given at equal dry-matter intake lucerne cobs produced significantly less milk than ryegrass. The milk fat percentages were similar with both forages, but lucerne cobs led to the production of milk with a lower content of SNF. Some results of subsidiary experiments with sheep comparing lucerne and ryegrass were also presented.

9. A NUTRITIONAL EVALUATION OF SILAGE MADE USING FORMIC, ACETIC AND HYDROCHLORIC, OR HYDROCHLORIC ACID

I. H. Pike, *ICI Agricultural Division, Jealott's Hill Research Station, Bracknell, Berks.*

Grass ensiled after the addition of no additive (C), 0.5% formic acid (85%) (F), or 1.25% of a mixture of hydrochloric (50%) and acetic (glacial) acids (in the ratio 3:2 by volume) (HA), was evaluated in a metabolism experiment with lambs and a production experiment with dairy cows. A fourth treatment, grass ensiled following addition of 1% hydrochloric acid (50%) (H), was included in the dairy cow experiment.

Nine entire and three rumen fistulated wether lambs (29 kg live weight) were fed approximately 750 g silage dry matter per day, in a 30-day 3 × 3 latin square experiment. Hydrochloric/acetic acid silage resulted in significantly higher nitrogen retention (2.42 g N/day) than formic acid silage (1.36 g N/day), which in turn was significantly higher than the control (0.68 g N/day) ($P < 0.05$). Organic matter digestibility was slightly lower in the control (C—64.8%, HA—66.3%, F—66.5%).

Twenty-eight cows received silage *ad libitum* and a restricted allowance of concentrate. Dry-matter intake was higher for the additive treatments than for the control (C—7.3, F—8.3, HA—7.6, H—7.4 kg/day, C *v.* F and C *v.* HA significant, $P < 0.01$ and $P < 0.05$ respectively). Yields of milk and 4% fat corrected milk (kg) were C—15.9, 13.3; HA—16.3, 14.4; F—16.8, 14.7; H—16.3, 13.9 respectively.

The use of additives improved the nutritive value of the silage; the reasons for this were discussed in relation to the chemical changes during ensilage.

10. A SIMPLE GRAZING SYSTEM FOR DAIRY HERD REPLACEMENTS

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The system involves rotationally grazing a group of calves in their first grazing season around a series of eight paddocks, immediately followed by a group of older female calves (heifers). Both groups of animals are moved to their next paddock every three and a half days, thus giving fixed rotations of 28 days. No conservation is taken from the area.

The system has been examined over two seasons at stocking rates initially of 3.5 and 4.0 replacement units/ha (one replacement unit equals one calf plus one heifer). There were 12 calves and 12 heifers at each stocking rate. Mean live-weight gains of calves at low and high stocking rates respectively were 0.62 and 0.56 kg/day in 1970, and 0.65 and 0.61 kg/day in 1971. For the heifers they were respectively 0.60 and 0.47 kg/day in 1970, and 0.66 and 0.60 kg/day in 1971. The output of live-weight gain/ha for low and high stocking rates respectively was 647 and 628 kg in 1970, and 697 and 735 kg in 1971.

Many of the decisions relating to grazing management are removed by this system, and it is ideal for situations where the winter conservation is either taken from the arable acreage or is bought-in.

11. CHANGES IN POPULATION STRUCTURE FOLLOWING THE USE OF DAIRY BULLS IN ARTIFICIAL INSEMINATION

C. J. M. Hinks, *ARC Animal Breeding Research Organisation, Edinburgh, EH9 3JQ.*

A numerical model of male and female replacement processes was developed, and used to construct a matrix which represents the number of lactations of different parities expressed at a given time by the female offspring of bulls used in artificial insemination.

It was pointed out that populations resulting from newly established breeding programmes contain an unduly high proportion of offspring by young bulls. An equilibrium is eventually reached in which the offspring of young and tested sires are present in proportions which depend on the relative usage of the two types of sire, and on differences in replacement rates amongst their progeny.

The technique may be used retrospectively to determine relationships between an existing cattle population and bulls used in the past; predictively to describe the age structure and composition of future populations in relation to males currently in use; to examine the progeny of a single sire; to examine several generations of descendants and, finally, to study the consequences of changes in the criteria and intensity of male and female selection.

12. THE COMPARATIVE PERFORMANCE OF BREEDS AND CROSSES IN SUCKLER HERDS

Rosalyn J. Stollard and J. B. Kilkenny, *Meat and Livestock Commission, Bletchley, Buckinghamshire.*

Data from suckler herds recorded in the period autumn 1966 to autumn 1971 have been analysed on a within-farm basis to compare:

- (a) the effect of breed of top-crossing sire on the weaning weights of suckled calves,
- (b) the effect of breed of top-crossing sire on daily gains during the finishing period and slaughter weights of suckled calves,
- (c) the effect of different breed-crosses of suckler cow on calf weaning weight.

Weaning weights recorded between 151 and 249 days of age were adjusted to 200-day equivalents using the formula:

$$200\text{-day weight} = \left[\frac{(\text{weaning weight} - \text{birth weight})}{\text{age}} \times 200 \right] + \text{birth weight}$$

Live-weight gains during the finishing period were adjusted for differences in 200-day weights.

The data were analysed on a contemporary comparison basis with Hereford-cross calves, the calculations being made within sex of calf and season of birth. Comparisons of sire breeds were made within type of cow, and comparisons of type of cow within sire-breed groupings.

Breed of top-crossing sire had significant effects on calf 200-day weight, daily gains during the finishing period, and live weight at slaughter. The breeds ranked in the order Charolais, South Devon, Red breeds (Devon, Lincoln Red or Sussex), Hereford, and Aberdeen Angus for the three traits.

Breed type of cow also had some significant effects on calf performance. However, differences were considerably smaller in hill herds than in upland and lowland herds.

13. COMPARISON OF 200-DAY AND 300-DAY ADJUSTED WEIGHTS OF THE PROGENY OF CROSSBRED CHAROLAIS BULLS AND BULLS OF BRITISH BREEDS

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The results of trials using imported Charolais bulls showed that their progeny grew faster than the progeny of bulls of British breeds, both types of bull having been mated to similar types of cow. It was later thought that similar results would be obtained if Charolais bulls were used in 'suckler' herds.

To encourage increased productivity in 'suckler' herds, and because few purebred bulls were available at economic prices, the Ministry of Agriculture in 1967 began to issue experimental breeding permits, subject to certain conditions, for crossbred Charolais bulls.

Interim results from 55 farms expressed as adjusted 200-day or 300-day weights were given. Compared with the progeny of all bulls of British breeds, the male and female progeny of the crossbred Charolais bulls were significantly heavier at both ages (males $P = < 0.01$, females $P = 0.05$).

The weights of the progeny of $\frac{3}{4}$ -bred Charolais bulls compared with those of Hereford sires only, at the two ages, showed marked advantages for the males at both ages, but a significant advantage for the females only at 300 days ($P = < 0.01$).

14. PERFORMANCE TESTING BULLS FOR BEEF FROM A YOUNG AGE

W. H. E. Lewis, *Meat and Livestock Commission, Bletchley, Buckinghamshire.*

A performance test is reported in which 25 Dairy Shorthorn bulls were tested from around 90 days of age after calf rearing on an early-weaning system. The bulls were participating in a breed society programme involving selection for both milk and beef characteristics.

The bulls were fed a complete-diet cob incorporating equal parts of dried lucerne and rolled barley. Growth rate was recorded and feed conversion efficiency measured over the live-weight range from 182 to 409 kg. The test terminated at 400 days of age.

