UNITED STATES DEPARTMENT OF AGRICULTURE
Agricultural Research Service
Washington 25, D. C.

Information on Animal Husbandry Research

Animal Husbandry Research Division

The headquarters of the Animal Husbandry Research Division and one of the Division's major field stations are located at the Agricultural Research Center. Extensive research studies are under way there to develop new and improved methods of livestock production, including more efficient breeding, feeding, and management of beef, dual-purpose, and dairy cattle, poultry, sheep, goats, and swine, and processing and preserving their products. The Nation's rapidly growing population emphasizes the need for more intensive livestock production, while at the same time current economic conditions stress the need for greater efficiency in farm- and livestock-production practices. Improved methods of animal breeding, feeding, and management are necessary to meet many current and prospective needs for food and clothing, while at the same time livestock production is being made more remunerative to the livestock producer.

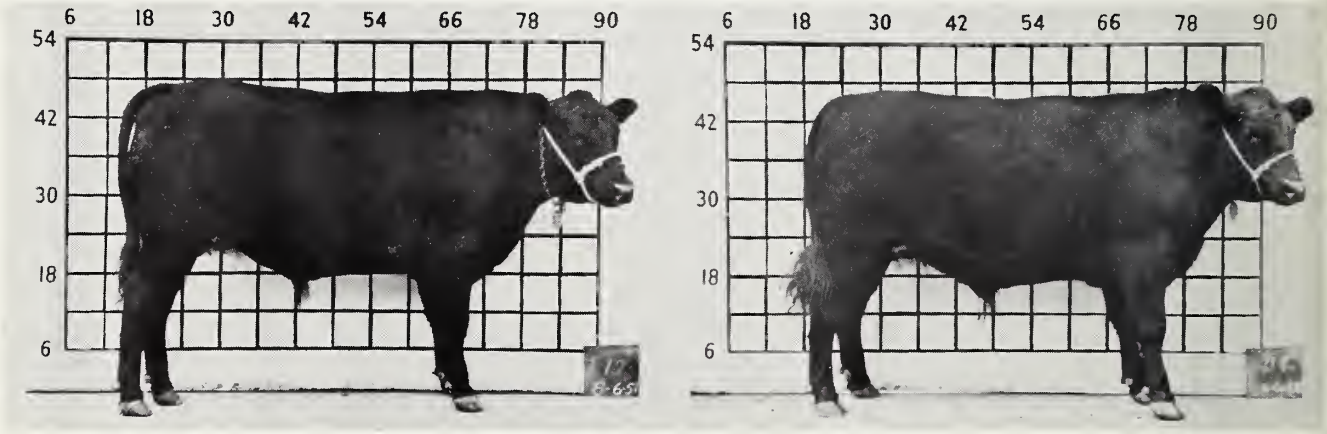
Beef Cattle Research Branch

This Branch carries on research in breeding, nutrition, physiology, and management of beef and dual-purpose cattle.

At the Center, the research studies emphasize beef cattle nutrition and physiology. Most of the Department's beef cattle breeding and management research is done at six federally owned field stations in Montana, Nebraska, Oklahoma, Louisiana, Virginia, and Florida and in cooperation with 35 State agricultural experiment stations. One State experiment station is cooperating on dual-purpose cattle breeding research.

Studies at the Center on ruminant bloat have provided much basic information on possible causes of both pasture and feed-lot bloat, but no reliable preventive measures are yet known. Legume bloat appears to be more complex than feed-lot bloat, as soil factors, plant constituents, and the ruminal microflora are probably involved in a sequence of biochemical events.

When animals were placed on a feed-lot type diet, slime-producing bacteria increased when the animals bloated. The slime produced by ruminal bacteria may alter the viscosity of the rumen fluid and thus cause an entrapment of the fermentation bases in a stable foam. The foam blocks the animal's normal belching mechanism and the animal becomes bloated. Other types of bacteria are probably involved. Recent studies on feed-lot bloat indicate that the incidence of bloat in steers is affected by the feeding schedule. Steers that received their daily ration in two feedings showed more bloat than those that have feed constantly available. Results from 1959 experiments indicate



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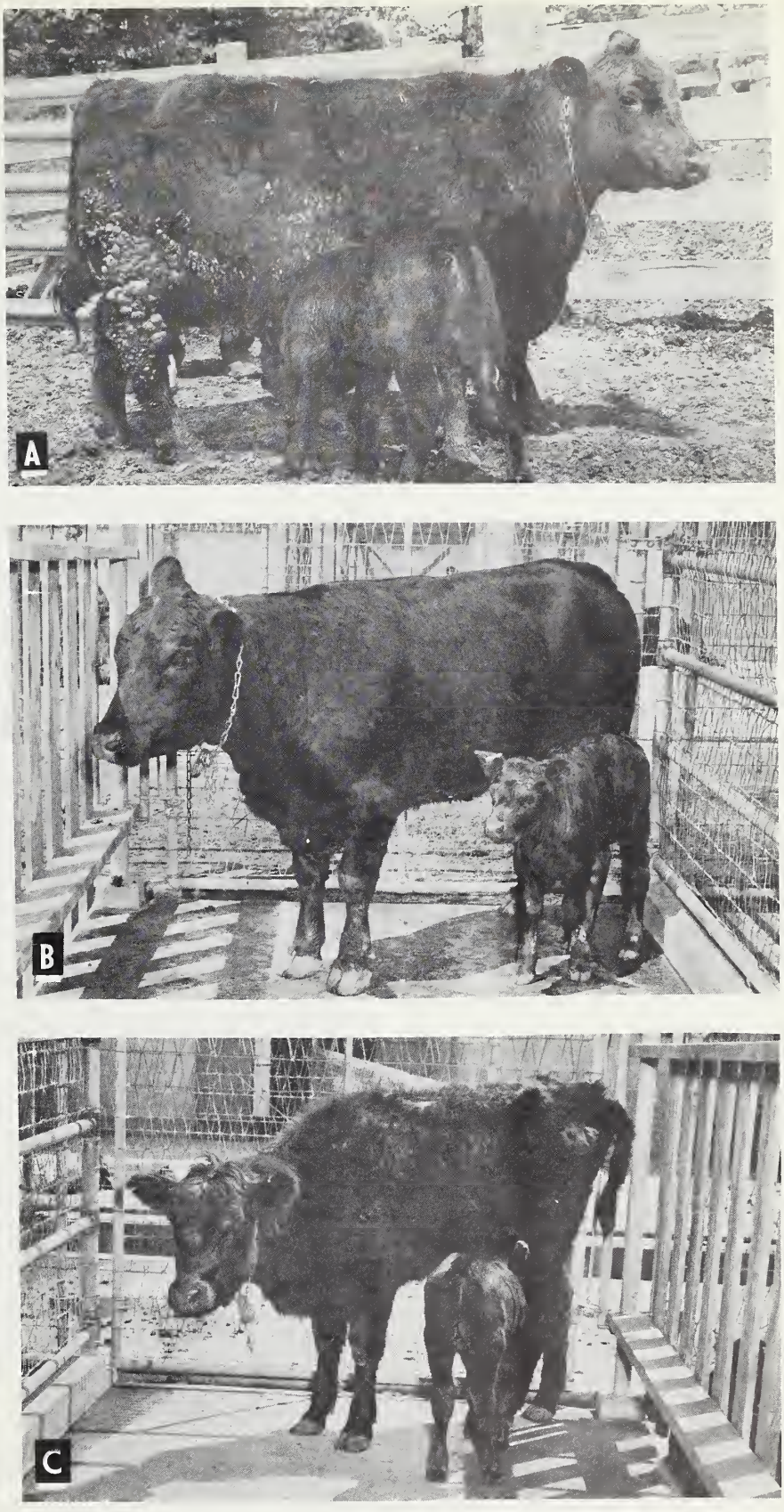
Steer A **Steer B**

