

SUMMARY REPORTS ON OTHER PROJECTS

Beef Cow-Calf

Beef Cattle Selection Studies

R. R. Frahm

The beef cattle selection study being conducted at the Ft. Reno Live-stock Research Station was designed to determine how much genetic response can be obtained from selections based solely on weaning weight or yearling weight performance. Of particular interest is the genetic relationship between pre- and post- weaning growth rate. The magnitude of this genetic relationship will determine the extent to which breeding stock can be selected at weaning time that are genetically superior for total growth rate. Table 1 presents the design of this experiment.

This is a long term experiment and it will be several years before conclusions can be reached concerning its primary objectives. However, the data being collected in this project have been analyzed to provide answers to other questions confronting the beef industry.

Table 1. Design of Beef Cattle Selection Experiment

	Line Number					
	5	6	7	8	9	10
Breed: H=Hereford, A=Angus	H	H	A	A	A	AH
Number of Cows per Line	50	50	50	50	50	50
Selection Procedure:						
Traits: Wt. at specified age (days)	205	365	205	365	R ¹ M	205
Criteria: I=Individual, P=Progeny	I	I	I	I	C	I/P
Number males selected per year	2	2	2	2	2	5/2 ²
Number males selected per year	2	2	2	2	2	2
Number years selected males used	2	2	2	2	2	2
Number females selected per year	10	10	10	10	10	10

¹ Random mating control line. The purpose of this line is to maintain genetic stability so that comparisons between it and the selection lines within a particular year provide a measure of genetic progress achieved in the selection lines.

² Five sires initially selected for progeny testing on the basis of their weaning weight performance. The top 2 bulls are selected for use in the line based on progeny weaning weight.

Publications

The following articles have been published from this project during the past year:

- Cardellino, Ricardo. 1970. A comparison of different age of dam correction factors for weaning weight in beef cattle. M.S. Thesis, Oklahoma State University.
- Cardellino, Ricardo and R. R. Frahm. 1970. Age of dam adjustments for weaning weights of beef cattle. *J. Anim. Sci.* 31:161 (Abstract).
- Deutscher, G. H. 1970. Productivity of Angus-Holstein crossbreds versus Angus heifers under tall grass range conditions. M.S. Thesis, Oklahoma State University.
- Frahm, R. R. 1970. Can you select herd bulls at weaning time? Proceedings of the Ft. Reno Livestock Research Station Field Day, Oct. 22, 1970.
- Frey, John. 1971. Evaluation of cow type classification score and its relationship to cow productivity. M.S. Thesis, Oklahoma State University.
- Tanner, J. E., R. R. Frahm, R. L. Willham and J. V. Whiteman. 1970. Sire x sex interactions and sex differences in growth and carcass traits of Angus bulls, steers and heifers *J. Anim. Sci.* 31:1058.
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Beef Feedlot and Nutrition

Effect of Previous Plane of Nutrition Upon Efficiency of Energy Utilization by Beef Steers

J. E. McCroskey, H. A. Deramus, Jr., R. R. Johnson and D. G. Wagner

Three lots of four Hereford steers each were started on feed in the summer of 1970 to study the effect of level of energy consumption and previous plane of nutrition upon efficiency of energy utilization by beef steers. Efficiency of feed and energy utilization are being determined from feedlot performance, respiration calorimetry, and the slaughter technique.

All lots of steers were individually hand-fed a high-grain finishing ration. One group of steers (lot 1) was fed at maximum feed intake from the start of the study to approximately 1000 lb. A second group (lot 2)

was fed to gain one pound per head daily until lot 1 reached slaughter weight, then put on full feed. The third group (lot 3) was fed at a maintenance level until lot 1 reached slaughter weight, then put on full feed.

Total energy balance was determined at the beginning, at intervals during the feeding period and will be determined just prior to slaughter, using respiration calorimetry and carbon-nitrogen balance. Carcass energy gain will also be determined using the slaughter technique.

The first two lots of steers have been slaughtered and the third group will complete the study about May 1, 1971. This study should show the relative efficiency of feed and energy utilization of beef cattle fed to slaughter weight under three widely different feeding regimes, and should answer some of the questions relating to compensatory gain. Results of the study will be presented in the 1972 report.

Effect of Melengestrol Acetate (MGA)¹ Upon Energetic Efficiency of Feedlot Heifers

J. E. McCroskey and H. E. Kiesling

Three sets of identical twin beef heifers were used in a feeding study to determine the effect of Melengestrol Acetate (MGA) upon energy gains and losses as determined by respiration calorimetry and carbon-nitrogen balance. The heifers were individually fed a high grain ration with both members of a pair fed the same amount of feed. One member of each pair also received 0.5 mg. of MGA daily. Fasting heat production and total energy balance were determined twice during the study.

Results of the study indicate that MGA-fed heifers were less efficient in energy utilization in both balance studies as reflected by lower values for digestible energy, metabolizable energy, and net energy. Energy stored as protein and fat was also lower for MGA-fed heifers. There was an indication of a slight decrease in energy required for maintenance due to MGA feeding as determined by the changes in fasting heat production from the beginning to the end of the study. Thus, the results suggest that when feed intake is limited, efficiency of energy utilization by feedlot heifers is not improved by feeding this level of MGA.

¹Melengestrol Acetate (MGA) provided courtesy of the Upjohn Company, Kalamazoo, Michigan

Publications

Kiesling, H. E. and J. E. McCroskey. 1971. Energetic efficiency of heifers fed MGA. Southern Section of American Society of Animal Science (Abstract).

Rumen Fermentation Rates In Steers Fed High Concentrate Rations

R. R. Johnson

Much work has been done in the past and more is presently being conducted on the utilization of various processed grains in high concentrate rations for beef cattle. It is now well known that the performance of beef cattle, especially feed efficiency, can be improved by the substitution of certain processed grains for dry rolled or ground grains.

In addition, there are basic differences between the cereal grains themselves in their ability to support performance of finishing beef cattle. Explanations for these differences in performance have not been found, however. During the past year, a new project was initiated to study the rates of synthesis of the volatile fatty acids from various processed grains in the rumens of beef cattle. Although it is well recognized that practically all carbohydrates that are fermented in the rumen are converted to volatile fatty acids which are eventually utilized by the host animal as an energy source, the rate of synthesis of these volatile fatty acids and the ratios of the three major acids, acetic, propionic and butyric acids, can be highly variable.

These variations are presumably associated with performance of the animal. The effects of grain processing and other ration modifications in high concentrate rations on these rates of synthesis have not been studied. During the past year, two preliminary experiments were conducted in which whole shelled corn was compared to ground corn and reconstituted milo was compared to dry rolled milo as the major feed ingredients in high concentrate rations for fistulated beef steers. The levels of lactic acid, volatile fatty acids and pH in the rumens of these animals were measured at various times after feeding. In addition, microscopic examination of the bacteria and protozoa were made. Analytical measurements on these samples have not been completed as yet. Presently an automatic feeding device which will allow more accurate measurement of the rate of synthesis in the rumen is being built and tested.