Results show live weights of 103, 216 and 359 and 489 kg at 100, 200, 300 and 400 days of age, respectively. Correlation coefficients between weights at successive ages are significant ($P < 0.001$) and range from +0.76 to +0.85. These are similar to correlations between 200- and 400-day weights in conventional tests in which the bulls are tested for six months, after weaning at seven months of age. However, there are positive but non-significant correlations between weight at 100 and 150 days of age and subsequent test gains. This compares with zero or negative correlations between 200-day weight and test gain in conventional tests and favours the collection of feed conversion data.

15. FEED-LOT PERFORMANCE OF WELSH MOUNTAIN RAMS

G. L. Williams, E. F. Edwards and J. Pilling, *Department of Agriculture, University College of North Wales, Bangor.*

Twenty-eight homebred North Wales type (27 kg) and seven South Wales type Welsh Mountain ram lambs (37 kg) were individually penned from six months of age and offered a complete pelleted diet *ad libitum* over a 120-day period. The diet consisted of 30% chopped barley straw, 50% rolled barley, 18% soya bean meal, and 2% of a mineral-vitamin mix. The apparent digestibility of the organic matter was 73% at the maintenance level of feeding, falling to 69% when fed *ad libitum*.

Mean voluntary intake of the pelleted diet was 82.6 ± 7.4 and 85.8 ± 4.1 g/kg $W^{0.73}$ per day for the North and South Wales rams respectively. Daily gains were 120.4 ± 25.8 and 137.2 ± 17.6 g for the two types. Final body weight at 12 months of age was highly correlated with initial weight ($r = 0.94$) and feed consumption ($r = 0.89$). Weight gains per unit of feed (efficiency) were 0.112 ± 0.017 and 0.100 ± 0.012 for the North and South Wales rams, but there was no evidence that efficiency was a function of body size or live weight.

Feed-lot testing of rams from *one* flock, over a four-month period, failed to improve the accuracy of selection for body weight or size in comparison with early post-weaning selection. However, evidence of a wide range in feed conversion efficiency between individual rams could only be obtained from such a test.

16. STUDIES ON THE REPRODUCTIVE POTENTIAL OF EWE LAMBS

M. G. Keane and J. P. Crowley, *An Foras Talúntais, Grange, Dunsany, Co. Meath, Ireland.*

Experiments with March/April-born Suffolk-cross ewe lambs showed that, in their first year, there was a threshold body weight below which animals did not reach puberty, and this threshold weight decreased as the breeding season progressed.

Supplementation of ewe lambs at pasture significantly increased the proportion that became pregnant, but had no effect on ovulation rate. Progestagen-PMS therapy also significantly increased the pregnancy rate in ewe lambs.

Most reproductive wastage occurred before day 40 of pregnancy. In a number of experiments over 30% of puberal animals were not pregnant at this time, and in those that were pregnant, there were many corpora lutea not represented by fetuses.

In a group of 33 control ewe lambs run with vasectomized rams, 8 remained cyclic until the end of February, but the remainder ceased to show heat after mid-January. A total of 17 missed or silent heats were noted during the breeding season.

Few problems were experienced with yearling ewes at parturition. Lamb birth weights were low (2.98 ± 0.07 kg), but performance at pasture was satisfactory (0.31 ± 0.14 kg/day).

Lambing as yearlings had no marked influence on the breeding ability of the animals in the following year. They had a lower mean body weight at the beginning of the breeding season than their contemporaries which had not lambed, and they also had a lower litter size, but the difference in this respect was not statistically significant.

17. VARIATION IN DATE OF FIRST OESTRUS AMONG WELSH MOUNTAIN EWES

A. F. Purser, *ARC Animal Breeding Research Organisation, Edinburgh, EH9 3JQ.*

Records were obtained over a period of 15 years on whether or not ewes were showing cyclic oestrus at various dates between 1 September and 30 November. Individual ewes were tested only once in a year, usually for four successive years. They were assumed to be cycling if they showed overt heat within the first 16 days following the introduction of the rams to a group.

In one series of observations rams were introduced to various groups of Welsh ewes on different dates. Each group contained 50 to 100 ewes, there being two to four groups each year. Probit analysis gave the mean date of first overt heat as 23 October and a standard deviation among ewes of 17 days. (Blackface ewes in the same flock had a mean onset eight days earlier.)

In another series of observations on 2910 Welsh ewes, the rams were introduced on the same date each year (15 October). Estimates of the repeatability and heritability of the presence of cyclic activity on this date were 0.35 and 0.33 respectively. A positive genetic correlation was found with gestation length and with birthcoat hairiness, but there was no correlation with litter size or weight of ewe.

18. ECONOMIC IMPLICATIONS OF ARTIFICIALLY REARING AND INDOOR FATTENING LAMBS IN AN INTENSIVE SYSTEM OF SHEEP PRODUCTION

W. M. Tempest and T. G. Boaz, *Department of Animal Physiology and Nutrition, The University, Leeds, LS2 9JT.*

Artificial rearing and subsequent indoor fattening of a proportion of the lambs born is an integral component of an intensive sheep production system which has been studied in detail for four years, 1968-71. However, the margin over food cost

of such lambs (out of (Border Leicester ♂ × Cheviot ♀) ewes) has averaged only £1.03 per head, with a maximum of £2.34 in 1969. Against this margin has to be set: (1) lamb variable costs other than food; (2) lamb fixed costs of buildings and equipment; (3) the appropriate share of the variable and fixed annual costs of the parent ewe flock.

The total cost, of £14.56 per lamb, casts considerable doubt on the economic viability of the system as a whole, despite a high biological efficiency, particularly in respect of those lambs which are naturally reared by the grazing ewe and fattened off grass. The further analysis of output relative to costs shows (a) the net breeding flock costs of a small ewe are relatively high in relation to its body size and productivity; (b) the use of hormones reduces the number of lambs sold per ewe whilst increasing costs; (c) the use of a breed of high natural prolificacy is uneconomic, despite high lamb output, because of the high proportion of the costs attributable to rearing artificially lambs surplus to one per ewe.

19. PRELIMINARY OBSERVATIONS ON THE PERFORMANCE OF FINNISH LANDRACE × DORSET HORN EWES IN AN INTENSIVE SYSTEM

J. J. Robinson, C. Fraser and J. C. Gill, *Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB.*

Two groups each of 48 (Finnish Landrace ♂ × Polled Dorset Horn ♀) ewes are on experiment to test their long-term reproductive performance in relation to level of nutrition in an intensive lamb production system. Group I ewes, due to lamb in late March–early April 1971, were individually penned from one month after mating. Two months after mating they were subjected to an 18-hr daylength for one month. Thereafter daylength was reduced by 3½ min per day. All the lambs were weaned by the end of the first month of lactation, and the ewes were synchronized in oestrus on 21 May using progesterone-impregnated pessaries. Half the ewes received 500 IU of pregnant mare's serum (PMS) at pessary withdrawal. Between 48 and 60 hr after withdrawal, each ewe was hand mated to one of eight Suffolk rams. Only one ewe from the PMS group and two from the 'no PMS' group returned to oestrus within 20 days. Twenty-two of the ewes which received PMS, and 23 which did not receive PMS, conceived to either the induced or first repeat oestrus, with mean litter sizes of 2.36 and 2.17, respectively. The mean age of the ewes at mating was 18 months.

Group II ewes, due to lamb in late June–early July 1971, received a similar photostimulation regime to group I ewes and were synchronized in oestrus on 29 August. Conception rate in this group was 98% and mean litter size, 2.10.

The performance of the ewes was discussed in relation to their nutrition before and after mating.