Identical twin steers, each photographed when it reached 1,000 pounds. Steer A was continuously well fed. Steer B was on a maintenance ration for 6 months, then returned to full feed. Steer A reached 1,000 pounds 2 months sooner than steer B.

that bloat is more apt to occur when soybean oil is added to the ration at levels of 4 to 8 percent.

Poor reproductive performance, as evidenced by low percentage of calf crops, is considered the most important problem of the beef industry. Nutritional factors are being studied at the Center in a project that includes feeding rations of varying levels of total feed intake (energy and protein) to breeding females. Estrus, ovulation, conception rates, and embryo survival are being studied. A preliminary experiment indicated that low protein levels reduced both calf crops and weaning weights. After 3 years of feeding low levels of energy or protein, or both, the reproductive cycle of cows ceased. Heifers that conceived calved normally and their calves were small but healthy. Heifers on high-energy diets conceived normally, had heavy calves, but had considerable trouble calving, suffering heavy death losses among the calves.

Experiments were started in 1950 with identical twin cattle to determine the effects of continuous versus interrupted growth on beef cattle. Identical twins are rare, probably occurring not more frequently than once in 2,000 or more calvings. Each pair of identical twins used in nutrition research yields results that are comparable with those obtained from considerably larger numbers of less closely related animals. Experiments with identical twin cattle are being carried out to determine the mechanism of response when animals are placed on full feed after having been fed rations limited in calories for periods of up to 7 months. Early experi-



Aberdeen Angus females and their calves used in studies relating nutritional levels to reproductive performance. Heifers *A* and *B* gave satisfactory reproductive performances: *A*, Fed a high-energy diet, raised a normal calf, although similarly fed heifers had heavy calf losses; *B*, fed a medium-level energy ration, raised a vigorous and sturdy calf. Heifer C, fed a low-level energy diet, calved normally, but most animals fed on this ration failed to conceive.

ments showed that animals fed restricted caloric rations for scheduled periods responded very favorably to full feedings, as measured by daily gains, feed consumption, and carcass characteristics, when compared with cotwins that were continuously fed full rations.

Data accumulated up to 1960 on pasture utilization studies indicate that animals grazed on wheat and sudangrass pastures (annual mixtures) gain more rapidly than those on perennial orchardgrass-Ladino clover pastures. The information from the pasture studies on comparison of perennial mixtures and annual mixtures should be applicable to the mid-Atlantic coastal area when animals are placed upon pasture without supplemental feeding.

Research on feeding pelleted rations for beef cattle indicates that fattening animals consuming complete mixed and pelleted rations require less feed per pound of gain but do not gain any more rapidly than those fed unpelleted rations.

Studies to determine ration digestibility have been underway for several years. These experiments are part of an overall program to study, and attempt to improve, research techniques used in the evaluation of feeds and forages. Comparisons of technique results show that substantial errors are sometimes found even in determinations made under well-controlled conditions.

High levels of salt are used by stockmen to control the daily intake of feed supplements by beef cattle and to increase water consumption in an attempt to reduce the incidence of urinary calculi. Studies are in progress to measure the effects of increasing levels of salt on feed consumption, digestibility, and efficiency of utilization of the feed.

Dairy Cattle Research Branch

Dairy research at the Center is concerned with the problems that affect the efficiency and profitableness of dairy farming. The work includes (1) studies in breeding and management to improve the milk-producing ability of dairy animals; (2) determination of nutritional requirements for normal growth, lactation, and reproduction and the feeds or feeding regimes that will supply the needed nutrients most efficiently; (3) investigations of the physiological factors affecting the general usefulness of dairy cattle; and (4) investigations on the nutritional value of milk.

The experimental herds used for breeding and nutrition studies consist of about 500 animals of all ages, including Holsteins, Jerseys, and crossbreds of various breeds. The facilities are barns to house the experimental herds and offices and special laboratories for the administrative and research staff. About 50 specialists in genetics, animal breeding, anatomy, physiology, chemistry, bacteriology, nutrition, and dairy husbandry work on about 60 projects. Approximately 600 acres is used for pasture and hays crops in connection with dairy operations.

Building Better Dairy Herds.—One of the problems in breeding dairy cows is the large number of low milk producers that are born in many farmers' herds every year. It has been estimated that one-third of the country's dairy cows return a profit, one-third show neither profit nor loss, and one-third fail to pay for their keep. On the dairy farm, cows that do not pay for their keep are usually culled. Since an objective at the Center is to get information on breeding, all females are raised and tested for production. Every effort is made to avoid practices that might alter the interpretation of results in terms of inheritance.