Utilization Of Waste Products In Animal Feeds

Ronald R. Johnson

A new research area which has received more emphases than any other research area in the last year or two is the utilization of waste products from agricultural as well as other industries for some productive purpose. Since many of these waste products are cellulosic in nature, it has logically been suggested that ruminant animal feeds might be the best area in which to utilize them. The ruminant has the natural capacity for digesting many materials such as the fibrous portions of plant tissues and miscellaneous forms of nitrogen which most other animals do not possess. Because of the importance of this type research, the overall area of improving the quality of our environment and the solution to pollution problems, a project is being initiated to study the utilization of waste materials in animal rations.

Basically, this project is designed to cover the study of the utilization of practically any type of waste or by-product that conceivably has a potential as a animal feed ingredient. The initial emphasis will be placed, however, on the utilization of high cellulose type materials in ruminant rations. A tremendous number of cellulose materials are at present accumulated as waste materials causing disposal problems as well as posing potential losses to the industries associated with them. Among these might be listed waste paper, municipal rubbish, residues from the wood-pulping and forest industries, rice hulls, sugar cane bagasse and other similar products of agricultural and industrial enterprises.

Virtually all of these materials contain high proportions of cellulose or fibrous type components, but in addition, almost all of them are highly lignified and, as a consequence, have a very low digestibility, in some cases approaching zero. Thus, it is quite likely that in order for any of these to be utilized as animal feeds, a certain amount of chemical processing will be required to release the usable forms of carbohydrates and other nutrients.

There are numerous chemical treatments which have already been developed which are capable of performing this process but which have not necessarily proven to be economically feasible. It is quite likely that these materials will find a role in the nutrition of animals existing on a maintenance type ration, such as a wintering cow, rather than on the rations that are commonly found in feedlot situations. During the coming year, a number of these products will be examined in laboratory tests and in limited number of animal tests to determine their possible contribution towards the nutritive requirement of ruminants.

Relationship Between Laboratory Characteristics And Intake Of Bermudagrass By Grazing Steers

J. E. McCroskey and D. E. Hopson

Five grazing studies were conducted during the summer of 1969 using eight yearling Hereford steers to determine the consumption of Midland Bermudagrass pasture and to relate intake to certain laboratory characteristics. Forage consumption was determined using an external indicator (polyethylene glycol) to calculate fecal dry matter output, and the lignin ratio to determine dry matter digestibility. Hand clipped and esophageal forage samples were analyzed chemically for crude protein, acid detergent fiber, acid detergent lignin, and cell-wall constituents. *In vitro* dry matter disappearance was also determined on all forage samples.

Average forage dry matter consumption for the five periods from May to October were 13.4, 13.2, 9.5, 23.5, and 30.6 lb., respectively. The high intake during the last two periods reflects an unusually abundant amount of forage due to heavy rainfall late in the summer. Intake normally would continue to decline throughout the growing season. Statistical analysis of the data showed that voluntary intake was highly correlated with the acid detergent lignin content of the forage samples collected by esophageal fistulated steers ($-.93$). *In vitro* dry matter disappearance, which is an estimate of forage digestibility, was highly correlated with the acid detergent fiber and cell-wall constituents on hand clipped forage samples ($-.97$ and $-.95$, respectively). Results of the study indicate that the acid detergent lignin content of forage samples obtained by esophageal fistulated animals can be used as a predictor of forage intake. Furthermore, increasing fiber and cell-wall constituents have a highly depressing effect upon forage digestibility.

Publications

Hopson, D. E. 1971. The determination of intake and digestibility of harvested and grazed forage by the use of indicators. M.S. Thesis. Oklahoma State University.

Indirect Determination Of Forage Intake Using Indicators

J. E. McCroskey and D. E. Hopson

Determination of forage intake by grazing animals requires (1) a measure of fecal output and (2) an estimate of forage digestibility. This study was conducted to compare different levels and methods of administration of an external indicator for measuring fecal output, and to compare the accuracy of two methods of estimating digestibility.

Four digestion trials were conducted using yearling Hereford steers to compare the accuracy of polyethylene glycol (PEG) given at levels of 50, 100, 150, and 200 gm. per day administered either in single (8:00 a.m.) or split doses (8 a.m. and 4:30 p.m.) to calculate fecal output. *In vitro* dry matter disappearance and the lignin-ratio were compared as estimates of forage digestibility. All steers were fed bermudagrass hay, and feed intake, fecal output, and digestibility were determined directly.

Results of the study revealed that PEG given in split doses gave more accurate estimates of measured fecal output than when given in a single dose. Of the four levels of PEG compared, 150 gm. given in split doses gave the greatest accuracy, however 50 and 100 gm. given in split doses gave fecal output calculations almost as accurate as the 150 gm. level. The 200 gm. level was the least accurate because of low percent recovery.

There was no significant difference between forage digestibility determined by the conventional digestion method and by the *in vitro* technique; however, digestion coefficients determined by the lignin-ratio method were significantly lower ($P < .05$) than those determined by conventional digestion trial. Comparison of actual intake with values calculated using PEG, lignin-ratio, and *in vitro* methods indicates the greatest accuracy was obtained with 150 gm. of PEG given in split doses, and using the *in vitro* procedure to estimate digestibility. In view of the small and non-significant differences in accuracy of fecal output determination between the 50 and 150 gm. levels of PEG, the lower level given in split doses would be more practical and would give essentially the same accuracy in estimating forage intake.

Publications

Hopson, D. E. 1971. The determination of intake and digestibility of harvested and grazed forage by the use of indicators. M.S. Thesis. Oklahoma State University.

Hopson, D. E. and J. E. McCroskey. 1971. Polyethylene glycol as an external indicator. Southern Section American Society of Animal Science (abstract).

Meat and Carcass Evaluation

Influence Of Level Of Potassium Intake on Net K^{40} Count In Beef Steers

Rodger Johnson, L. E. Walters and J. V. Whiteman

Thirty-six Angus-Hereford crossbred steers were used to study the influence of 3 levels of dietary potassium on net K^{40} count, blood serum potassium levels and muscle tissue potassium concentration. The 3 diets (approximately 50 percent roughage-50 percent concentrate) were alfalfa-corn, wheat straw-corn and a diet consisting of 1.7 lbs. KCL added to each 100 pounds of the wheat straw-corn ration. Potassium levels of the 3 diets were 1.31, 0.29 and 1.03 percent, respectively. The steers were allotted into 3 groups and each group placed on one of the above diets for a two-week feeding period. Appropriate K^{40} counts and tissue samples were taken at the end of each feeding period. At the end of the two week feeding period, steers were placed on a different ration so that at the end of 3 two-week periods, each steer had received each ration. K^{40} data were collected on steers unshrunk and after 24 hours shrink. The experiment was balanced so that carry-over effects of each ration from one period to the next could be evaluated.

