Policy Implications of New Technologies in the U.S. Dairy Industry

Farrell E. Jensen,* Robert L. Park, Daniel B. Waggoner, David K. Waggoner, and David R. Dyer

Technologies covered in this report are embryo transfer, freezing of embryos, embryo sexing, in vitro fertilization, transgenic animals, cloning by nuclear transplantation, and bovine growth hormone. The nature of the technologies are described and their economic implications are discussed. The purpose of this paper is to help those in policymaking roles better understand the nature of the technologies and establish rational policies to deal with their introduction. It is essential that the government have a cost-effective, flexible policy to assure that producers and consumers receive benefits of technology. At the same time, attempts should be made to mitigate potential negative economic impacts from implementation of the new technologies.

DESCRIPTION OF CURRENT TECHNOLOGIES AND LIKELIHOOD OF SUCCESS

Embryo Transfer

Embryo transfer technology is a method of expanding the reproductive capabilities of genetically superior cows. A single cow is capable of producing up to 75,000 fertilizable eggs in her lifetime, although in each normal estrous cycle usually only one egg matures. Embryo transfer technology allows a superior cow to theoretically generate up to 50 offspring/yr with current technology. Involved are the steps of superovulation, insemination, recovery of embryos, storage, and transfer of embryos to recipients (18, 23, 62, 70, 81).

Superovulation is a procedure by which a donor cow is given intramuscular injections of hormones to stimulate maturation and ovulation of more than one egg (14, 28, 42). Individual donors can produce up to 50 eggs with an average of approximately five or six transferable eggs per flush and a range of zero to 15 or more. Frequently, the donor does not give any viable eggs. At the proper time of estrus, the donor is inseminated (15). This is usually done twice in 24-h to assure that as many eggs are fertilized as possible. Recipient cows are injected with specific hormones which synchronize their estrus with that of the donors and ensure that the uteri of the recipients are receptive to the transferred embryos.

Recovery of embryos is done most commonly by surgical methods, which cause less trauma to the donors. On Day 6 or 7 after the first insemination, both uterine horns of the donor's uterus are flushed with a buffered saline solution and the embryos are recovered. Embryos can recover 70% or more of the embryos for up to 24 h can be done in a buffered saline supplemented with serum albumin. More elaborate procedures, such as freezing, are required for long term storage.

Nonsurgical implantation and flank surgery are the methods used to transfer embryos to recipients. The most common nonsurgical method is to place embryos in the uterine horn via the cervix. In flank surgery, an incision is made in the flank wall and the embryo is pushed through the uterine wall into the uterus. Success rates range from 50 to 70% for both methods, depending largely upon technique.

Dairy trade journals routinely carry articles of embryo transfer technologies or laboratories, but the current market is generated by sales of high priced embryos intended for production of replacement breeding animals in herds (4, 19, 74). Frozen embryos are sold domestically and internationally (45).

All of the articles that have examined the economics of embryo transfer have emphasized costs (6, 34, 48, 63). Most research indicates that production from embryo transfer daughters alone to cover the higher costs of embryo transfer to artificial insemination and natural births (42). Individual genetic benefits of embryo transfer to the best cows in the herd as donors are too small.

Discounted cash flow analyses that consider the value of milk over the productive life of cows indicate that embryo transfer does not provide a satisfactory return on investment at current input and milk price conditions. Farms that can sell embryos or animals at premium prices can economically justify embryo transfer under economic conditions. Before this procedure is adopted for commercial milk production, cost-effective...