A herd of registered Holsteins was established at the Center in 1918. It was maintained for experimental purposes, chief of which was to determine the value of using proved sires. The females in this herd today total more than 220 and represent daughters of 18 sires. They are the result of from 5 to 10 generations of continuous proved-sire breeding. The number of low milk-producing cows has gradually diminished with each succeeding proved-

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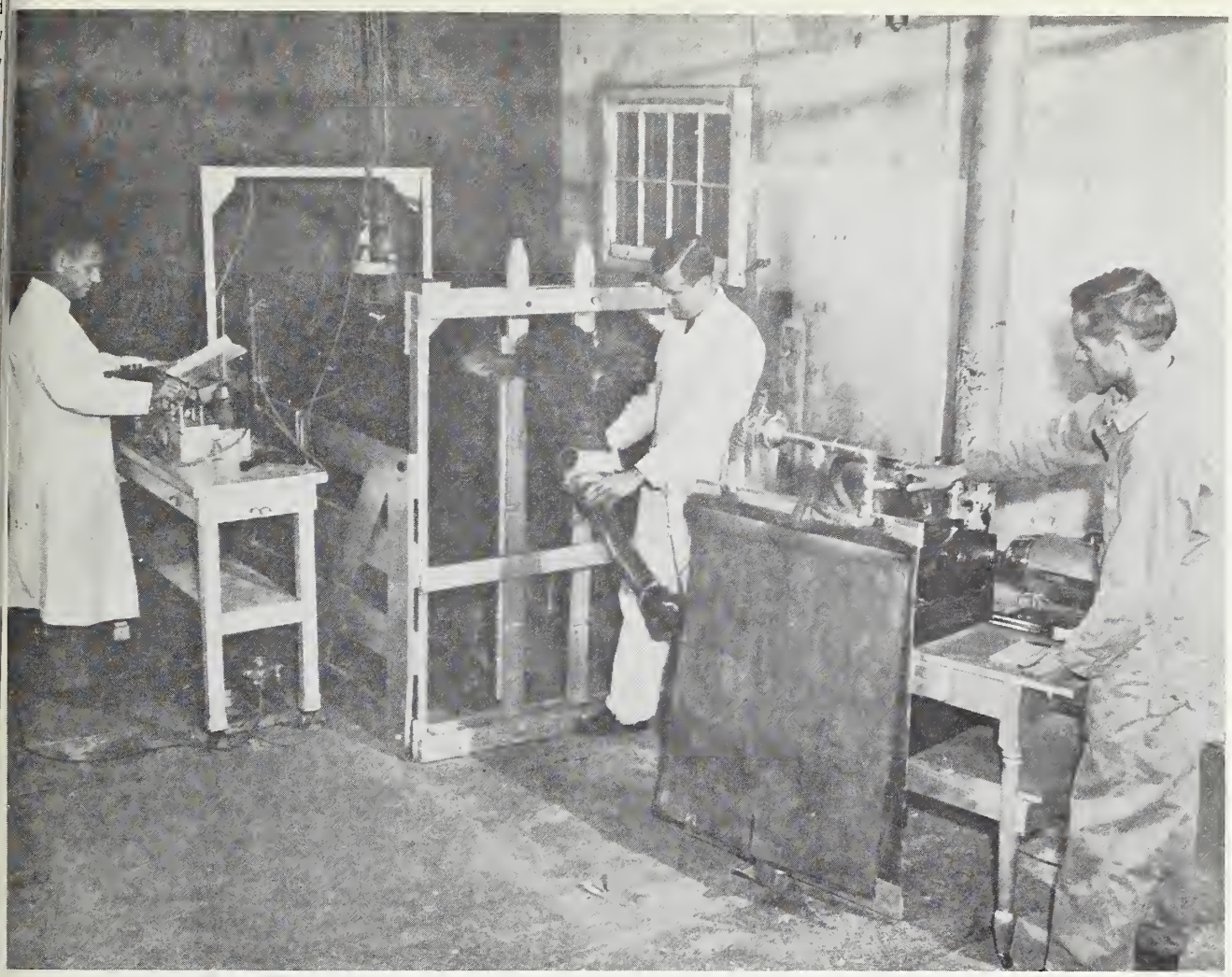
Scientists studying body conformation and anatomy of a dairy cow to learn how cattle develop and the relationship of their development to production.



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Scientists measuring respiration rate and volume of skin evaporation under hot conditions in the adaptability laboratory at the Center.

sire cross, and the butterfat production per cow now averages about 700 pounds as compared with 540 pounds in the foundation herd, an increase of approximately 30 percent.

This herd is presently serving as a foundation group for a new experiment, in which three systems of mating are being compared. One-third of the herd is being used to continue the present practice of utilizing superior proved sires that are distinctly unrelated to each other. Another third of the herd is being closed and improvement will be attempted through selection and inbreeding. The final third is being bred to superior proved sires of breeds other than Holstein-Friesian. All the sires are being selected on the basis of showing the most promise of maintaining or increasing the existing levels of milk, butterfat, and solids-not-fat. Young sires developed from each plan of mating are to be loaned to cooperating dairymen, so that a comparison can be made of the results of the three systems of mating on the performance of the cows and also of the bulls. Sire services for this research are being obtained from artificial-breeding organizations through the cooperation of the membership of the National Association of Artificial Breeders.

The original crossbreeding experiment, which was started in 1939, entailed the use of proved sires of the Holstein, Jersey, and Red Dane breeds crossed with females of these breeds and also with Guernsey females. This initial study has been completed and a new one started, which is comparing the results of crossbreeding to purebred matings through reciprocal crosses of the Holstein, Brown Swiss, and Ayrshire breeds. The differences in milk and butterfat production among the breeds used are being evaluated, and the effect of crossbreeding on these differences will be estimated.

To learn more about the ability of cattle to adapt themselves to different

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A dairy-management specialist examines the stems of cut alfalfa that have been crushed by the heavy rollers of this modern machine—the mower-crusher—to make the stems dry faster and thus decrease the time required for field-curing the hay.

environments, particularly in the South, considerable research has been carried on in regard to their physiology and genetics. Much of it is conducted in a specially constructed heat chamber, where temperature and humidity can be controlled or varied as the experimental procedure requires. Measurements are made of heat losses through respiration and from the skin and also of certain physiological responses within the body. Results have shown that high production makes it more difficult for a cow to be heat tolerant. Tests have indicated that not only have cattle the ability to sweat but also this ability varies considerably among animals. These tests have also indicated that the amount of surface area on the skin and the presence of the dewlap and hump do not explain the measured differences in heat tolerance.

