Artificial Insemination

A group of dairymen in New Jersey organized in 1938 the first cooperative in the United States for the artificial insemination of their cows. This method of serving females without natural mating has since become one of the most significant programs for livestock improvement in the history of American agriculture.

A great deal of research has been done on all phases. A basic contribution was the invention of the artificial vagina, by which semen is obtained directly from the bull without contamination. After that came the development of the rectovaginal insemination technique, which permits the placement of semen in the cow’s cervix or uterus and improves the conception rate. The development of the yolk-phosphate diluent made it possible for the first time to store semen for as long as 2 days without seriously affecting its fertilizing ability. The addition of antibiotics to diluted semen improves breeding efficiency and helps to prevent the transmission of certain reproductive diseases. Adoption of the photoelectric colorimeter for determining sperm concentration permits maximum dilution of semen without lowering breeding efficiency. One of the newest developments, the freezing of semen, makes it possible to store diluted semen for indefinite periods. Improvements in semen diluents, methods of handling semen, and insemination techniques have enabled most studs to maintain breeding efficiency equal to or slightly higher than natural service.

A shortcoming of artificial insemination used to be that a sire could be made available to dairymen only about 2 days each week. Semen was collected from a bull at weekly intervals, and satisfactory fertilizing capacity could not be maintained for more than 2 days. We have learned how to freeze bull semen without destroying its fertilizing capacity. By adding glycerol as a protective agent, then freezing and storing diluted semen at extremely low temperatures (—110° F. with dry ice or —320° with liquid nitrogen), fertility can be maintained for several years. The use of frozen semen makes it possible to have semen from each sire available every day. It facilitates the long-distance transportation of semen. It permits more cows to be bred to some bulls, as a “bank” of semen can be accumulated during periods of light demand. Cows can be mated to a bull during extended periods of sexual inactivity or after the bull is dead. Thirteen studs were using frozen semen for their entire oper-
Artificial insemination—sometimes shortened to "A.I."—offers great opportunities for improving dairy cattle if only the best bulls are used, but great harm could be done by using inferior bulls. A bull can produce enough sperm in a year to inseminate 100 thousand or more cows. No doubt the trend toward fewer bulls and more services per bull will continue. In 1960, 24 bulls sired 11.4 percent of all registered Holsteins. Improvement in the dairy industry therefore may well be in the hands of those who select bulls for use in the program.

Progeny testing is the most accurate method of measuring a bull's breeding value. Since the performance of dairy cows is influenced by feeding and management, it is difficult to measure transmitting ability even though a bull has daughters in production, particularly if all his daughters are in one herd. Many geneticists agree that a sire selection program based on the development of A.I.-proved sires
As many as 275 calls a day for service are received at the Lancaster office, one of 10 service offices of the Southeastern Pennsylvania Artificial Breeding Cooperative. From this office, 16 technicians breed about 40 thousand cows a year on more than 2 thousand farms. Each member's farm is marked on a wall map, and a small map is used to route the technicians.

offers the greatest opportunity to improve dairy cattle. Under this plan, carefully selected bulls are placed in service when they are about a year old. Each is mated to enough cows to insure that at least 50 of his daughters will complete lactations on a recognized production testing program. Ideally, the bull is then removed from service until production and type information is available for his daughters. Thus he becomes an A.I.-proved sire. If the average level of production among his daughters is satisfactory, he can be used intensively with reasonable assurance that his future daughters will produce at a level indicated by the A.I. proof.

A relatively new method of measuring a sire's breeding value is the herdmate comparison. Production of each daughter of a particular bull is compared with the production of other cows freshening in the same herd during the same calving period. Effects of management and feeding upon differences in production thus are minimized. It is highly desirable to measure the breeding value of a bull at an early age in order to lengthen his useful life in the stud. In Pennsylvania, where 18 percent of the cows are enrolled in Dairy Herd Improvement Associations, breeding 2,500 cows to a
American Breeders Service transports frozen semen to technicians in liquid-nitrogen refrigerators, each with a capacity of 50 thousand ampules. They normally have about 1 million ampules in storage and as many as 50 thousand from one bull.

Recharging a technician’s refrigerator with liquid nitrogen at a distribution point. The small refrigerator holds about 500 ampules of semen and enough liquid nitrogen for 2 weeks’ storage. Frozen semen permits more efficient utilization of semen.

young sire provides enough records to appraise his breeding value. All D.H.I.A. records in the State are processed by means of electronic data-processing equipment, and records completed by A.I. daughters are reported promptly to the studs.