20. THE COMPARATIVE PERFORMANCE OF PUREBRED AND CROSSBRED BOARS IN COMMERCIAL PIG PRODUCTION

W. B. Lishman, W. C. Smith and M. Bichard, *School of Agriculture, The University, Newcastle upon Tyne, NE1 7RU,* and R. Thompson, *ARC Unit of Statistics, University of Edinburgh.*

A field scale investigation was undertaken firstly to evaluate the crossbred boar *per se*, and secondly to assess the value of including the imported Hampshire breed into a first-cross sire. Boars for the trial were produced by three of the major pig breeding companies, and groups of three animals were placed on 21 commercial pig producers' farms. A group consisted of either a Large White, Large White × Landrace and Hampshire × Large White boar, or Landrace, Landrace × Large White and Hampshire × Landrace boar. Cooperators were requested to supply

performance data from at least 10 litters per boar. These included number of live births and stillbirths, number weaned, and individual body weights at birth and weaning. A random sample of each boar's progeny, comprising a barrow-gilt pair from two litters, was reared from weaning to slaughter at 90 kg live weight under standard conditions. Subsequent carcass appraisal was based on various indirect measurements, complete physical dissection of half carcasses of pigs obtained from eight farms, and dissection of a sample joint from the remainder of the carcasses. Muscle and subcutaneous fat samples were taken for quality evaluation. These tests embraced muscle colour, water binding capacity and transmission percentage, and iodine values of subcutaneous fat.

21. GENOTYPE-NUTRITION INTERACTION IN PIGS WITH REFERENCE TO THE RELATIONSHIP BETWEEN EFFICIENCY OF LIVE-WEIGHT GAIN AND EFFICIENCY OF LEAN TISSUE GAIN

A. J. Kempster, S. Fox and J. C. Bowman, *Department of Agriculture, The University, Reading.*

A series of experiments is in progress to investigate the contributions of genotype and feeding level to the relationship between energy intake per unit live-weight gain and energy intake per unit lean tissue gain, over the live-weight range 20 to 90 kg. Four sires were selected, from within the population of Large White and Landrace boars performance tested on *ad libitum* feeding by a commercial breeding company, to exhibit the extreme combinations of the characters efficiency of live-weight gain, and leanness predicted by ultrasonic backfat depths. These were mated with a group of closely related (Large White ♂ × Landrace ♀) females.

In Experiment I, progeny groups from two sires EL (efficient and lean) and IL (inefficient and lean) were compared when fed to the ARC (1967) live-weight scale, and 115% of this, at each of three percentage crude protein/percentage lysine levels (14.3/0.68, 16.6/0.88 and 18.7/1.09). For performance characters progeny of EL were superior and no interactions were found. Significant sire × feeding level interactions ($P < 0.05$) were recorded for percentage fat in the rump back and backfat measurements.

In Experiment II, which was more detailed, progeny groups from the four sires: EL, IL, EF (efficient and fat) and IF (inefficient and fat), were compared when fed *ad libitum* and according to the live-weight scales above. Protein intakes were approximately equal on each feeding regimen. Preliminary results indicated that genetic variation in voluntary feed intake was an important determinant of the relationship studied.

22. THE PREDICTION OF BODY COMPOSITION IN PIGS BY COMBINATIONS OF *IN VIVO* MEASUREMENTS

R. A. Houseman, *Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB.*

Twenty-four pigs, 12 castrated males and 12 females, were fed to produce large differences in fatness, with an overall range from 17.1% to 34.5% fat. At about 90 kg, seven different types of *in vivo* measurement were made on each pig to obtain estimates of body composition. These were the dilution of administered potassium 42 (⁴²K), of deuterium oxide (D₂O), and of Evans Blue; various external measurements of the animals, ultrasonic measurements of backfat thickness, and their feed conversion ratio adjusted for estimated maintenance food requirements (CFCR).

The pigs were killed immediately after the measurements had been made, and their carcasses chemically analysed.

Regression equations of a number of body components on each predictor in isolation, and then in combination with other predictors, were computed.

A prominent feature of the results was the precision with which body composition could be predicted from measurements of CFCR. The correlations between this predictor and the fat-free mass ($r = 0.953$) and body lipid ($r = 0.943$) were extremely high, and the residual coefficients of variation about the regressions (RCV) were 3.4% and 6.9%, respectively.

In combination with ^{42}K and the minimum loin fat depth determined by ultrasonics, CFCR was even more highly correlated with the body lipid ($r = 0.987$), the RCV being 4.0%.

Other combinations of predictors were considered in relation to a range of agricultural situations in which they might be used.

23. BUTCHER AND CONSUMER REACTIONS TO MEAT FROM PIETRAIN-CROSS PIGS

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An investigation was undertaken to determine the reaction of retail butchers to Pietrain-cross carcasses, and that of consumers to meat from them. Material for the study came initially from six commercial pork producers, each of whom had previously been supplied with a Pietrain and a Large White boar, for mating with either Large White or (Large White \times Landrace) females. Progeny from these matings were slaughtered at one of six abattoirs when body weight was in the region of 64 kg, and their carcasses subsequently distributed to retail butchers. A questionnaire, the contents of which were aimed at obtaining an appraisal of shape, lean content and muscle quality of Pietrain-cross carcasses relative to that of their normal purchase from the wholesaler, accompanied each Pietrain-cross carcass. Consumer reaction to loin chops, taken from a sample of Pietrain-cross and Large White-cross carcasses, balanced for sex and farm of origin, was ascertained by means of panel, household and shop tests.

Retail butchers showed a strong preference for Pietrain-cross carcasses on the basis of lean content, but not shape of carcass, while few considered the quality of the lean tissue to be inferior to that of their normal purchase. In both the panel and household tests, participants showed a strong preference for Pietrain-cross chops on the basis of appearance but broad equality for the two types of chops on organoleptic properties. Reasons most commonly given as most important in arriving at their preference for Pietrain-cross chops on appearance, were a higher lean/fat ratio and better colour of lean. In shop tests a strong preference was shown for Pietrain-cross chops over Large White-cross chops and the product normally stocked by the shop.

24. EFFECTS ON THE PERFORMANCE OF GROWING PIGS OF (a) FEEDING WET MEAL OR DRY OR WET PELLETS AND (b) IRREGULARITY IN FEEDING TIMES

R. S. Barber, R. Braude, K. G. Mitchell and R. J. Pittman, *National Institute for Research in Dairying, Shinfield, Reading, Berkshire.*

(a) Previous studies with growing pigs indicated first, that a better performance was obtained if meal was fed wet rather than dry, and secondly, that when both were fed dry, pellets gave better results than meal. The object of the first experiment reported here was to compare directly the best of these methods of feeding (meal wet and pellets dry), and to determine whether pellets might also be fed wet with advantage. The three treatments were randomly allocated to each of 10 blocks of pigs, each block consisting of 3 pens of 7 pigs, taking litter origin, initial weight, and sex into consideration. Pigs were fed twice daily, and were on experiment from 20 to 90 kg live weight; for the two wet-fed groups, 2.5 litre water/kg diet was added direct to the trough before feeding, while for those fed dry pellets an unrestricted

supply of water was available. Feeding a wet meal gave significantly better results (2.6% higher daily gain and 3.0% better feed : gain ratio) than feeding pellets whether dry or wet, there being no difference between these latter two methods of feeding. There were no differences in carcass backfat thickness between any of the three treatments.

(b) The importance of regularity in feeding times was investigated in a second experiment of similar balanced design in which 10 pens, of 7 or 8 pigs each, were fed regularly once daily at 08.00 hr throughout the experiment; while the other 10 pens of pigs were fed at 08.00 hr on 5 days, and at 12.00 hr on 2 days (selected at random), of each week. All pigs were fed dry pellets on the floor and had an unrestricted supply of water available. There were no significant differences in performance or carcass quality between the two treatments.