To provide a proper basis for identifying both superior and inferior milk-producing capacity, scientists at the Center have been conducting a study in which the body form of the heifer and the cow is measured, and after slaughter the size of all internal organs and body parts is determined. More than 540 cows with records of production have been slaughtered and measured according to this procedure. In addition, more than 460 cows of known milk-producing capacity have been slaughtered and measured as a part of the same study at various State agricultural experiment stations. The work has already provided data showing how dairy animals grow and how their form changes with age, as well as the average weights and measurements of the anatomical parts of the cow, all as a scientific approach to the yet-unsolved puzzle of judging production from conformation.

Special emphasis has been given to a study of the udder. When a cow or heifer is slaughtered at the Center, the udder is removed, suspended in natural position, filled with formalin, frozen, and later cut into vertical slices to show the structure of the glands at various ages and to provide a basis for studying the relationship of tissue structure and producing ability. The sectioned udders are photographed. Several hundred specimens of typical and abnormal udders have been preserved and are available for examination by visitors and students.

After several years of research a method has been developed that may make it possible to prejudge the potential milk-producing ability of a calf when she is only 4 to 5 months old. Examination by palpation of the udder shows marked differences in the development of the mammary glands in individual calves. It has been found at the Center that, in general, calves with relatively advanced development tend to make better milk producers than those with retarded development of the mammary glands at the same age. If these results are upheld by field tests now in progress, some of the selection of herd replacements should be possible during early calfhood and a preliminary appraisal of a herd sire might be obtained when his daughters are less than 6 months old. The palpation examination is not difficult and can readily be demonstrated.

Breeders have long been in need of genetic information on the solids-not-fat portion of milk. The Dairy Cattle Research Branch has tried to adapt the Watson-lactometer method, which was developed by Department scientists, for use in the field. New portable equipment that requires small amounts of milk for sampling has been developed experimentally and tested with cooperators. Solids-not-fat tests are being made routinely within the herd at the Center. The Branch is participating in an interstate cooperative study on the genetics of these milk constituents, and tests are being made with a large number of cows.

Exploratory studies are underway regarding methods of measuring the efficiency of feed utilization in lactating cows. All the breeding effort in dairy cattle has been to develop a cow that produced a gross amount of milk without knowing whether it produced most efficiently. These studies are designed to find out whether differences in efficiency between cows do exist and if so, how factors such as body weight and breed affect these differences.

In addition to the work at the Center, the personnel there are actively engaged

in cooperative investigations with research workers in more than 15 States and several countries on the reliability of sire provings, inbreeding, crossbreeding, adaptability of dairy cattle to the gulf coast region, methods of utilizing artificial breeding, environmental adaptability, body form and internal organ measurements, udder palpations, genetics of milk constituents, feed utilization, and blood typing. Cooperative studies are also being made with the Agricultural Engineering Division and the Eastern Utilization Research and Development Division on milk recording and milk handling, as well as on the development of a marker that will make it possible to identify the presence of antibiotics in milk.

Dairy Cattle Nutrition and Physiology.—Considerable emphasis in the research program is given to problems of preserving and processing grassland crops. In cooperation with the Agricultural Engineering Division, studies are conducted on the use of preservatives in silage, different types of silos, various types of covers for bunkers and stacks, and the effect of harvesting and other storage procedures on nutrient preservation and silage quality. Investigations of fundamental bacteriological and chemical changes in silage make it possible to recommend the best methods of producing dairy cattle feeds under a wide variety of farm conditions. In conjunction with the forage preservation work, studies are conducted on the effects of such harvesting procedures as pelleting, chopping, and laceration, and storage procedures on palatibility and nutritional value of hays. Comparisons are also made of the feeding value of hays and silages for growth and milk production of dairy cattle.

In pasture research different management systems are evaluated—rotational and strip grazing, zero grazing, and irrigation. Pasture mixtures of such plant species as millet, sudangrass, and bermudagrass are also being studied for use in special locations and certain management practices.

The recently developed energy metabolism laboratory conducts fundamental and applied research on the energy evaluation of feeds and rations. Studies on the usefulness of feed additives—antibiotics and hormone supplements—and on the basic nutritional requirements of rearing dairy heifers are also included in this general area of research. Work is also conducted on rumen metabolism and the function of paunch bacteria in the digestion and utilization of feeds, the growth of calves, and other problems related to rumen metabolism.

Basic physiology of reproduction in relation to sterility in cattle includes studies on ovulation mechanisms, the defense mechanisms of the uterus, hormone mechanisms, and the role of nutrition and genetics in relation to repeat breeding and other reproductive disorders.

A rat colony is maintained for basic nutrition research. The colony has provided important leads in basic nutrition, especially in relation to vitamin B_{12}, and has provided data on the nutritional values of butter, butterfat, cheese, and other dairy products. Work is also continuing with the rats on the isolation of unidentified nutrients that may be in certain feeds.

Techniques have been developed for evaluating carotene, vitamin A, and organic acids for use in forage and nutrition research. The use of ratio techniques for digestibility studies has been developed. A new technique to determine energy expenditure of cattle while pasturing shows great promise. Considerable emphasis is being placed on feed fractionation studies to develop an analytical method that measures more exactly the nutritional value of feeds than does the system now in use.

Meat Quality Laboratory

The object of research in animal breeding, nutrition, and management is the production of more meat of better quality. To obtain this objective the Division maintains at the Center a complete meat laboratory with modern facilities for slaughtering and processing experimental animals. These facilities are augmented by laboratories for chemical, biochemical, organoleptic, and histological evaluation of the meat and also by an office for statistical analysis of the data.

Cattle, hogs, and lambs from breeding, feeding, and management experiments are slaughtered in the meat laboratory, then measured, cut, and analyzed for physical composition—muscle, bone, and fat. In this way research workers have established standards for meat-type hogs yielding a large proportion of preferred cuts. Similar standards of excellence are being established for cattle and lambs. Objective methods of estimating the composition of live animals are being investigated, and methods have been developed and are being improved, as well as new methods studied, for determining the amounts of fat, moisture, lean, and bone in animals.

Studies of factors relating to palatability of the meat are made by trained taste panels and by objective techniques. Mechanical devices have been designed and are used to determine objectively tenderness and juiciness of the heated meat samples from the experimental animals.

Detailed microscopic and chemical studies of meat samples are in progress. The object of these studies is to (1) determine the relationship of production factors to tenderness and flavor of the meat, (2) provide a sound basis for the improvement of meat-animal production, and (3) create a greater demand for quality meat by the consumer.