Statistical analysis of the data indicate that carry-over effects appeared negligible for all treatments. Steers fed the alfalfa diet had the highest net K^{40} count and steers on wheat straw the lowest. This difference was considerably larger when determined on unshrunk steers than after the same steers were shrunk for 24 hours (without feed and water).

Preliminary analysis of the data indicate that the difference after 24 hours shrink is large enough to suggest that the diet cattle are receiving prior to K^{40} counting may influence the accuracy of K^{40} estimates of lean in cattle. Dietary potassium levels appeared not to influence blood serum potassium levels or muscle tissue potassium levels. However consistent differences between animals were evident in blood serum and muscle tissue potassium concentrations.

These data indicate that if estimates of lean in cattle are to be made from K^{40} net count, the same ration should be fed to all animals for a period of time prior to counting. Thus it appears that the K^{40} counter is the best adapted to comparison of similar weight animals that have been fed and managed alike for a period of time prior to K^{40} evaluation.

These data are undergoing further analysis and a more complete report will be available at a later date.

Net K⁴⁰ Count As A Predictor Of Fat-Free-Lean In Cattle And Swine

Lowell E. Walters

Recently, certain support instrumentation has been added to the equipment at the Live Animal Evaluation Center which is needed in the calibration and maintenance of the K⁴⁰ counter. Through the incorporation of these facilities into the evaluation program, improvement may be achieved in the capability of the counter to predict pounds of fat-free-lean in both cattle and swine. The following described studies incorporating these facilities are in progress.

Cattle

Thirty-six 900-1000 pound Choice quality slaughter steers were counted in the whole-body counter at the Live Animal Evaluation Center in the fall of 1970 for the purpose of re-evaluating K⁴⁰ net count as a predictor of total muscle in beef steers. The steers were allotted to six groups and were processed through the Evaluation Center and the O.S.U. Meat Laboratory during six successive weeks. The steers were thoroughly washed and shrunk for 24 hours prior to counting. Five 2 minute counts were taken for each steer.

Following slaughter, the right half of each carcass was separated into lean, fat and bone. The separable lean was sampled for chemical analysis which is currently in the final stages of completion. Ether extract content of the separable lean will be used in order to determine the total quantity of fat-free-lean for each animal. Statistical analysis of the data will be completed to ascertain the relationship between net K⁴⁰ count and pounds of total fat-free-lean.

Hogs

Earlier research designed to monitor muscle development in growing and finishing swine using the large cattle K⁴⁰ counting equipment pointed to the need for a different detector arrangement, especially for 100-200 pound pigs. It appeared from this work that for greater counting efficiency, the detector logs needed to be much closer to the pigs than was possible in the larger cattle arrangement; therefore, six detectors were remounted in a smaller configuration and an experiment conducted to determine the improvement, if any, with "lean cuts" in the carcasses from counted animals as the end-point. Since this study showed promise of improvement in counter efficiency using the new detector design, 23 Hampshire, 21 Duroc and 21 Yorkshire market barrows weighing 215 pounds were counted in the fall of 1970 to further study counting efficiency.

In this work the animals were thoroughly washed and shrunk 24 hours prior to counting. After slaughter, the warm carcasses were mounted in a standing position and returned to the counter for carcass counting efficiency studies. The carcasses were chilled, split and the right half separated into lean, fat and bone. The separable lean was sampled for chemical analysis which is nearly completed at this writing. Fat-free lean determination will be made from ether extract analysis of the ground lean samples from each carcass and all the data treated statistically.

Estimation Of Fat Thickness And Loin Eye Area By Ultrasound

Lowell Walters and Michael May

During recent years, several probing techniques have been studied in efforts to learn more about the composition of meat animals without resorting to slaughter and chemical analysis of the animals. Among these techniques is that of ultrasound, of interest primarily because of its promise in providing some information relative to thickness of subcutaneous fat and the size (shape) of muscles such as the loin eye in the animal alive. These two estimates of composition have been shown to be of some value as predictors of composition.

Ultrasonics refers to sound waves or vibrations at a frequency above the audible range of the human ear. This ultrasonic energy is mechanical vibration that can be focused in a narrow beam which may be transmitted and reflected in much the same way as a beam of light. The technique is useful in animal appraisal because of the differential rate of transmission of the sound in tissues that differ in density such as fat and lean. Thus, when a beam of these sound waves passes from fat into lean, an "echo" is established in the calibrated instrument from which a fat depth and a muscle size and shape can be estimated.

The Scanogram is an instrument under study in this research which makes use of this principle, coupled with a Polaroid film pack and a mechanically synchronized drive which makes possible a plot of "echos" representing fat layers and muscle systems on the Polaroid film.

Results from studies with slaughter cattle and hogs indicate that the Scanogram can estimate fat thickness in both species with greater accuracy than loin eye area. With cattle, the results have been somewhat variable depending upon the function of the electronics in the instrument. Aver-

age errors for fat thickness and rib eye area at the 12th rib location on one group of ninety-eight 1000 lb. steers were found to be 0.17 inches and 0.59 square inches, respectively. The average errors for a group of thirty-six 1000 pound slaughter steers were 0.11 inches and 0.74 square inches for fat thickness and rib eye area, respectively. A second group of 36 slaughter steers was evaluated at a time in which the machine was less stable and in this case, rib eye areas were missed on the average by 1.28 square inches and fat thickness by 0.17 inches.

In the studies with 200-225 pound slaughter barrows and gilts the results have also been quite variable. In one group of 16 market barrows, the average error for loin eye area estimates was 0.63 square inches and for backfat thickness, .096 inches. With another group of 67 market weight hogs the average errors for fat and loin eye area were found to be 0.10 inches and 0.84 square inches, respectively. The correlation between estimated fat thickness and percent lean cuts of live weight was -0.65. In the fall of 1970, a group of 43 market hogs were evaluated by the Scano-gram in a somewhat different fashion to include an estimate of fat thickness made on the midline of the back from the thirteenth rib to a point eight inches posterior. In this work the correlation between actual "linear fat" and the estimated was found to be +0.78. However, correlations between the linear fat estimate with lean cut yield and estimated average backfat thickness with lean cut yield were found to be almost identical (-0.59 and -0.58).