25. THE SULPHUR AMINO ACIDS REQUIREMENTS FOR GROWING PIGS

R. Braude, M. A. Esnaola and J. W. G. Porter, *National Institute for Research in Dairying, Shinfield, Reading, Berkshire.*

Two experiments have been conducted to estimate the methionine (M) plus cystine (C) requirements of growing pigs. In each, Large White castrate male litter mates, of about 20 kg initial live weight, were randomly distributed to four experimental treatments, and eventually slaughtered on attaining 60 kg live weight. Purified diets were used consisting of maize starch, sucrose, maize oil, cellulose and comprehensive mineral and vitamin mixtures.

In Expt 1 extracted groundnut meal, to provide 16% crude protein (CP), 0.14% M and 0.19% C, while in Expt 2 casein, to provide 10% CP, 0.28% M and 0.09% C, were used as sole sources of protein. Both basal diets were adequate in essential amino acids except for sulphur amino acids, and were supplemented with graded levels of DL-methionine (0.15% and 0.1% difference between consecutive treatments on Expts 1 and 2 respectively). The diets were fed twice daily, wet, in amounts based on live weight and the Shinfield feeding scale.

The response to M supplementation was different in the two experiments. On the groundnut diets the growth rate, feed/gain ratio, daily nitrogen retention and leanness of carcass were significantly improved by M supplementation, while on the casein diets the differences were not significant.

In both experiments the levels of free amino acids in plasma have not produced the 'broken line response' reported by several workers. The urea levels in plasma appear to be a useful criterion to measure protein utilization.

26. SWEDES AND POTATOES AS FEEDS FOR PIGS

A. S. Jones and R. M. Livingstone, *Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB.*

Swedes (*Brassica napus*) or potatoes were pulverized in a Wolfking mincing machine and used to replace a mixture of barley, 10% fish meal, minerals and vitamins, so as to provide diets in which 50% of the dry matter was from roots.

Eight groups of three littermate male pigs weighing approximately 41 kg were used to measure dry matter, energy and nitrogen digestibility, and nitrogen retention on the three diets. Total dry matter intake was based on the live weight of the pigs and was in accordance with the ARC recommended scale. Intake was held constant over a 10-day collection period.

There were no significant differences between treatments in dry matter digestibility. Digestibility of energy was significantly ($P < 0.05$) lower on the barley treatment, the values being 85.7, 83.0 and 85.0% for swedes, barley and potatoes,

respectively. Nitrogen digestibility was significantly lower with the swedes (71.7%, cf. 76.8% for the other treatments), although there were no significant differences between the treatments in the percentage of food nitrogen retained.

27. EVALUATION OF FIELD BEANS (*VICIA FABEA*) IN PIG DIETS BY SLOPE-RATIO ASSAY

V. R. Fowler and R. M. Livingstone, *Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB.*

A total of 96 pigs used in an experiment in which beans (Throws MS) and bean/fish-meal mixtures were compared with fish meal alone as a protein supplement for barley-based diets. The constituents of the mixed supplement of beans and fish meal were proportioned so that each contributed an approximately equal amount of protein to the final diet, after allowing for displacement of barley protein. Methionine additions were made on the basis of the amount required to bring the total methionine plus cystine of the diet to the same concentration as that of a diet of similar crude protein content but supplemented only with fish meal. The reference slope was determined by the response of four groups of eight pigs given diets supplemented with 2, 4, 6 or 8% of fish meal. The response slopes for the treatment diets, which included beans, were obtained by incorporating the supplement at two levels to give crude protein concentrations equivalent to the 4 and 8% level of fish meal in the control.

Responses measured in terms of 'dead-weight gain' showed that if beans were used as the only protein supplement, they fell well below their 'theoretical' exchange ratio of 3.75% beans to 1% fish meal based on either crude protein or lysine, particularly at the high inclusion rate of 30%; additions of methionine gave no advantage in this case. When beans were used in combination with fish meal, however, the exchange ratio was much improved, and the addition of methionine succeeded in bringing the ratio almost exactly to the theoretical value.

28. THE EFFECT OF PROTEIN CONCENTRATION ON THE PERFORMANCE OF PIGS FED *AD LIBITUM* FROM 65 TO 105 KG LIVE WEIGHT

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Sixty Large White \times (Large White \times Landrace) animals, comprising five blocks containing six female pigs and five blocks containing six castrates, were used. The pigs, from the Institute minimal disease herd, were given *ad libitum* a diet containing 16.5 crude protein (CP) and 2.9 Mcal DE/kg from 25 kg, so that they were 129 days of age when they reached 65 kg live weight. The pigs were then placed in individual pens and offered one of six diets *ad libitum*, until they were slaughtered at 105 kg live weight. The isocaloric diets containing 9.0, 10.75, 12.50, 14.25, 16.00 and 17.75% CP respectively, were obtained by a progressive substitution of a mixture of white fish meal and soya bean with barley. The increase in protein concentration was therefore confounded with changes in the quality of the protein. The health of the pigs was outstandingly good and the average gain of all pigs was 1.2 kg per day. In all major respects it was found that data for the two sexes could be combined.

An increase in protein concentration in the diet, up to 16.00% CP, led to a significant linear increase in both daily gain and the efficiency of feed utilization, although a further increase in protein concentration to 17.75% CP resulted in a reduction of performance. The carcass composition of the pigs was measured by dissection of the carcass into saleable lean, by specific gravity, and by backfat measurement. These indicated a linear increase in leanness until the diet was increased to 16.00% CP, and thereafter an increase in fatness of the carcasses.

29. THE EFFECTS OF VARYING LEVELS AND PATTERNS OF FOOD INTAKE ON GROWTH, APPETITE, DIGESTIBILITY AND CARCASS CHARACTERISTICS IN PIGS

K. Pratsos, M. K. Curran and I. J. Lean, *Wye College (University of London), Ashford, Kent.*

Using 128 Landrace pigs housed in single-sex pens of four pigs, four dietary regimes and two intake levels were studied based on eight consecutive 14-day cycles commencing after weaning. On the basis of a control regime in which food was always available *ad libitum* (T1), two regimes allowed pigs access to food *ad libitum* for seven days followed by seven days of restriction, and a further one restricted intake in both halves of each cycle. The three restricted regimes, with the intakes permitted in each half were:

- (T2) *ad libitum*, 40 or 60% of T1 consumption;
- (T3) T1 consumption, 40 or 60% of T1 consumption;
- (T4) *ad libitum*, 40 or 60% of preceding seven-day consumption.

In total, pigs on T2 and T4 consumed significantly more food ($P < 0.05$) than those on T3, but differences in live-weight gains, feed conversion efficiencies and carcass fat depths were not significant. Intakes of T2 and T4 in *ad libitum* access periods increasingly exceeded those of T1 in successive cycles, reaching a maximum of +15% ($P < 0.001$) in the sixth cycle; responses of 40 and 60% restriction levels were similar. Empty stomach weights were significantly different ($P < 0.001$) between restriction levels and between T1 and the other regimes. The results were associated with differences in dry matter and nitrogen digestibility in supplementary metabolism studies.

30. THE EFFECT OF SOME DIETARY SYNTHETIC HORMONES ON PIG PERFORMANCE AND CARCASS COMPOSITION

N. Walker, *Agricultural Research Institute of Northern Ireland, Hillsborough, Co. Down.*

A preliminary experiment indicated that a combination of 2 mg diethylstilbestrol (DES) and 2 mg methyltestosterone (MT)/kg air-dry diet reduced the average backfat thickness of castrated male pigs by about 4 mm, when fed from 20 to 84 kg live weight. The improvement in efficiency of feed conversion suggested in other reports was not found here, but treated pigs had reduced killing-out percentage. Sample joint dissection suggested that an increase in bone content in the treated pigs was greater than that which would normally be associated with the increase in lean.