Poultry Research Branch

Poultry-Breeding Developments.—The experimental poultry plant includes 177 acres, on which are 4 laboratory buildings, 11 large laying houses, 2 wooden brooder houses, 1 large concrete brooder house for 20,000 chicks, 6 large turkey houses, and nearly 200 colony houses of various sizes for the experimental flocks and equipment. The poultry buildings have a capacity of approximately 8,000 adult chickens and 1,500 turkeys. Facilities are available for brooding about 35,000 chicks and 2,500 poults. About 150,000 eggs are incubated annually. The experimental flocks are made up principally of Rhode Island Reds, White Leghorns, New Hampshires, Anconas, Black Australorps, Black Minorcas, and hybrids.

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Chicks and poults are hatched in wire baskets—the offspring of one female per basket—to provide pedigree records in poultry-breeding projects.

Experiments in outbreeding, crossbreeding, and crossing of inbred lines (hybridization) are conducted to improve egg production. Crosses between selected White Leghorns and Rhode Island Reds, with and without previous inbreeding, have improved viability and produced from 35 to 50 more eggs per hen than the control stock of White Leghorns and Rhode Island Reds.

Selective breeding for several years has resulted in chickens that produce eggs of superior interior quality with a minimum of seasonal variation. A current experiment is designed to determine whether superior egg production, egg weight, hatchability, and viability can be bred into these same birds.

Studies of blood types in the fowl are being made to determine how the various types are inherited and whether these characteristics can be used to identify individuals and lines with superior performance potentials.

The Beltsville Small White Turkey.—The Beltsville Small White turkey is the product of an experiment in the pedigree breeding of turkeys, with the specific objectives of small size, quick market maturity, compact meaty body, and good reproductive ability. Average weight at full market maturity (22 to 24 weeks old) is about 7 pounds ready-to-cook for the hens and about 12 pounds for the toms. Several types and strains of turkeys were combined to produce the new turkey, which was admitted to the American Standard of Perfection in 1951 as a new variety.

After World War II the Beltsville Small White turkey was widely accepted by the industry and became well established in the United States. These small-type white turkeys are marketed when about 16 weeks old as turkey fryer-roasters or "turkey broilers" and weigh from 4 to 8 pounds ready-to-cook. They are actually small roasters and seldom are fried or broiled. In 1956 about one-sixth of all turkeys in the United States were Beltsville Small Whites. Of these estimated 13 million birds, nearly 73 percent were marketed as fryer-roasters. Breeding work is being continued, and surplus poults may be purchased by the public for breeding purposes.

National Poultry and Turkey Improvement Plans.—The National Poultry and Turkey Improvement Plans are administered from the Center. Through these programs the Agricultural Research Service cooperates with the States and industry in formulating provisions to govern the classification of breeding stock, hatching eggs, chicks, and poults produced by participating hatcheries, breeders, and flockowners. These classifications provide for the identification of products in regard to breeding improvement and for the control and eradication of pullorum, typhoid, and other infectious diseases. The organization that administers the Plans disseminates new research information on breeding and disease control. Approximately 60 percent of the hatcheries with more than 70 percent of the hatching-egg capacity in the United States participate in these programs.

Poultry-Product Quality.—Poultry-product technologists are studying the effects of different breeding, feeding, and management practices on the meat yield, carcass composition, and carcass quality of chickens and turkeys. Investigations on the microbiology of the egg are directed at the determination of basic factors causing the deterioration of shell egg quality. Improved methods of measuring egg quality are being investigated. Typical examples of results are a shell-color grading machine, an automatic detector of green rots, which has been plant tested, and a blood-spot detector, which is being distributed by a commercial firm. These and other

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Breeding, feeding, and management experiments result in high-quality, plump-breasted chickens and turkeys.

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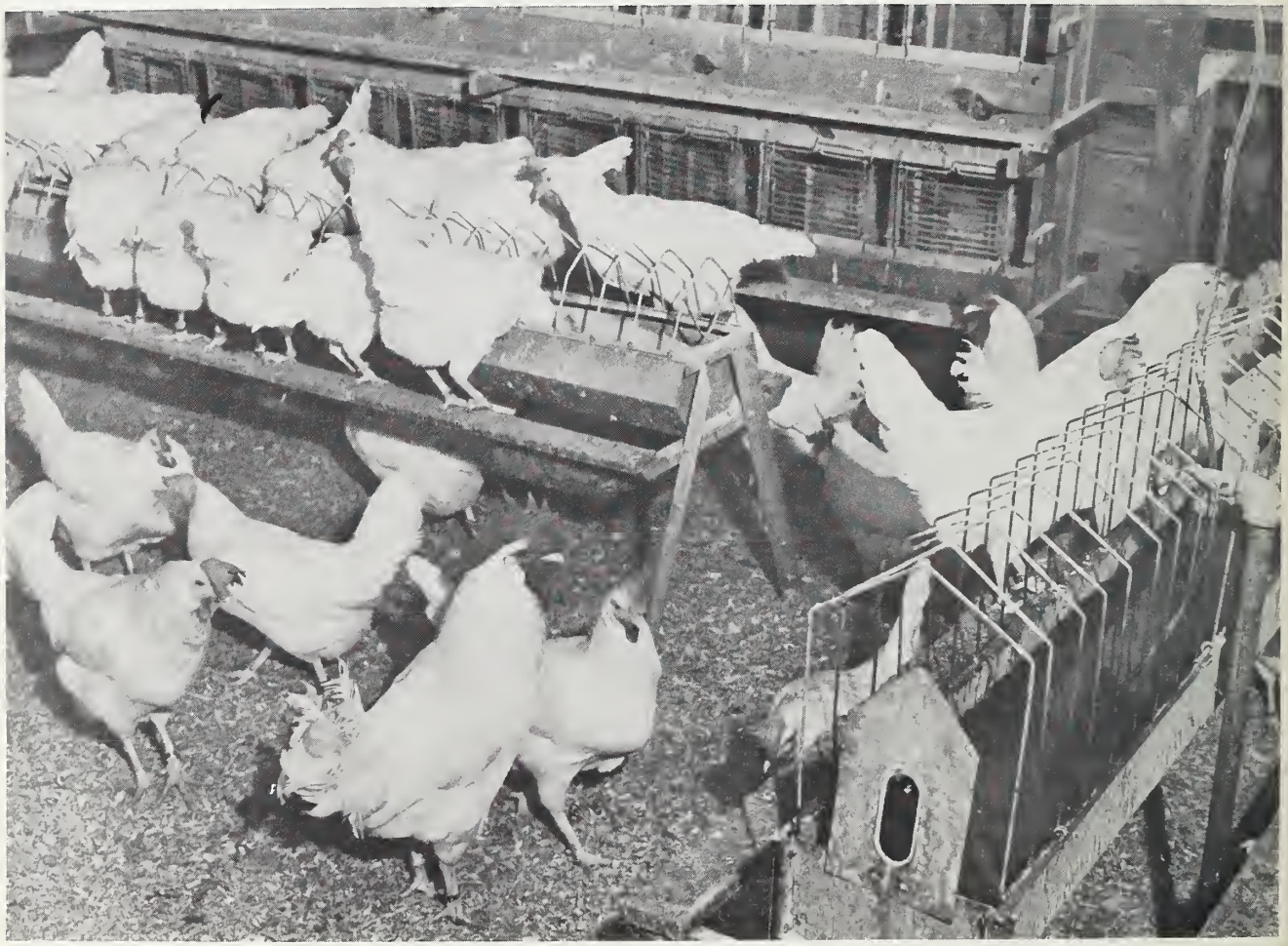
automatic devices for grading eggs are being studied in cooperation with the Department's marketing specialists and engineers.