Mouse Selection Studies As An Aid To Animal Breeding Research

R. R. Frahm, I. T. Omtvedt and C. R. McLellan, Jr.

The economic importance of growth rate is well recognized by all segments of the livestock industry. It is most desirable from the standpoint of efficiency to select breeding stock with superior genetic capability for rapid growth at the earliest age possible. Determination of the optimal age at which selections can be made effectively requires a basic understanding of the genetic relationships that exist among growth rate at different stages of the growth curve. Experiments are underway with the livestock species to provide information on this very fundamental question, however, it will be several years before adequate answers will be available. This type of research requires large numbers of experimental

animals to obtain good measurement of these genetic relationships coupled with the fact that it is a slow process because of the long generation intervals involved with the livestock species.

Mice are well suited for genetic studies to explore basic genetic relationships and provide an indication of what can be expected with the livestock species. Large numbers of mice can be economically maintained in a relatively small amount of space under well controlled environmental conditions. Since 4 generations are produced each year, results are obtained considerably faster with mice than with the livestock species.

Project 1405 was initiated to measure direct and correlated response to selection for preweaning and postweaning rate of gain in mice for the purpose of determining the basic genetic relationships between growth rate at these two intervals in the life cycle. This project consists of 6 selection lines of 20 litters each (3 lines selected on basis of individual weaning weight and 3 lines selected on the basis of weight gain from 3-6 weeks of age) and a random mating control line of 40 litters that is used for measuring genetic changes that occur in the selection lines.

After 2 generations of selection, the average 3-week weight of the 3 lines selected on the basis of weaning weight was 0.76 gram (7.5 percent heavier than the control lines and the average daily gain from 3-6 weeks of age for the 3 lines selected for postweaning growth rate was 0.072 gram/day (11.0 percent greater than the control lines which indicates that direct selection for these two traits has been effective. Average daily gain from 3-6 weeks was essentially the same in the weaning weight selection lines as the control lines indicating little correlated response to date for postweaning gain. However, the average 3-week weight of the postweaning gain selection lines was 0.48 gram (4.7 percent) heavier than the control lines indicating that some correlated response for 3-week weight has apparently been realized.

In order to determine if the total weight of a particular muscle system can be altered by selection, a study involving two selection lines has been initiated. One line is being selected on the basis of the heaviest weight of the hindquarter muscle system and the other on the basis of the lightest muscle weight in the mature mouse (12 weeks of age). After 3 generations of selection, the heavy-muscle line had an average hindquarter muscle weight of 2.59 gram which was 14.1 percent heavier than the 2.27 gram average muscle weight of the light-muscle line. These results indicate that direct selection to alter the weight of a specific muscle system has been effective to date, however, more generations of data will be required to reach specific conclusions. Of particular interest in this study will be whether live weight of the mice change proportionally with the alteration in muscle weight or whether the altered muscle weight will reflect a change in the ratio of muscle weight to live weight.

Hot Boning Of Bovine Muscle

C. L. Kastner and R. L. Henrickson

Processing meat prior to chilling is of commercial interest; consequently, extensive research has been conducted on porcine muscle. Bovine muscle has received limited attention, thus a meaningful research project would consist of evaluating "hot boning" of the beef carcass.

Fabrication of the bovine carcass prior to chilling has several potential advantages. The economy of this process is reflected by the fact that waste fat (20-30 percent) and bone (15-18 percent) are removed prior to chilling thus conserving on cooler space and total refrigeration input. A boneless closely trimmed product, produced from "hot boning" could lend itself well to portion control and marketability.

The objective of this investigation is to evaluate the feasibility of "hot boning" of the U.S. Good grade beef carcass with respect to yield, juiciness, tenderness, flavor, and color.

Even though this current research project is not completed there are some indicated trends considering the test parameters. When "hot boning", yield does not appear to be significantly different from boning a cold carcass. Removing muscle from the skeleton while it is still hot appears to have no marked effect on the flavor or juiciness as evaluated by a taste panel, percent moisture, or the Carver Press. Fresh meat color is slightly darker for the hot boned muscle but this color is not undesirable. Color differences are difficult to detect unless a direct comparison is made with the cold boned muscle. To date all color results have been based on visual color panel evaluations.

In conjunction with the panel, a Photovolt Reflection Meter is used to objectively measure hue, value, and chroma so that the authors will substantiate the visual color appraisal. Tenderness appears to be the primary problem when muscles are removed from the hot carcass. This would be expected because hot excised muscle can freely contract during rigor mortis. Muscles left on the skeleton until rigor is complete, do not extensively contract due to their muscle and/or bone attachments. Therefore the cold boned muscles are more tender as evaluated by a tenderness panel and the Warner-Bratzler shear apparatus.

With minor modifications in the existing process, the authors feel that the tenderness problem may be resolved.

The Effect Of Ethylene Diamine Tetraacetic Acid On Bovine Myosin Adenosine Triphosphatase

J. J. Guenther

Bovine myosin was isolated from the longissimus dorsi muscle of mature, choice-grade hereford steers. Myosin ATPase activity was determined at 0°C and expressed as micromoles inorganic phosphate released per milligram protein per minute.

Factors studied were Ethylene Diamine Tetraacetic Acid, E.D.T.A. level (0, .005, .01, .02, .04mM/ml), ionic strength of ATPase incubation system and the influence of Ca^{++} activation. Results showed that both E.D.T.A. and the ionic strength of the incubation system had a highly significant effect on myosin ATPase activity and that the effect of E.D.T.A. was strongly influenced by the ionic strength of the incubation system. E.D.T.A. functioned as an ATPase activator in the high ionic system, but as an inhibitor at low ionic strength.

In the high ionic strength system, with no added $CaCl_2$, maximum ATPase rate occurred at 0.01 mM concentration of E.D.T.A.; whereas in the presence of $CaCl_2$, maximum acceleration did not occur until the E.D.T.A. concentration exceeded that of $CaCl_2$. It was also noted that E.D.T.A., at a concentration equivalent to $CaCl_2$ (0.01 mM), had a greater activating effect on myosin ATPase than Ca^{++} . In the low ionic strength system, which contained $CaCl_2$, E.D.T.A. suppressed myosin ATPase activity. The addition of E.D.T.A. had little effect on myosin ATPase activity in the low ionic strength incubation system which did not contain $CaCl_2$. Partially supported by Market Quality Research Division, ARS, USDA, Cooperative Agreement 12-14-100-9348 (51).

Amino Acid Composition Of Bovine G-Actin

J. J. Guenther

Bovine G-actin was purified according to procedures previously reported. Amino acid analyses were carried out on a Beckman Model 120C automatic amino acid analyzer according to the standard methods of Stein and Moore. G-actin samples (4.8305 mg/ml) were acid hydrolyzed at 110°C for 12, 24 and 72 hours in sealed, evacuated tubes.

The values for threonine, serine and half-cystine were determined by extrapolation of the data to zero time of hydrolysis, since these amino acids were partially destroyed when exposed to prolonged acid hydrolysis. The value for ammonia was calculated by subtracting losses in serine, threonine and half-cystine after 24 hours hydrolysis, from the observed ammonia value at 24 hours.