These effects were further investigated in a 2×3 factorial experiment to compare the response of entire males, castrated males and entire females to the hormone combination. Carcass composition was assessed by dissection of one side into subcutaneous fat plus skin, eight sample muscles, and bones other than vertebrae.

31. CALORIMETRIC STUDIES ON GROWING PIGS USING A CLOSED-CIRCUIT RESPIRATION CHAMBER

K. J. McCracken, *Chemical and Animal Nutrition Research Division, Ministry of Agriculture, Northern Ireland, and Agricultural Chemistry Department, Queen's University, Belfast,* and R. Gray, *Agricultural Chemistry Department, Queen's University, Belfast.*

The chamber is of similar design to those in use at the Rowett Research Institute. However, the system for metering oxygen consists of a fibre-glass burette of approximately 60-litre capacity, which is automatically refilled at a known temperature and pressure.

The minimum time interval for equilibration of heat production was studied, following change-over from low to high levels of energy intake and vice versa. The results were discussed and data presented on the fasting, maintenance, and normal heat production of pigs weighing 20–30 kg, kept singly in cages in an environmental temperature of 22°C.

Preliminary observations indicate that the maintenance requirement of such pigs is approximately 230 kcal/kg $W^{0.56}$, and the efficiency of utilization of metabolizable energy for production is approximately 75%. The heat production of pigs closely confined in a metabolism cage was compared with that of the same animals given a reasonable amount of freedom. The extra heat production arising from increased activity amounted to less than 5% of the total maintenance requirement.

These results were discussed in relation to predictions and results of other workers.

32. THE EFFECTS OF CALF-REARING SYSTEM EARLY IN LIFE ON SUBSEQUENT PERFORMANCE

J. R. Southgate and D. G. Evans, *Meat and Livestock Commission, Bletchley, Buckinghamshire.*

During the autumn of 1969, 170 Hereford × Friesian male calves by four Hereford bulls were purchased from 84 dairy herds at about 10 days of age, and allocated to four commercial semi-intensive beef units. In the period before collection 106 calves had suckled their dams or nurse cows, and 64 had been bucket fed milk. Calves reared by both systems occurred in each sire/rearing group.

The calves were weighed at collection, at 3, 7, 10 and 14 months, and at slaughter (around 18 months of age). Age at slaughter and cold carcass weights were recorded.

Suckled calves were heavier ($P < 0.05$) than bucket-reared calves at all ages except 14 months and at slaughter. However, age at slaughter was less for suckled than bucket-reared calves. The suckled calves had slightly heavier cold carcass weights but a lower killing-out percentage ($P < 0.1$).

Preliminary results for a further 620 calves, by 11 Hereford bulls, purchased in the autumn of 1970 broadly confirm the earlier findings.

Reasons for the difference in performance are discussed, particularly in relation to the analysis of progeny test data.

33. THE RESPONSE OF SUCKLED CALVES TO VARYING LEVELS OF MILK INTAKES

B. G. Lowman and T. D. Clark, *The East of Scotland College of Agriculture, West Mains Road, Edinburgh EH9 3JG.*

A long-term experiment, investigating the relationship between feed intake and milk production by Blue-Grey (White Shorthorn ♂ × Galloway ♀) suckler cows, is being undertaken in the School of Agriculture. In the first year the calves from five Blue-Grey heifers were fed the milk from their dams from birth to eight weeks of age. The heifers were machine-milked twice daily, and all the milk produced by each heifer was bucket-fed to her own calf twice daily, and refusals of milk noted. No other feedstuffs were available to the calves. The changes in milk composition and the live weight of the calves were recorded throughout the period.

The results were used to test the hypothesis that beef calves have the same response to milk intakes as do dairy calves. Regression co-efficients a and b which fit into the equation:

$$\text{Growth kg/day} = bM + aW$$

(where M is mean milk intake, W is starting live weight, and the time period is

2 to 3 days) were developed from the experimental data of previous workers, and used as the standard for dairy-type calves. No significant differences were shown between the coefficients produced from this experiment (0.22 and -0.012), compared with those (0.24 and -0.017) from the dairy cattle data.

In the second year 25 Blue-Grey cows were placed on the experiment and given one of four nutritional regimes. The calves from these cows were fed in a similar way to the first group. The implications of the results from the first two years of the project were discussed in relation to practical management of suckler cows.

34. SOME ANIMAL AND FEED FACTORS AFFECTING SILAGE INTAKE IN BEEF CATTLE

M. Hastings, *Agricultural Development and Advisory Service, Liscombe Experimental Husbandry Farm, Dulverton, Somerset.*

Single-suckled Devon male castrate calves (steers) ate much less silage, whether young and leafy or more mature, than Devon \times British Friesian steers, of similar age and weight, which had been bucket-reared and summer grazed.

A simple trial of 2×2 factorial design compared Devon or Devon \times British Friesian calves, bucket-reared or single-suckled on Devon cows. The results indicated that Devon single-suckled calves had low appetites for silage during the first 3 months of feeding, but this suckling treatment had much less effect on appetite in the crossbred calves.

With Devon \times British Friesian and Hereford \times British Friesian calves the relative effects upon intake of digestibility, percentage dry matter, and fermentation of the silage, and protein content of the concentrate supplement, were examined in trials covering three seasons. Digestibility and fermentation had most effect on intake.

Further studies have been undertaken in 1971-72 to show the relative magnitude of the effects of self- or manger-feeding, length of chop and additives, on intake in animals of different breed and system of rearing.

35. CONCENTRATE COMPOSITION AND HORMONE IMPLANTATION FOR INTENSIVELY-FED WEANED SUCKLED CALVES

T. L. Powell, *Agricultural Development and Advisory Service, Liscombe Experimental Husbandry Farm, Dulverton, Somerset.*

During the winters of 1969/70 and 1970/71, the same 2×2 factorial experiment was conducted with 20 weaned spring-born single-suckled calves of Devon type, which weighed 240 kg at the commencement of the trial in early November.

Daily live-weight gain to slaughter at 395 kg live weight was significantly improved ($P < 0.05$) by the implantation of 45 mg of hexoestrol when the cattle weighed 260 kg, but was unaffected by whether the concentrate fed to appetite contained 15.5 or 12.8% crude protein in the dry matter (85% v. 95% barley in the mix).

Subcutaneous fat measurements were smaller ($P < 0.05$) in cattle fed the lower protein mix, but commercial gradings were unaffected.

A £12.13 reduction in feed costs/animal was achieved by reducing the protein content of the concentrate and implanting.

36. THE EFFECTS OF PELLETING VARIOUS DIETS ON INTAKE AND DIGESTIBILITY IN CATTLE AND SHEEP OF VARIOUS AGES

J. F. D. Greenhalgh and G. W. Reid, *Rowett Research Institute, Bucksburn, Aberdeen, AB2 9SB.*

Three groups of six castrate male cattle aged 0.5, 1.5 and 3 years, and three corresponding groups of sheep, were fed to appetite on six diets. Two were of high-

quality dried S24 ryegrass given either long to cattle or chopped to sheep (AL), or ground and pelleted (AP). The remainder consisted of low-quality dried grass alone (BL and BP) or 60% of the same grass with 40% barley concentrate (CL and CP). Each animal ate each diet in turn for three weeks.

Daily dry-matter intake (% W^{0.75}) was higher in cattle than in sheep, but was increased more by pelleting in the latter; mean values for the P diets were 9.07 for cattle and 8.24 for sheep, and for the L diets, 8.18 and 5.68. Pelleting increased intake more for the low quality diet, B (8.82 v. 6.13) than for A (8.63 v. 7.25) or C (8.51 v. 7.40), and more for the youngest animals (9.14 v. 7.08) than for the middle aged (8.58 v. 6.10) or oldest (8.15 v. 7.70).