Physiology and Embryology of Poultry.—Studies on the basic nature of the reproductive system of the hen have shown that the cyclical nature of laying performance is due to a periodic interaction of nervous-system activity with hormone activity. Some barbiturates interfere with this interaction and others cause a premature response. Progesterone, a hormone once thought to be present only in mammals, has been found in chickens. This substance, when injected into regularly laying hens, causes premature ovulation. Recent work demonstrates that progesterone acts directly on the hen's brain to cause the release of a hormone from the pituitary, which in turn induces ovulation.

Studies on fertility have shown that embryonic development of parthenogenetic origin occurs in eggs of nonmated Beltsville Small White, Light Palm, and Broad Breasted Bronze turkey hens and of nonmated Dark Cornish and Silver Cornish chickens. Parthenogenesis in turkey and chicken eggs has been confirmed by other laboratories. More than 50 parthenogenetic poults have been hatched from eggs of Beltsville Small White Turkeys. Six of these poults have been raised to maturity. A parthenogenetic turkey male hatched in 1958 from an unfertilized egg has produced viable semen in quantity. This semen was used to inseminate virgin Beltsville Small White hens. More than 80 offspring, about equally divided between males and females, have been sired by this parthenogenetic male. Selective breeding appears to intensify the tendency to produce parthenogenetic eggs, and the use of fowl-pox vaccine appears to increase the incidence.

Physiologists and agricultural engineers are engaged in an extensive study of the effects of environmental factors on the body processes of chickens. Chicks with large thyroid glands are able to resist loss of body weight and death at high temperatures (100° F. continuously) better than those with small thyroids. The large- and small-thyroid lines of chickens were developed through selective breeding. The physiologist's work will guide not only the engineer in designing poultry houses but the breeder as well in developing superior birds. Studies on the effects of limiting feed or water intake on



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More eggs for less feed is the aim of this nutrition experiment.

chicks have shown that the adrenal gland is involved in the resistance to these stresses and that the administration of certain antibiotics may also protect the birds.

Studies on the artificial lighting of turkey-breeding stock have shown the males to be sensitive to the duration of the artificial light supplied to obtain out-of-season reproduction. Females are responsive to artificial light but are less sensitive than males. A combination of natural and artificial light to extend the light-day to about 14 hours seems to be about right. The intensity of artificial light endured by the males without adverse effects appears to be within the range of about 1 to at least 40 foot-candles at bird level.

Poultry Nutrition.—Nutritionists at the Center recognized that soybean oil meal would not give good hatchability and livability when used as the only protein concentrate in the hen's diet. They found that the addition of animal protein or a water extract of dried cow manure would correct this condition. After the discovery of B_{12}, this vitamin was shown to be the active factor in the animal protein and in the cow-manure concentrate. Further work at the Center showed animal and fish byproducts to be good sources of the vitamin. These studies led to the discovery that fish byproducts contain, in addition to B_{12}, another growth factor that is still unidentified.

More recently the egg yolk has been found to contain a factor that is different from the fish factor and that stimulates chick growth and improves feed conversion. The egg-yolk factor is soluble in fat solvents, whereas the fish factor is water soluble. Work at the Center and elsewhere with inedible fats and oils and poultry byproducts indicates that these materials are well utilized by poultry, since they improve both the rate of gain and feed conversion. This finding has been of considerable economic importance, since it created markets for products that were either surplus or waste and at the same time proved them to be of benefit to the poultry industry.

Other fields of investigation that are of current interest in poultry-nutrition work at the Center are protein and amino acid requirements, calories and their relationship to the nutrients in the diet, particularly protein, effect of feeding and management of growing stock on subsequent henhouse performance, and effect of administering hormone-like compounds on turkey broilers. Work on the characterization and identification of the several unidentified growth factors is being continued. A new but important phase of the nutrition work is the use of radioisotopes to study the metabolism of the amino acids, fats, carbohydrates, and vitamins that are required by poultry.

Sheep, Goat, and Fur Animal Research Branch

More Productive Sheep.—About 850 sheep are used in breeding, feeding, management, and basic investigations at the Center.

Breeding investigations involve a long-term program of comparing selected purebred matings of Hampshire, Shropshire, Southdown, and Delaine Merino sheep with many of the possible two- and three-way crosses of these breeds in respect to fat lamb and wool production under farm flock conditions. Experimental work has shown that crossbreeding results in increased production of lambs and wool over the average production of the parent breeds. A new crossbred strain has been developed for both fat lamb and wool production under Eastern United States environmental conditions by mating Columbia rams to Southdale (Southdown × Corriedale) ewes. The performance of this strain is being compared with the previously listed farm sheep breeds. The performance of Targhee sheep under farm flock conditions also is being evaluated in order to ascertain the possibility of incorporating range (wool) type sheep in crossbreeding programs for optimum wool and lamb production.

Approximately 100 sheep are used each year solely in nutrition research, and in addition applied nutritional research is conducted with the breeding flock.

Basic research is directed toward metabolic disorders such as bloat and urinary calculi; rumen metabolism and the effect of diet on the synthesis of amino acids and proteins by microorganisms; calorie-intake and protein requirements for maintenance, reproduction, and growth; and new and better methods of evaluating pastures and forages.