The data from the amino acid analyses are shown in Tables 1, 2, and 3. After 12, 24 and 72 hours acid hydrolysis amino acid recovery was 96.35, 97.44 and 89.92 percent, respectively. A significant difference existed between recoveries at the 12 and 72 hour period.

At the 24 hour period, 57 glutamic acid and 44 aspartic acid residues were obtained (Table 2). This indicates that the isoelectric point of bovine G-actin is on the acidic side. Methionine had the smallest number of residues, 7 per molecule. Bovine G-actin also contained considerable quantities of neutral amino acids such as alanine (38 residues/mole), glycine (36 residues/mole) and leucine (34 residues/mole). These values agree with G-actin from rabbit muscle. However, rabbit G-actin has a much greater amount of sulfur-containing amino acids. For example, rabbit G-actin contains 20 methionine residues per mole, whereas bovine G-actin contains only 7.

The minimal molecular weight of bovine G-actin can be calculated

Table I. Amino Acid Recoveries After Acid Hydrolysis

Amino Acid	mg/4.8305 mg G-action		
	12 hr hydrolysis	24 hr hydrolysis	72 hr hydrolysis
Lysine	0.22141	0.24601	0.23898
Histidine	0.10550	0.13188	0.12412
Ammonia	0.80743	0.08045	0.06889
Arginine	0.26828	0.28396	0.27176
Aspartic Acid	0.46718	0.47117	0.44508
Threonine	0.31442	0.30132	0.26392
Serine	0.21858	0.20282	0.15385
Glutamic Acid	0.63707	0.67091	0.59205
Proline	0.20953	0.20147	0.09249
Glycine	0.22070	0.21770	0.21019
Alanine	0.28508	0.27439	0.26156
Half-cystine	0.10572	0.08169	0.06343
Valine	0.20852	0.23312	0.23804
Methionine	0.09549	0.08206	0.07281
Isoleucine	0.29250	0.30562	0.31375
Leucine	0.35022	0.36858	0.34419
Tyrosine	0.27359	0.27359	0.22032
Phenylalanine	0.18666	0.20153	0.18104
Unknown	0.10624	0.07864	0.08720
	4.65412	4.70691	4.34367
Recovery %	96.35%	97.44%	89.92%

Table 2. Numbers of Amino Acid Residues per Molecular Weight=60,000 G-Actin

Amino Acid	12 hr hydrolysis	24 hr hydrolysis	72 hr hydrolysis
Lysine	23.4758	26.0842	25.3389
Histidine	8.4463	10.5579	9.9368
Ammonia	63.8443	58.7516	50.3053
Arginine	19.1284	20.2463	19.3768
Aspartic Acid	43.5979	43.9706	41.5360
Threonine	32.7916	31.4253	27.5251
Serine	25.8358	23.9726	18.1844
Glutamic Acid	53.7832	56.6400	49.9824
Proline	22.6063	21.7368	20.7680
Glycine	36.5179	36.0211	35.7790
Alanine	39.7474	38.2569	36.4682
Half-cystine	5.4652	4.2231	3.2791
Valine	22.1095	24.7179	25.2396
Methionine	7.9494	6.8315	6.0614
Isoleucine	27.6989	28.9411	29.7112
Leucine	33.1642	34.9032	32.5928
Tyrosine	18.7558	18.7558	15.1040
Phenylalanine	14.0358	15.1537	13.6134
Unknown	9.5642	7.0800	7.8501

Table 3. Amino Acid Composition of Bovine G-Actin

Amino Acid	Residues ¹ per molecule ²	gm per molecule ²	Residue % (moles)	Weight % (gm)
Lysine	26.0842	3055.7640	5.13	5.12
Histidine	10.5579	1638.1637	2.08	2.75
Ammonia	49.8034 ³	847.2408	9.80	1.42
Arginine	20.2463	3527.1079	3.98	5.92
Aspartic Acid	43.9706	5852.4868	8.65	9.82
Threonine	34.1579 ⁴	4068.2058	6.72	6.82
Serine	27.6990 ⁴	2910.3879	5.45	4.88
Glutamic Acid	56.6400	8333.4432	11.14	13.93
Proline	21.7368	2502.5577	4.28	4.20
Glycine	36.0211	2704.1039	7.09	4.53
Alanine	38.2569	3508.3072	7.53	5.72
Half-cystine	6.7073 ⁴	1611.6971	1.32	2.70
Valine	24.7179	2895.7019	4.86	4.86
Methionine	6.8315	1019.3281	1.34	1.71
Isoleucine	28.9411	3796.2040	5.69	6.37
Leucine	34.0932	4573.2527	6.87	7.68
Tyrosine	18.7558	3398.3634	3.69	5.70
Phenylalanine	15.1537	2503.2397	2.98	4.20
Unknown	7.0800	976.8984	1.39	1.64
	508.2696	59627.4541		

¹ Values taken at 24 hours hydrolysis.

² Assumes M. Wt. of 60,000.

³ The value for ammonia was obtained by subtracting losses in serine, threonine, and half-cystine after 24 hours hydrolysis, from the ammonia value at 24 hours.

⁴ Extrapolated value.

from its amino acid composition. Assuming one mole of methionine per mole of protein, a value of 8,782.7 is attained. If 7 methionine residues were present per molecule of G-actin, the molecular weight would be about 61,479. If molecular weight is computed in terms of tyrosine residues, the result is about 60,781. Partially supported by Market Quality Research Division, ARS, USDA, Cooperative Agreement 12-14-100-9348 (51).

Swine

Selection For Crossing Ability In Swine

I. T. Omtvedt

The basic objective of Project 808 is to study the feasibility of selecting purebreds on the basis of their ability to cross. Sow productivity traits generally exhibit considerable hybrid vigor in crossbreeding studies, but unfortunately, these traits are lowly heritable and show very little response to direct selection. The hybrid vigor obtained in crossbreeding is "one-shot improvement" and breeders cannot expect to obtain increased performance due to additional heterotic response each generation. In this project an effort is made to make continued improvement in two-breed crossbred gilts by selecting the two parent lines on the basis of their crossing ability. The basic procedure is to select the Duroc and Beltsville boars and gilts for breeding on the basis of their Duroc-Beltsville crossbred half-sisters' productivity (litter size and 21-day weight).

The project is currently in the sixth generation of selection. Productivity of the crossbreds has been very desirable but continual improvement in the crossbreds over the controls each generation is not readily apparent at this time. This procedure is widely used in plant breeding and research with laboratory organisms indicated that it may have application in swine breeding, but results to date are not very encouraging. This project will be phased out at the end of sixth generation.