Mean dry-matter digestibility coefficients for the diets, measured in two animals from each group of six, were: AL 71.2, AP 56.1, BL 65.7, BP 54.1, CL 68.7 and CP 63.2. There were significant interactions between form of roughage and diet, between form and animal species, and between form, diet and age of animal.

37. THE EFFECT OF STOCKING RATE ON THE COMPENSATORY GROWTH OF FRIESIAN DAIRY HEIFERS FED AT TWO LEVELS DURING THEIR YEARLING WINTER

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At three centres, over three years, yearling dairy heifers were winter-fed at two levels to give a difference of approximately 0.45 kg live-weight increase per day.

In the following grazing seasons the heifers were stocked at grass at different intensities (intensive, moderate and extensive) at two of the centres. Heifers from the high-level winter feeding treatments were grazed at either the intensive or moderate rates. Animals from the low-level treatments were grazed at the moderate or extensive rates.

At two centres the live-weight differences achieved during the yearling winter were only 3% of the final target weight, where 10% was intended. At the third centre the intended level of difference was attained.

Compensatory growth was exhibited during the grazing seasons. The level of compensation for slower growth in the winter was markedly affected by the size of the difference at the start of the summer, and by the stocking rate. Enhanced summer growth did not fully compensate for winter differences at any stocking rate.

Live frame measurements indicate that yearling winter growth restriction influenced frame size. Previous experiments indicate that it is unlikely that these physical effects are completely eliminated throughout life.

38. SEMI-INTENSIVE BEEF PRODUCTION FROM AUTUMN BORN CALVES: THE EFFECT OF STOCKING RATE ON PERFORMANCE FROM SANDLAND LEYS

R. Hardy, *Agricultural Development and Advisory Service, Gleadthorpe Experimental Husbandry Farm, Welbeck Colliery Village, Mansfield, Notts.*

During the summer of 1970, 3 groups of 8 British Friesian steers, 6 months of age and 200 kg live weight at turnout, were stocked at 2.47, 3.71 and 4.94 animals/ha respectively, on a ryegrass/timothy/clover ley grown on a loamy sand soil with a low available water holding capacity. All treatments received a common dressing of 264 kg N/ha. The grass was managed to provide both grazing and conserved fodder for rearing from 3 to 6 months of age, and for fattening from 12 to approximately 18 months of age. Any deficiency in either grazing or fodder was supplemented at each stocking rate by concentrate feeding, to achieve a similar live-weight performance from each treatment group.

Following conservation in late May, abnormally dry weather was experienced, and no regrowth occurred until late July. Hay and concentrate was fed to all

treatments from mid June and continued until 1 and 12 August respectively for animals stocked at 2.47 and 3.71/ha, and until yarding for those stocked at 4.94/ha. When deductions for forage required for rearing and supplement at grass were made from the total forage ensiled on each treatment group, only 91 kg/head of forage dry matter were available for the winter fattening of cattle stocked at 4.94/ha, and 286 kg/head for those at 3.71/ha. The barley required to fatten these two groups was high at 980 and 703 kg/head respectively. Cattle stocked at 2.47/ha had 757 kg/head of forage dry matter for winter fattening, and required only 426 kg/head of barley to reach fat condition.

Gross margins/ha rose linearly from £119 at 2.47 beast/ha to £188 at 4.94 beasts/ha.

39. THE NITROGENOUS MANURING OF GRASSLAND FOR MEAT PRODUCTION

Barbara A. Maund, J. E. Whybrew and M. V. Jackson, *Agricultural Development and Advisory Service, Drayton Experimental Husbandry Farm, Stratford on Avon, Warwickshire.*

This was a farm unit experiment commenced in 1964 to investigate the potential of different levels of nitrogen application to grassland for meat production.

From 1964 to 1967 the nitrogen levels were 0, 100 and 201 kg/ha with a stocking rate of 0.89, 0.73 and 0.61 hectares per livestock unit (LSU) respectively. The stocking rates were made up of equal proportions, on a LSU basis, of 14-month-old cattle and ewes with lambs. The mean live-weight gain of cattle and lambs was 325, 384 and 454 kg/ha for the three nitrogen levels respectively, with approximately half the production from cattle and half from lambs. In addition sufficient hay was made to meet all the cattle and ewe requirements.

For the years 1968–70, the nitrogen levels and stocking rates for the 0 and 201 kg N/ha remained unchanged, but a treatment using 402 kg N/ha with a stocking rate of 0.36 ha/LSU was introduced. The total live-weight gain per hectare was 327, 464 and 680 kg/ha with production again approximately equally divided between cattle and sheep. Sufficient hay for the cattle and ewe requirements was made on the zero nitrogen treatment, an excess with the 201 kg N/ha, but a deficit on the 402 kg N/ha treatment occurred in two out of the three years. In terms of self-sufficiency this suggests that the highest stocking rate was at about the upper limit.

40. ZERO GRAZING OF BEEF CATTLE

R. B. Mair and P. J. Turner, *High Mowthorpe Experimental Husbandry Farm, Malton, Yorkshire,* and J. E. Whybrew, *Drayton Experimental Husbandry Farm, Stratford on Avon, Warwickshire.*

Two experimental husbandry farms have been investigating the effect of feeding beef cattle on cut and carted grass.

At Drayton observations were made for three years on the performance of groups of 20 or 24 cattle, which were housed throughout the summer and received cut grass. The effect of feeding supplementary cereals when the average rate of live-weight gain fell below 0.90 kg per day, was recorded. The supplementary cereals always improved performance over that of grass alone, but only in 1969 was the objective of obtaining a mean live-weight gain of 0.90 kg per head per day achieved. In 1971 a total of 54 November born calves was used in a trial. Cattle paddock-grazing at a stocking density of 4.7 per hectare had a mean live-weight gain of 0.94 kg per day over a grazing period of 164 days. Cattle at a similar stocking density, receiving cut

grass in yards, had a mean performance of 0.77 kg per day, over 147 days. The third group received cut grass to supplement normal grazing and gained 0.83 kg per day.

At High Mowthorpe the comparisons of zero grazing and paddock grazing have shown advantages in favour of zero grazing in terms of weight gain per head and per hectare. Encouraging results in comparative trials in 1969 and 1970 led to a system of zero grazing out of doors being tested on a commercial scale in 1971. One hundred and thirteen cattle were kept outside on two exercise areas totalling 1.45 hectares. Grass was carted from another area of 19.0 hectares. A group of 56 November-born British Friesian steer calves had a mean live-weight gain of 0.78 kg per day, over a 166-day period. A group of 57 February-born Friesian steer calves had a live-weight gain of 0.74 kg per day over a 174-day period.

The practical implications of the results were discussed.

41. THE EFFECT OF FEEDING RED CLOVER CONSERVED BY DRYING AND ENSILING ON REPRODUCTION IN THE EWE

D. J. Thomson, *The Grassland Research Institute, Hurley, SL6 5LR.*

New tetraploid varieties of red clover have been bred which yield 25–30% more dry matter per annum, and sustain production for 2–3 years longer, than currently grown diploid varieties. Field experiments have demonstrated that ewes grazing tetraploid red clover prior to, and during, mating produce fewer lambs compared with ewes grazing non-oestrogenic grasses. It was not known whether the level and activity of formononetin present in the fresh crop was maintained in the conserved diets.

Three groups of 20 Border Leicester × Cheviot ewes were fed a control non-oestrogenic ryegrass, red clover pellets, and red clover silage (unwilted) respectively, for 3 weeks prior to mating, and for two cycles after the introduction of the rams. The level of formononetin in the silage was three times that in the dried pelleted diet. The number of ewes bearing twin lambs was reduced from 18 on the ryegrass control, to 12 on the red clover pellets and 6 on the red clover silage. Six ewes (30%) fed on silage were barren. The lambing percentages were 190, 165 and 100% for the control, dried and silage treatments.