New and improved techniques such as the use of X-ray movies (cooperative studies with the New York State Veterinary College) and radioactive isotopes (cooperative studies with the Atomic Energy Commission) have added to the fundamental knowledge concerning ruminal motility, eructation, and metabolic activity within the rumens of sheep.

Cooperative work with the Crops Research Division has yielded promising results in the selection and development of new and improved forage plants for sheep. For example, research has shown that the palatability of sericea lespedeza for sheep was directly correlated with the plant's tannin content and that strains of sericea lespedeza could be developed that were low in tannin content.

Feeding tests have shown that pelleted feeds for growing and fattening lambs can lead to an increase in feed consumption, rate of gain, and feed efficiency. Fundamental work is now in progress to determine how pelleting affects the chemical composition and digestibility of feeds and to determine the effects on sheep of feeding pellets over extended periods of time.

Applied nutrition work with the breeding flock is being directed toward such problems as supplemental feeding of sheep during drought periods and during the breeding and lambing seasons and toward the selection of pasture species and methods of pasture management that will yield the maximum production of lambs and wool.

Environmental studies include comparisons of the performance of genetically similar sheep under conditions at the Center and other geographic regions of the United States. The effect of season and light on wool production and feed requirements and the reactions of sheep to high temperatures are also being studied.

A mixture of 1 part of phenothiazine to 9 parts of salt is available to the sheep at all times to control internal parasites.

Animal Fibers.—Wool, mohair, and other animal fibers are analyzed at the Animal Fiber Laboratory to determine the effect of breeding, feeding, and management on the quantity and quality of fiber produced.

Most of the wools used in the research program are individual fleeces from sheep of known genetic origin. The wool is scoured, carded, and combed, and at various stages during this processing the wool is measured for fineness, length, and variability. The findings are analyzed to determine the extent to which these characteristics can be used in a selective breeding program.

Studies are also conducted on the relationships among sorted, partially sorted, and unsorted lots of wool of various grades to determine the value of various degrees of sorting on the quantity and quality of the wool after processing.

Fleeces from sheep of known genetic origin, located in various geographical regions of the country, are studied to determine the effect of the environment on the quantity and quality of the wool. Biopsic skin samples from these sheep are also studied to determine the effect of the environment on the growth pattern of the wool. The results of this project are analyzed and are made available to sheep breeders, in order that they may plan their breeding programs so as to produce wools with characteristics that will be of the most value in the finished product.

Information regarding the early development of wool and fur fibers, as well as the correlative changes in the skin that take place during such development, is basic to understanding the nature of animal fibers. Histological preparations are made of skin sections from animals of different ages, with essentially similar methods being used for the various animals under investigation. These preparations are required for a detailed study of the prenatal and postnatal growth of fiber follicles of sheep and goats and such fur animals as mink, fox, chinchilla, and rabbit. The various factors studied include the fiber growth cycle, the manner of fiber-follicle grouping, the availability of energy-giving substances such as fat and glycogen within the skin, the activity of the skin glands, and the amount and manner of pigment-granule distribution. Results from this research can be used in selecting stock for the improvement of wool or fur fibers, as well as the skin, or pelt, of the animal.

Swine Research Branch

Research on hogs is conducted on an area of about 270 acres at the Center. The plant includes a 28-pen farrowing house, record-of-performance house, feed barn, and 50 colony houses on individual pastures. One breeding herd totals about 200 hogs, and about 250 litters of pigs are farrowed annually.

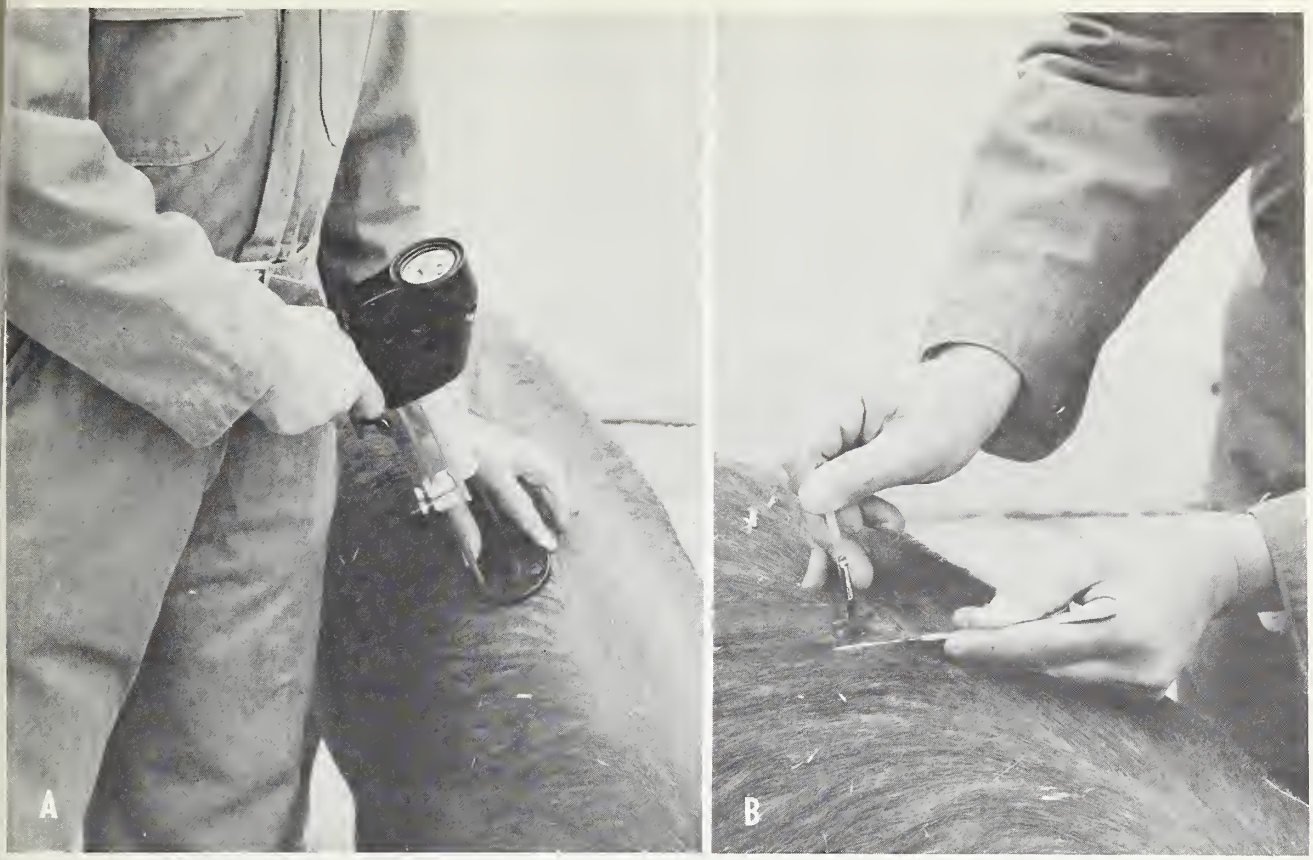
Swine-breeding research is directed toward development and improvement of methods by which hog raisers can produce most efficiently the kind of pork products most consumers prefer. Since housewives are demanding more lean cuts of pork and less fat, swine producers should raise the kind of meat-type hogs that will meet this demand. Special attention is given to the effects of selection—inbreeding and crossbreeding—on such characteristics as fecundity, viability, rate of growth, feed efficiency, and carcass quality.