The project is currently in the sixth and final generation of selection. The productivity of the Duroc-Beltsville No. 1 crossbred gilts compared to the productivity of the control line gilts will be used to evaluate the effectiveness of selection for crossing ability. An analysis of the control line data from 1961 to 1970 showed that performance and productivity

for this line remained relatively stable during the course of this experiment so should be a valid basis for comparing possible improvement in the selected lines. Preliminary analyses of the records do not reveal any steady divergence in productivity of the 2-line cross from the control live gilts. In the sixth generation, the selected line farrowed larger litters (10.5 vs. 10.1) of heavier pigs (2.6 lb. vs. 2.2 lb.) but the differences in litter size at 21 days were relatively small (8.8 vs. 8.7). The average pig 21-day weight was 11.6 lbs. for the crossbreds compared to 10.5 lbs. for the controls.

Publications

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-

Genetic Evaluation Of Purebred And Crossbred Performance Of Duroc, Hampshire And Yorkshire Swine

I. T. Omtvedt

The fact that approximately 90 percent of the pigs marketed in the U.S. today are estimated to be of crossbred origin indicates that swine producers recognize the benefits of crossing. The two basic reasons for crossing are:

1. To obtain hybrid vigor or heterosis.
2. To combine the strong points of the different breeds.

Much of the crossbreeding research with swine has been conducted at Oklahoma and the general response expected for most traits has been established. In general, crossbred sows farrow and raise larger litters than

the average for the breeds making up the cross. In addition to crossbred pigs being more rugged and having greater livability, they are heavier at weaning and gain faster during the postweaning period thus resulting in their reaching market weight at an earlier age. No consistent advantage of crossbreds over purebreds for either feed required per unit of gain or carcass merit has been demonstrated.

Even though the general results expected from crossings are known, data on specific crosses and crossing sequences that will yield maximum performance in a breeding program are not available. Most of the early investigations involved inbred lines and breeding stock typical of that time under management conditions quite different from those recommended today. Breed differences in productivity, growing ability and carcass merit are known to exist, but how to best combine the breeds to obtain maximum overall performance is not known. How important is maternal influence? In a 2-breed cross, does pig performance vary depending on which breed is used as the sire and which breed is used as the dam? In a 3-breed cross, which breed combinations make the best female and which combinations result in best overall performance? These are very important questions to a swine producer when he lays out his crossbreeding program.

In an effort to answer these questions and to re-evaluate the response expected from crossbreeding using modern-type breeding stocks, project 1444 was initiated to evaluate the combining ability of the Duroc, Hampshire and Yorkshire breeds in 2-breed and 3-breed crosses.

Three purebred herds were established at the Experimental Swine Farm at Stillwater to provide the seedstock for this project. In Phase I purebreds are compared to the 2-breed crosses while in Phase II the productivity of crossbred gilts and purebred gilts from Phase I are evaluated in 3-breed and 2-breed crosses. Phase II involves 135 matings and Phase III 144 matings during each 6 month period. One-third of gilts in each group will be slaughtered one month after breeding to determine ovulation rate and embryo survival. Sow productivity will be evaluated at birth, 21 days and 42 days. Postweaning growth rate, feed efficiency, probe back-fat thickness and carcass data will also be obtained.

Results not yet available. The first pigs for this project were produced at Stillwater between February 24 and April 20, 1970 and consisted of 21 Duroc litters, 25 Hamp litters and 25 York litters. From these litters, 45 gilts and 5 boars from each of the 3 breeds served as the seedstock for Phase II at Ft. Reno. In November, each of these 15 boars were mated to 3 gilts of their own breed and 3 gilts from each of the other 2 breeds. Fifteen gilts from each breed (one gilt from each mating type for each boar) are being sacrificed 25 days postbreeding to evaluate ovulation rate and early embryo survival. The other 30 gilts of each breed will be carried

full term to produce the seedstock for Phase III. In 1970 fall, 24 Duroc litters, 28 Hamp litters and 23 York litters were farrowed at Stillwater and pigs from these litters will be mated at Ft. Reno in 1971 spring to serve as the second replication of Phase II. New boars are continuously being introduced into the 3 foundation herds at Stillwater to maintain a broad genetic base for each breed.

The Effect Of Ration Ingredient Change On Pig Performance

W. G. Luce and C. V. Maxwell

One trial was conducted involving sixty-four growing-finishing swine to measure the effect of ration ingredient change.

Treatments involved were: (1) A basal milo-soybean meal ration fed throughout the trial; (2) The cereal grain portion of the rations (milo, corn and wheat) was rotated every 7 days; (3) The protein source (all soybean meal, $\frac{1}{3}$ meat and bone scraps and $\frac{2}{3}$ soybean meal, and $\frac{1}{3}$ peanut meal and $\frac{2}{3}$ soybean meal) were rotated every 7 days; (4) Both the cereal grain and protein sources, as outlined in treatments 2 and 3, were rotated every 7 days (9 different combinations). Average daily gains, average daily feed intake, and feed efficiency were similar for all treatments.

The data is presently being further analyzed. Another trial is also being planned at a later date.

The Effect Of Temperature And Humidity Upon The Performance Of Growing Swine

R. A. Battaglia

The first replicate of a study to determine the effects of adverse environmental conditions upon "doing ability" in growing swine has been completed.

Six gilts, averaging 40 pounds in weight were allotted, three each, to either a 90 degree F. group or to a 70 degree F. group. The relative humidity was held constant in the 45-50 percent range. The replicate lasted for 28 days, during which time the gilts were maintained in the environmental chambers on the Stillwater campus. Floor space allotment was 6.8 square feet per animal, with one half of each of the floor area being expanded-metal and plywood. Feed and water was available *ad libitum*. Rectal temperatures and respirations rates were taken at 6 a.m. and 6 p.m. daily.

Results for the cool (70 degree F) group and hot (90 degree F) group respectively are as follows: rectal temperature, 102.7 vs. 103.5; respiration rate, 27 per minute vs. 75 per minute; daily feed consumption, 3.5 pounds vs. 2.6 lb; average daily gain, 1.59 lb. vs. 1.16 lb.; total gain for 28 days, 44.7 lb. vs. 32.5 lb.; water consumption 3.5 qt. vs. 4.6 qt. All figures, where applicable, are group averages for 28 days.

It is the purpose of this study not only to demonstrate differences such as those listed above but also to elucidate what physiological phenomena are responsible for these differences. With this in mind, histological preparations are being made of the appropriate endocrine glands from one gilt taken from each group at the completion of the study.

Nutrient Requirements For Artificially Reared Young Pigs

C. V. Maxwell, James A. Coalson and J. C. Hillier

Ninety-one baby pigs, obtained by caesarean section on the 113th day of gestation, were used to perfect artificial rearing techniques in a total of five trials. Each pig was placed in a sterile cardboard incubator equipped with a metal feeding tray and was provided with a constant supply of heated, sterilized air. Pigs were fed five times daily beginning at 6:00 a.m. and terminating at 10:00 p.m.