Scientists at the Dairy Breeding Research Center of The Pennsylvania State University have made several contributions to the A.I. program—coloring semen to identify the semen of bulls of different breeds; the use of penicillin and streptomycin to improve fertility of semen; the development of milk diluents; the management of bulls to increase their production of sperm; and the use of glycerol in liquid diluents to extend effective storage time. This research has enabled the five cooperative studs in Pennsylvania to offer service to each bull every day at a net cost of less than 5 dollars per first service. Lauxmont Admiral Lucifer is an example of a bull that was proved in natural service and then made an outstanding contribution to the A.I. program in Pennsylvania. His 50 “natural” daughters averaged 12,454 pounds of milk and 475 pounds of fat. His A.I. daughters in 1961 had completed 3,835 records, which average 12,806 pounds of milk and 481 pounds of fat. Lucifer had been mated to 45,190 first-service cows when he died at the age of 17 years and 4 months. Another outstanding bull, Spruceleigh Monogram Rag Apple (Expectation), was bought as a calf by the Western Pennsylvania Artificial Breeding Cooperative and placed in service when he was a year old. In 2 years he had been mated to 1,655 first-service cows—fewer than 2 percent of all Holstein serv-
ices during this time. As his first A.I. daughters completed lactations, it became apparent he was transmitting outstanding production and desirable type. During 1958-1960, he was mated to almost 55 thousand cows—24 percent of the Holstein services. In the herdmate comparison, 315 of Expectation’s daughters averaged 12,455 pounds of milk and 480 pounds of fat—495 pounds of milk and 31 pounds of fat more than their herdmates. The increased production for the first lactations of the 315 daughters had a value of more than 7 thousand dollars. As of June 1, 1961, Expectation had been mated to more than 81 thousand first-service cows. It was estimated that 28 thousand daughters would result from those services and complete at least one lactation. If these daughters perform as well as the herdmate comparison suggests, their combined superiority will be worth more than 600 thousand dollars per lactation. An average of three lactations per daughter would boost this value to almost 2 million dollars.

Artificial insemination has been practiced with all species of farm animals, but extensive application in the United States has been limited to dairy cattle. Some of the reasons are that management practices may make the detection of heat and insemination difficult, as in beef cattle and sheep; breed registry organizations may restrict the registration of offspring resulting from artificial insemination, as in beef cattle and horses; and satisfactory diluents and insemination techniques may be lacking, as in poultry, horses, and swine. Most of these problems may be solved by research, but it is unlikely that artificial insemination will be used extensively as a means of improving livestock other than dairy cattle, beef cattle, and swine.

It is hard to predict possible developments for a program that has been changing so fast, but it seems likely that emphasis will be put on ways to get earlier and more accurate methods of evaluating sires. Longtime storage of semen at room temperature may become a reality through the use of metabolic inhibitors, freeze-drying, or other means. Control of sex in dairy cattle, longtime storage of fertilized ova, and fertilization in a test tube may become feasible. Scientists have attempted to alter the normal sex ratio by destroying the fertilizing capacity of spermatozoa that carry one of sex-determining chromosomes or by separating the two types of spermatozoa in an electric field. Limited success has been achieved with laboratory animals. A cow’s ovaries can be stimulated by injections of hormones to produce several eggs during each estrus cycle. These eggs can be fertilized by the usual insemination technique or they can be removed from the oviduct and fertilized in vitro. Each fertilized egg can then be placed in the uterus of a host cow, where it develops. Although maintaining pregnancy in the host cow is difficult and expensive, this may become a way to increase the influence of genetically superior females. (Harvey E. Shaffer)
Expectation, an outstanding A.I.-proved sire.

Five of Expectation's daughters in the herd of Ray Simpson, Butler, Pa.
The herd of A. S. Hallock Estate, Laceyville, Pa., illustrates the results that can be achieved when A.I. service to outstanding sires is combined with good feeding and management. Since 1950, all of the cows in this herd have been sired by bulls in the Nepa Artificial Breeding Cooperative. The D.H.I.A. herd average has exceeded 13 thousand pounds of milk and 500 pounds of fat each year since 1950, and the 10-year average is 14,265 pounds of milk and 569 pounds of fat. The 18 cows classified in 1961 were sired by 13 bulls and had an average score of 81.5.

This calf was born in the herd of John Melchor, Easton, Pa., more than 5 years after her sire, Lauxmont Admiral Lucifer, had died. Frozen semen was used.