In 1934 the U.S. Department of Agriculture imported 23 Landrace and 6 Yorkshire hogs to evaluate their performance in crosses with different domestic breeds. Seven inbred lines possessing varying amounts of Landrace blood were developed from crosses made at the Center. One line, which is of Landrace-Poland China breeding, has attained the status of a pure breed and is now recorded as the Beltsville No. 1 in the Inbred Livestock Registry Association, St. Louis Park, Minn.

Four other inbred lines have attained a similar status. The Minnesota No. 1 was developed at the University of Minnesota by crossing the Landrace and Tamworth breeds. The Montana No. 1, which is derived from a cross of Landrace and Black Hampshire, was developed at the U.S. Range Livestock Experiment Station at Miles City, Mont., in cooperation with the Montana Agricultural Experiment Station. The Maryland No. 1 was developed from crossing the Landrace and Berkshire breeds at Blakeford Farms, Queenstown, Md., in cooperation with the Maryland Agricultural Experiment Station. The Palouse resulted from crossing Beltsville-bred Landrace boars with Chester White sows. This line was developed at the State College of Washington at Pullman.

Breeding studies recently completed at the Center have shown that crossing selected inbred lines with outbred stocks of unrelated pure breeds offers an excellent opportunity for surpassing the performance of both inbred and noninbred stocks. In order to explore the possibility of using hybrid vigor more effectively in producing market hogs, a program of recurrent reciprocal selection similar to that used by corn breeders to increase hybrid corn yields was started at the Center with crosses among three of the Beltsville lines—Landrace, Landrace-Large Black, and Landrace-Poland China, representing the foundation stock for one of the two strains used in this program. The other strain was started from crosses among noninbred purebred stocks of Chester White, Hampshire, and Poland China.

The program is expected to continue for 10 to 15 years. It includes the following steps: (1) Crossing at 2-year intervals line-cross strain L with breed-cross strain B, (2) testing the resulting cross progeny for various economically important traits, (3) retention in strains B and L of breeding animals proved best by the performance of their cross progeny, and (4) propagation of strains B and L by mating selected animals for litters in intervening years. Selection of breeding animals for propagating strains B and L is primarily based on the performance of their cross progeny with respect to rate of growth and efficiency of feed utilization from weaning to a final market weight of about 225 pounds and various carcass characteristics such as thickness of back fat, percentage of preferred cuts, and loin eye-muscle area. The dams' prolificacy and mothering and nursing



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Probing back-fat thickness of live hogs electrically (*A*) and with the metal rule (*B*) as a method of identifying superior meat-type hogs.

ability are also considered. Although several cycles of selection will probably be necessary before the usefulness of recurrent selection can be evaluated, results obtained to date show that the progeny produced from crossing strains B and L excel both their parent strains in most of the traits being studied.

A second breeding experiment with swine now in progress at the Center is concerned with the effectiveness of selection for high and low back-fat thickness. Specifically the plan is (1) to determine the rate at which thickness of back fat can be changed by selecting individual pigs for high back-fat thickness in one line and for low back-fat thickness in another line within each of the Duroc and Yorkshire breeds and (2) to determine how selection for high and low back-fat thickness affects other traits, such as type and conformation, rate of gain, and carcass composition. The primary criterion used in selecting breeding stock within the various lines is back-fat thickness at a live weight of 175 pounds. Results obtained to date show clearly that selection based on probing back-fat thickness of live hogs may be highly effective in changing the lean-to-fat ratio of hog carcasses.

Research in swine nutrition has been directed into a variety of fields. In vitamin studies major emphasis has been directed at establishing minimum requirements for gestation and lactation in swine and in checking requirement figures that have not been firmly established. This method of attack is being continued in order to fill in some of the more important and obvious gaps in our current knowledge of vitamin nutrition.

Progress is being made in reducing baby pig losses due to faulty nutrition. Female swine have been reared under controlled dietary regimes and carried through two successive gestation-lactation cycles. Measurements have been made of the effects of diets of varying nutritional levels fed to the dams on the number, size, vigor, and survival of pigs born and on the average weight of pigs at a given age. A direct relationship has been established between inadequate nutrition and baby pig losses.

In the field of mineral interrelationships, studies have established a definite connection between the zinc and calcium contents of swine diets and the incidence and severity of parakeratosis, including tentative recommendations as to preventive and therapeutic levels of zinc. Studies are being continued to confirm or modify these tentative recommendations, to investigate the mechanisms in the production of parakeratosis, and to establish quantitative requirements for trace minerals, particularly in gestation and lactation diets for sows.

A series of tests to evaluate improved processing methods for producing by-product feeds have been primarily directed at the problem of toxicity of cottonseed meal for swine. Previous attempts to adapt cottonseed meal for increased use in swine and poultry feeds have been concerned with methods of reducing the content of free gossypol in the meal. However, the discovery that both quantity and quality of crude protein in the diet modify the susceptibility of swine to gossypol toxicity has suggested another approach to the problem of rendering cottonseed meal safe for increased utilization in diets.

Other nutrition research entailing the cooperative efforts of several State experiment stations includes evaluation of cooked garbage as swine feed, a study of the development of the enzyme system in the pig, and investigations to measure the effects of dietary factors on carcass quality of market hogs.