The diet was 21 percent milk solids fortified with minerals and vitamins. Feeding was accomplished with the use of a 50 cc plastic syringe equipped with a 12 gauge needle. The needle was inserted through a rubber stopper to place the diet in the metal feeding tray. The initial amount of feed was 30 milliliters. This was increased by 5 ml. at each successive feeding provided the diet had been consumed within 30 min-

utes. Percent survival ranged from 83 to 100 percent for the different trials with an average survival rate of 90 percent.

Total gains for the 21 day period ranged from 8.72 pounds to 10.83 pounds with an overall average gain of 9.21 pounds. Efficiency of gain as measured by pounds of dry matter intake per pound of gain ranged from 0.76 to 1.15 for the five trials. The gains obtained with this artificial rearing system were comparable to those obtained under normal rearing conditions.

In a separate study, the sows used in the above surgical procedures were rebred after 2 estrus cycles following surgery and allowed to go to term. The six Yorkshire and six Hampshire sows farrowed an average of 8.5 and 9.5 live pigs, respectively. Five stillborn pigs occurred in two of the Yorkshire litters. For this same time period, 23 Yorkshire and Hampshire sows in the University herd farrowed litter averages of 9.9 and 9.3 live pigs, respectively. Caesarean section surgery had no apparent effect on the rebreeding and subsequent litter size of the 12 sows used in this study.

Publications

The following articles were published from this project during the past year:

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- Maxwell, C. V. 1970. Calcium requirements for young pigs. *Proceedings of the 12th Annual State Swine Short Course, Stillwater, Oklahoma.* Page 28.
- Coalson, J. A., I. L. Anderson, C. V. Maxwell and J. C. Hillier. 1971. Effect of Caesarean surgery on sow performance. *J. Animal Sci.* 32:375. (Abstract)
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The Effect Of Protein And Amino Acid Nutrition On The Reproductive Performance Of Sows And Gilts

C. V. Maxwell

A total of 30 Yorkshire gilts were fed diets containing 8, 14 or 20 percent crude protein from 135 days of age until they were slaughtered at 28 days post coitum. These diets were fed at the rate of 5 pounds per head per day from 135 to 180 days of age and 4 pounds per gilt per day after 180 days of age. Constant amino acid ratios were maintained by diluting the 20 percent protein diet with cornstarch.

A higher weight gain was noted for each increase in level of crude protein. Gilts fed the high and low levels of protein showed increased age at puberty. No differences were noted in the number of corpora lutea present at 28 days post coitum. There was, however, a decrease in the number of embryo observed as the level of protein was decreased. Percent embryo survival decreased from 93.4 percent in pigs fed the high level of protein to 79.2 percent in pigs fed the low level of protein.

Publications:

- Maxwell, C. V. 1970. The effect of protein and amino acid nutrition on the reproductive performance of gilts. Proceedings of 12th Annual State Swine Short Course, Stillwater, Oklahoma. Page 16.
-

Effects of High Ambient Temperatures On Sow Reproductive Performance

I. T. Omtvedt, E. J. Turman and D. F. Stephens

Two trials involving a total of 126 gilts were conducted to investigate the effect of high ambient temperatures immediately following breeding, during second week postbreeding, during midpregnancy and during late pregnancy on the reproductive performance of first-litter gilts. Although exposure to heat stress during the first and second weeks postbreeding resulted in fewer viable embryos at 30-days postbreeding, exposure during the second week had the greatest adverse affect on embryo survival.

Productivity of gilts subjected to either the control chamber or hot chamber during midpregnancy was comparable to those maintained outside full term. Pronounced adverse effects of high ambient temperatures were noted during late pregnancy. Gilts subjected to the hot chamber in late pregnancy farrowed fewer live pigs and more stillborn pigs. There was a trend for pigs from heat-stressed gilts to be lighter at birth but these differences were not significant. Results indicate that high ambient temperatures have an adverse effect on sow productivity during early and late pregnancy with gilts being more resistant to this stress in midpregnancy.

Another trial involving 60 crossbred gilts was initiated to evaluate the influence of heat stress during estrus. The gilts were confined to the environmental chambers on the 15th day after being observed through at least two normal estrous cycles. The hot chamber was maintained at 96°F for 8 hours and reduced to 90°F for the remaining 16 hours during each 24 hour period with the control chamber maintained at 74°F continuously. Ten gilts maintained in each chamber were slaughtered between 53 to 69 hours after first service to evaluate fertilization rates and the other 20 gilts allotted to each chamber were slaughtered 25 days after breeding to evaluate early embryo survival.

The hot chamber gilts were transferred to the control chamber two days after breeding and maintained with the control chamber gilts until they were slaughtered 25 days postbreeding. Although the data are being analyzed at the present time, it appears that heat stress prior to and during estrus caused no sizeable adverse affects on either ovulation rate or embryo survival.

Publications:

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Dairy

Absorption Of Colostral Immunoglobulins By Newborn Calves

L. J. Bush and M. B. Mungle

An experiment designed to quantify the relationship between immunoglobulin (Ig) intake and level of passive immunity attained in calves during early life is nearing completion. To date, data has been obtained on 26 calves. Three separate batches of pooled colostrum having different concentrations of Ig are being fed at two levels to different calves. In addition to determination of total blood serum Ig, specific fractions of the Ig are to be measured.

Another phase of the same project involves an examination of factors affecting Ig level in colostrum. Serial samples of colostrum taken immediately after parturition are being used for this analysis.

Methods of Processing Grain for Lactating Dairy Cows

B. J. Steevens and L. J. Bush

The importance of processing sorghum grain to the extent of breaking the kernels by grinding or rolling has been well established; however, the most optimum particle size has not been clearly defined. Therefore, the first part of this experiment is concerned with grinding sorghum grain (milo) for lactating dairy cows. A 50:50 ratio of concentrate to hay was fed to 36 Holstein and Ayrshire cows with the concentrate portion consisting of 70 percent milo. The milo was ground to the various degrees of fineness as follows: (a) very fine, (b) fine and (c) medium.

The response criteria were total milk production and composition, rumen volatile fatty acids, body weight changes and apparent digestibility of the major components of the ration. All data except the starch digestibility of the ration have been collected and are currently being prepared for analysis with the aid of the computer. The grain ration was

of a fine consistency but all cows readily consumed their allotted portion. Milk production was maintained at a high level and the composition was normal for the respective breeds. Sample analysis will be completed shortly after which comparative results will be available.

A later portion of the experiment involves feeding lactating dairy cows micronized sorghum grain to see if this is an advantageous processing method with respect to milk yield and composition and ration digestibility.