In flock management, both the grazing of red clover and the feeding of red clover pellets or silage, prior to and during mating, should be avoided.

42. THE EFFECT OF FEEDING REGIMES AND MILK SUBSTITUTE TEMPERATURE ON THE PERFORMANCE OF ARTIFICIALLY REARED LAMBS

Ines M. Penning, T. T. Treacher and P. D. Penning, *The Grassland Research Institute, Hurley, SL6 5LR.*

Forty lambs were used to assess the effect of three feeding regimes and two milk temperatures on intake of milk substitute and lamb performance. The three feeding regimes were (1) *ad libitum* availability of milk substitute, (2) feeding four times daily to appetite at each feed, or (3) feeding four times daily to a daily intake of milk substitute dry matter of 59 g/kg $W^{0.73}$. The milk substitute was fed at 5°C on all regimes, and also at 34°C on regimes 2 and 3. Two milk substitutes were used to assess the effects on digestibility or utilization arising from interactions between milk composition and feeding regime or temperature. The two milk substitutes consisted of 66% skimmed milk and 30% fat, either butterfat (MS1) or a mixture of beef tallow and coconut oil (MS2). Dry-matter digestibility was higher for MS1 (98% v. 92%), but was not affected by feeding method or feeding temperature. Intake, live-weight gain and efficiency of conversion were higher on MS1.

The highest intakes and growth rates occurred on the *ad libitum* regime. Intakes

of milk on regimes 2 and 3 were 79% and 49% of the *ad libitum* intake respectively. With respect to feeding regime 2, milk temperature affected intake but not live-weight gain. Efficiency of feed conversion was highest on regime 2.

43. THE EFFECT OF VITAMIN E AND SELENIUM ON PREGNANT EWES

A. J. Mudd and I. L. Mackie, *Beecham Research Laboratories, Nutritional Research Centre, Walton Oaks, Tadworth, Surrey.*

Australian and New Zealand work has demonstrated that supplementary selenium given to ewes before mating increases the number of lambs born. Recently intra-uterine mortality of the lamb foetus has been described in this country, and this may be associated with a vitamin E/Se deficiency which causes a reduction of the number of lambs born.

A series of trials was conducted in Scotland during the 1970/71 season to study the effect of a vitamin E plus selenium injection on the number of lambs born. Control ewes were compared with two trial groups one of which received an injection about one month prior to mating, and the other received the same treatment with a further injection after 60 days of pregnancy.

Lambing percentages of the three groups were 103, 122 and 128 respectively. Differences between controls and injected sheep were very highly significant ($P < 0.001$). Single injections apparently increased the number of male lambs born ($P < 0.01$), whilst the double injection increased the number of females ($P < 0.01$).

44. THE USE OF COMPLETE DIETS OF VARYING STRAW LEVELS FOR EARLY WEANED LAMBS

D. A. R. Davies, *Department of Applied Biology, Cambridge.*

Three complete diets were made from a barley-based concentrate by substituting 0, 20 and 40% of the barley with coarsely milled straw. Estimated metabolizable energy contents of the diets were 2.90, 2.61 and 2.33 M cal/kg dry matter.

Thirty-six lambs artificially reared on a milk replacer from two days were used. Lambs were weaned at either 20 or 30 days, following free access to the pelleted diets since 10 days of age. Growth performance and solid food intake were recorded every fourth day during the period 20 to 70 days of age.

Four lambs were removed from the experiment, two died because of bacterial scours, and two on the diet containing no straw refused to eat.

Growth rate of the remaining lambs averaged 0.17 kg/day, with growth rate significantly better for lambs weaned at the older age and for lambs fed diets containing straw.

It is suggested that the early-weaned ruminant in the immediate post weaning period should be given complete diets including a source of roughage such as straw.

45. DRIED SUGAR BEET PULP AS A ROUGHAGE SUBSTITUTE FOR PREGNANT EWES

I. A. Dickson, *The West of Scotland Agricultural College, Auchincruive, Ayr.*

In December 1968 ninety-six crossbred gimmers (20-month-old female sheep) were housed in pens of 12 and offered daily one of four diets: (a) commercial hay (0.9 kg), (b) dried sugar beet pulp nuts (0.45 kg), (c) hay plus beet pulp (half of each allowance), or (d) barn-dried hay (1.1 kg). In the following year 107 gimmers and ewes were similarly offered diets (a), (b) and (c). A concentrate supplement of 0.17 kg per head daily was given to all ewes except those receiving barn-dried hay. Pre-lambing concentrates were given in addition and at uniform rates throughout. Lambing commenced on 1 March. Each ewe was withdrawn from treatment at lambing. Lamed ewes were fed as a single flock.

The feeding of beet pulp resulted in a significantly greater loss of weight between

October and lambing, in absolute and in percentage terms, in the first year only. No other significant differences in ewe weights or weight changes were observed in either year. The commercial hay diet in 1968/69 resulted in fewer lambs born alive per ewe lambing. No other significant differences were found between treatments in lamb numbers, or weight of litter per ewe at birth, or at four weeks of age. There were no digestive disturbances in ewes on the beet pulp diet.

46. THE COST/BENEFIT OF THE AGE OF WEANING PIGS

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An empirical study has been made to determine break-even levels of the number of pigs produced per sow per annum for four ages of weaning. The theoretical maximum number of litters per sow per year was calculated to be 2.05, 2.3, 2.5 and 2.7 respectively for 56-, 35-, 21-, and 7-day weaning. From this information, graphs were constructed relating the number of pigs produced per sow per year to: (a) the annual cash surplus generated per sow, and (b) the return on capital invested under each system of weaning. From these graphs it is possible to predict that, compared with a 35-day weaning system in which 2.3 litters/year and 9 pigs per litter is achieved (20.7 pigs/year), the number of pigs per sow per year necessary would have to be 21.1, 22.2 and 24.8 for weaning ages of 56, 21 and 7 days respectively, to produce the same annual cash surplus per sow.

If the theoretical maximum number of litters per sow suggested above could be achieved, then the number of pigs sold per litter would have to be 10.5, 8.8 and 9.2 for weaning ages of 56, 21 and 7 days respectively, to break even with 9 pigs/litter from 35-day weaning.

The graphs therefore help to provide research workers with a measure of the levels of sow performance which must be achieved commercially to make early weaning systems viable alternatives to more traditional methods.

47. BREEDING OF GILTS AT PUBERTY AND LOW BODY WEIGHTS

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Eighty-two female pigs (gilts) were allocated to one of three treatments at 54 kg live weight, having been reared on the same plane of nutrition up to that weight. The treatments were (1) 1.36 kg of meal per day before service—served at 1st heat, (2) same ration but served at 2nd heat, and (3) 2.27 kg of meal per day before service—served at 3rd heat.

The gilts were fed on a conventional 16% protein rearing ration.

The gilts were then fed 1.81 kg of the same meal throughout pregnancy until farrowing. Data were collected for days to puberty, service weight, conception rate, litter size and post farrowing weight.

The results indicate that it is possible to breed from gilts once, and then slaughter them for bacon or 'heavy hog' production.

48. EFFECT OF FEED PATTERN IN LACTATION, AND FASTING FOLLOWING WEANING, ON REPRODUCTIVE PHENOMENA IN THE SOW

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Fifty-two Landrace \times (Landrace \times Large White) sows were used in a 2 \times 2 factorial design. Sows received either a high feed level (H), 1.8 kg + 0.45 kg food/piglet/day, or a low level (L) 2.3 kg/day, for the last week of a six-week lactation.