The Effect of Rate of Freezing on Sperm Cell Characteristics

Mark Hodson, Steven Fancy and Milton Wells

Freezing sperm cells in liquid nitrogen (-320°F) is the usual method used to store and maintain cells for extended periods of time. This freezing process causes the death of a high percentage (30 percent-60 percent) of sperm cells. This loss is compensated for by starting with sufficient cells to assure adequate numbers for fertilization in the delivered ampule.

A study is underway to determine the effect of rate of freezing on sperm cell characteristics, particularly, the integrity of the acrosome. Approximately 45 ejaculates from six bulls are being subjected to rates of freezing varying from extremely slow, $.25\text{-}.50^{\circ}\text{C}$ per minute, to extremely fast, $15\text{-}20^{\circ}\text{C}$ per minute, with the control rate, $3\text{-}5^{\circ}\text{C}$ per minute, being that currently generally recommended as being the most desirable way to freeze bull sperm cells.

Preliminary results to date indicate that the rate of freezing can definitely affect the condition of the acrosome. The excessively slow rate and the excessively fast rate seem to be the most harmful to cells. This study will be completed this year and complete analyses of the data should reveal the most desirable way to freeze semen. The results should yield information on ways to decrease losses of cells in the freezing process and thereby increase the utilization of the sperm cell production capacity of our highly desirable bulls.

Yeast Cultivation

J. B. Mickle and N. S. Knight

As the world's population continues to grow, it's logical to expect additional pressures on the animal industry for waste disposal. At present, over 14 billion pounds of whey are produced in the United States each year. Less than 30 percent of this is used and the remaining 70 percent is dumped.

Processing whey directly into animal feeds is not entirely satisfactory since the high lactose content often upsets the animals' digestive system. However, this milk sugar (lactose) can be converted into suitable nutrients by yeast and in the process most of biological oxygen demand of the whey is used. Yeast can use a variety of carbon sources, thus it also can be grown on animal wastes. However, the experimental work with whey and sewage substrates is fragmentary and there is much left to be done before this process can have wide commercial acceptance.

Algae have been grown on sewage at a cost of $\frac{1}{2}$ cent a pound. Thus it would appear that there might be a market for yeast grown

Thus it would appear that there might be a market for yeast grown on animal wastes to be used as a protein feed supplement since the amino acid composition of certain yeasts fit the minimum requirements of a protein supplement for some animals.

The research at O.S.U. is aimed at finding yeast strains which will produce the amount of fat and protein necessary for an animal feed supplement and finding an efficient way of cultivating these. Presently, three yeast strains are being used as pure cultures. It is anticipated that other organisms will be tried in the future and an effort will be made to find groups of organisms which grow well together.

Acknowledgements

Many companies, organizations and individuals have contributed money, materials and/or services to aid animal sciences research, teaching or Extension programs as indicated below. These contributions were instrumental in furthering the various programs of the department and are gratefully acknowledged.

On campus, the cooperation of staff in the College of Veterinary Medicine and the departments of Biochemistry, Agronomy, Agricultural Economics, Agricultural Engineering and Entomology was important in the design and implementation of several projects.

Studies at the Ft. Reno Experiment Station were conducted in cooperation with USDA Agricultural Research Service, Animal Husbandry Research Division. The assistance and counsel of Superintendent Dwight Stephens and Assistant Superintendent, Bob Renbarger of the Ft. Reno Station is gratefully acknowledged. Several studies at Stillwater were part of regional research projects.

The following is a list of those who have contributed to programs of the Department of Animal Sciences and Industry during the *preceding year*.

American Breeders Service, DeForest, Wisconsin for a grant supporting dairy research.

American Cyanamid Co., Princeton, New Jersey for providing Aureomycin and Aureo S700 for cattle feeding research.

American Dairy Association for providing a grant for dairy research.

A.O. Smith, Harvestore Products, Inc., Arlington Heights, Illinois, for financial assistance and materials to support research.

Armour and Company, Food Research Division, Oakbrook, Illinois, for financial assistance on high temperature meat processing research.

Calcium Carbonate Company, Springfield, Missouri, and Quincey, Illinois, for supplying minerals for swine and beef cattle research.

Codding-NOBA Beef Stud, Foraker, Oklahoma, for providing frozen semen for use in beef cattle research.

Edwards Equipment Company, Ponca City, Oklahoma, for providing equipment and service for research purposes.

Elanco Products Company, Division of Eli Lilly Company, Indianapolis, Indiana, for drugs for experimental use.

Eli Lilly and Company, Greenfield Laboratores, Greenfield, Indiana, for providing hormones for multiple birth research.

Farmland Industries, Kansas City, Missouri, for providing a financial grant to support research assistantships and a grant for dairy research.

Food and Drug Administration, Department of Health, Education and Welfare for a grant supporting dairy research.

Garst and Inomas Hybrid Seed Company, Coon Rapids, Iowa, and Guymon, Oklahoma, for financial aid for cattle finishing experiments at Panhandle State College, Goodwell, Oklahoma.

Griffeth Laboratories, Chicago, Illinois, furnished cure and flavor ingredients for pork processing research.

Harris Packing Company, Oklahoma City, for cooperation in obtaining carcass data for research and extension programs.

Maurer-Neuer, Inc., Arkansas City, Kansas, for assistance in obtaining carcass data on experimental cattle.

Merck and Company, Rahway, New Jersey, for providing financial assistance and drugs to support studies on internal parasites in range cattle and lysine for swine nutrition research.

National Commission Company, Oklahoma City, Oklahoma, for assistance in procuring marketing experimental livestock.

National Molasses Company, Willow Grove, Pennsylvania, and Lyle Perry, Waukomis, Oklahoma, for supplying liquid protein supplement for range cow research.

Nipak, Inc., Pryor, Oklahoma, contributed materials and financial aid to studies on non-protein nitrogen utilization.

Oklahoma Feed Manufacturers Association provided assistance with the graduate research scholarship program.

Oklahoma Pork Commission, for a grant supporting swine research.

Ralph's Packing Company, Perkins, Oklahoma, for slaughtering experimental animals and obtaining carcass data.

Ross Machine and Tool Co., Oklahoma City for providing equipment and services for research purposes.

Schwab and Company, Oklahoma City, for assistance in obtaining swine carcass data for research and Extension programs.

Schwartz Meat Company, Norman, Oklahoma, for financial assistance on precooked meat and meat products research.

Syntex Laboratories, Inc., Palo Alto, California, for providing implants for field trials with beef cattle.

Union Carbide Corporation, Chicago, Illinois, furnished casings used in pork processing research.

USDA, ARS, Market Quality Research Division, for financial support for muscle protein research.

Weyerhaeuser Co., Dierks Division, Hot Springs, Arkansas, furnished a grant for nutrition research.

Wilson and Company, Oklahoma City, for financial assistance toward the operation of the Evaluation Center and assistance in obtaining carcass data on research animals.