Feed intake in the first five weeks of lactation was adjusted to provide the same total food intake for the whole lactation, for litters of the same size, on either treatment. On the day following weaning, half the sows on each lactation treatment had food withheld for 24 hr (S), while the remainder received 3.6 kg food (F). All the sows received 3.6 kg food/day for the remainder of the period to remating. The mean period from weaning to remating (days), and the mean litter size at birth, for the four treatment groups were as follows; HF 4.7, 10.5; HS 5.2, 11.9; LF 5.0, 11.8; LS 5.8, 11.1. These differences were not statistically significant.

49. A COMPARISON OF THE PERFORMANCE OF SOWS HOUSED IN SOW STALLS OR IN YARDS DURING PREGNANCY

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Gilts were randomly assigned at first service to one of two systems of housing: (i) individually in a dry sow stall house, (ii) in groups of four in outside yards. Once allocated to stalls or outside yards, an animal remained on that system for the first three pregnancies. All gilts and sows were individually fed 2.73 kg meal per day during pregnancy, and 1.36 kg basic + 0.45 kg per piglet during lactation. On the 110th day of pregnancy gilts and sows from both housing systems were moved to farrowing crates, and weaning was at 5-6 weeks.

To date 165 farrowings have been recorded in the two systems as follows: stalls 41 first, 30 second and 14 third farrowings, and yards 42, 25 and 13 respectively. The number of piglets born alive, and reared to three weeks, per litter were as follows: stall sows 8.78 and 7.63, and yard sows 8.55 and 7.07 respectively, the difference in mortality being 4.2%. Litter weights were similar in the two systems, although individual pig weights at birth and three weeks were slightly lower in the stall system. In the second and third litters the numbers of piglets born alive were higher for the stall sows at birth (10.61 v. 9.58), and at three weeks of age (9.34 v. 8.40). Piglet weights at these ages were similar, but total litter weights were higher in the stall system. Farrowing interval was longer in the stall system by 12.6 days. There was no evidence that the performance and health of gilts and sows were adversely affected by confinement during pregnancy.

50. EFFECT OF INWINTERING ON THE NUMBER OF LAMBS BORN

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In a series of experiments comparing in- and outwintering, and involving over 300 ewes, inwintered ewes produced significantly more lambs. The mean lambing percentages for four years were 162 and 146 for in- and outwintered ewes respectively ($P < 0.01$).

A suggested reason for the difference is foetal resorption occurring in potentially twin-bearing outwintered ewes, since the differences in lambing percentage were due to differences in the number of multiple births, rather than the number of barren ewes.

Ewes were, on average, 37 days pregnant when the differential treatments were imposed. The bulk of the difference between treatments was, however, due to those ewes which lambed early, i.e. were on average 42 days pregnant when treatments were imposed. Resorption is not generally thought to take place after day 30, but the suggested resorption in the outwintered ewes would have had to take place at a later stage of development.

In order to check this, ewes were slaughtered at various stages of pregnancy, and dead foetuses were found, usually one of a pair of twins. Measurements of

weight and crown: rump length gave an indication of when these foetuses stopped growing, and this appeared to be associated with periods of cold weather, rather than with the overall level of nutrition.

51. THE EFFECT OF DIFFERENT RATIOS OF INCLUSION OF EITHER GROUND MAIZE OR GROUND BARLEY WITH GROUND PELLETTED GRASS (RYEGRASS) OR LEGUME (RED CLOVER) ON THE EFFICIENCY OF LAMB PRODUCTION

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Dried ryegrass and red clover diets of similar digestibility and nitrogen content were ground (3 mm screen) and pelleted. To each of these forage diets was added 10, 25 or 50% of either ground maize or ground barley, and young growing lambs were fed *ad libitum*, and at restricted levels of feeding, for 84 days. An initial sample group of lambs (18) was slaughtered at the beginning, and all test lambs were slaughtered at the end of the experiment.

The carcass weight gain results for the *ad libitum* fed lambs indicated there was no difference between the ground legume and the ground pelleted grass, either fed alone or when supplemented with cereal. Lambs fed forage diets supplemented with maize had a daily rate of carcass gain 10% higher than those fed barley. The rate of carcass weight increase declined with diets containing 25 and 50% as ground cereal.

52. A CASE OF REJECTION BY LAMBS OF REGROWTHS FROM PREVIOUSLY GRAZED RYEGRASS SWARDS

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During a study of the effect of grazing pressure on the herbage intake of lambs, it was noted that there was a marked rejection of the grass on areas previously subjected to high grazing pressures. Since there have been few reports on such rejection by sheep, the opportunity was taken to examine this situation.

A behaviour study was carried out using eight lambs on swards that had been grazed 38 days previously, at five different grazing pressures, and subsequently topped. A significant difference was found between the times spent grazing on the five swards. These ranged from 5.7 to 1.7 minutes/m²/lamb in 28 hours of daylight on two successive days, for the plots previously grazed at the lowest and highest grazing pressures.

The voluntary intake of grass regrowth cut from similar plots, receiving high and low levels of N, was measured using lambs. As was expected, mean daily dry-matter intakes were lower for grass cut from swards previously grazed at high grazing pressure, than for grass cut from swards previously grazed at low grazing pressure. However, the lowest intakes occurred among lambs on treatments receiving grass cut from previously ungrazed swards. Fertiliser application rates also had significant effects on intake.

53. DIETARY pH AS A PALATABILITY FACTOR AFFECTING VOLUNTARY FOOD INTAKE OF SHEEP

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This experiment was carried out to compare the metabolic and palatability effect of hydrochloric acid on the voluntary food intake of sheep. Eight sheep in a latin square change-over design experiment were fed as follows: A. grass pellets alone, B. grass pellets plus HCl added to the pellets before feeding, C. grass pellets

plus the same level of HCl as in B but given intraruminally, D. grass pellets plus HCl added to the pellets before feeding plus NaHCO₃ given intraruminally at a level equivalent to the HCl in the diet. The HCl was offered at two levels: 250 m equiv/kg grass pellets, which lowered the pH of the grass meal to about 4.4; and 500 m equiv/kg which lowered it to about pH 3.2.

Dry-matter (DM) intake (kg/sheep per day) for treatments A, B, C and D was 1.54, 1.28, 1.50 and 1.34 respectively at the low acid level, and 1.58, 0.82, 0.91 and 0.98 respectively at the high acid level. Thus there was a palatability effect on DM intake at both levels of acid supplementation, and a metabolic effect at the high level only.

Treatment effects on DM digestibility, rumen fluid pH, volatile fatty acid production in the rumen, and acid-base balance of the sheep were measured. The results suggest that palatability associated with dietary pH may have an important influence on voluntary intake of low pH silage.

54. EFFECTS OF OESTROGEN ON MILK SECRETION IN GOATS

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Declines in milk yield, in the percentages of some milk constituents, and in food intake, often occur at oestrus or in the second half of pregnancy in cows and goats. Previous experiments showed that infusions of oestradiol 17- β depressed milk secretion and the intake of concentrates in goats; plasma oestrogens are elevated at oestrus and in the second half of pregnancy.

Six goats were given either continuous intravenous infusions, or single subcutaneous injections, of oestradiol 17- β . Food was offered at below the *ad libitum* level and refusals did not occur; depression of food intake was therefore not a complicating factor. With low levels of treatment (below 100 μ g oestradiol/24 hr infused, or below 1 mg injected), there was a consistent though non-significant increase in milk yield in every animal. Higher levels depressed milk yield and gave increased fat and protein percentages. The effect on lactose content was variable. Two of the goats which were in early lactation, and two in which those treatments were repeated following ovariectomy, showed less response at any dose level than did the intact animals in later lactation. Oestrus occurred spontaneously in some of the goats and the effect of this is compared with that of oestrogen infusions.