ANIMAL BREEDING

Bullseye

THE first deep-frozen bull has been born. Late last week a healthy bull calf was born to a cross bred Hereford-Friesian cow at the Agricultural Research Council's Unit of Reproductive Physiology and Biochemistry at Cambridge. Nine months ago the embryo of the calf was immersed in liquid nitrogen having been removed, after fertilization, from the uterus of its true mother.

The bull calf is the first large mammal to be born after being deep-frozen as an embryo. If the technique is perfected it could have large commercial implications for the livestock industry.

In all, the Cambridge unit transplanted twenty-two eggs into eleven cows some nine months ago. The eggs all came from normal mothers fertilized by artificial insemination, and were removed from the uterus on day 10 of pregnancy, in the blastocyst stage.

The eggs were then frozen to $-196°$ C with dimethylsulphoxide, a cryoprotective (antifreeze) agent, replacing some of the water in the embryo cells to prevent ice forming within them. Having been cooled very slowly at $0.2°$ C a minute they were kept frozen for six days. They were then thawed at a rate of $360°$ C a minute in a $37°$ C water bath, and transplanted into the uterus of the host mother.

Only two of the eggs became implanted in the host uteri. Six weeks into pregnancy one cow was developing two embryos, but one of these died later in the pregnancy. Nonetheless, one bull was born successfully.

This success with cattle follows the development of the freezing technique with mice in the summer of last year by the Cambridge unit and by the Oak Ridge National Laboratory in the United States. The mouse and cattle programmes were in fact running virtually in tandem, but the faster rate of reproduction in mice naturally brought success there before success with cattle, which have a gestation period of about nine months. Similar experiments with pigs and sheep have not as yet been successful.

The failure with ten of the cows is attributed to damage to the embryos during freezing and thawing.

Dr Wilmut, one of the research leaders at the Cambridge unit, said this week that the freezing and thawing process undoubtedly kills some of the embryo cells. Because some differentiation has occurred in the blastocyst stage it is probable that in the unsuccessful attempts a number of vital cells were killed, whereas in the successful attempt the cells killed were replaceable.

Experiments already carried out with earlier stages of embryo development have not been successful, possibly because of the presence of the zona pellucida, a relatively tough membrane which surrounds the ovum and which complicates the freezing process.

Future experiments, Dr Wilmut said, will involve varying four factors—the stage of development at which the embryo is removed from its true mother, the rate at which the embryo is frozen, the rate at which it is thawed, and the composition of the medium in which it is frozen. Any one of these factors is crucial.

The potential value of the technique, however, makes careful experiments that may lead to a commercial system well worth while.

If perfected commercially, milk cows could be used to breed beef cattle. The saving would lie in not having to keep beef cows alive purely for breeding purposes. Milk cows could still be used for milk production before and after they carry beef cattle.

Equally the technique would allow genetic characteristics that are in danger of being bred out of cattle for economic reasons to be kept in cold storage for the day when these characteristics may again become commercially important. At present if certain gene strains are bred out then there is no way they can be recovered.

Entire herds could be transported around the world in liquid nitrogen flasks, and countries such as Australia, which are still free of certain European diseases, could import frozen embryos that time would have shown to be disease free, whereas at present cattle imports are strictly limited.

The technique would also allow for a careful record of genetic change to be kept, as frozen embryos could be developed decades after the eggs were first fertilized. The resulting animal could be compared to the types that have developed by natural selection. This could in time improve selection methods in cattle breeding.

But all this may be many years away. Developing a commercial freezing method with a high success rate could be a long job, and various refinements to the peripheries of the technique will be needed before frozen embryos become comercially available. For example a non-surgical method of transplanting the embryos will have to be devised as surgery is time consuming and expensive. But these problems are likely to prove quite minor. The problem that really needs solving is how to guarantee a high success rate.

SOVIET SCIENCE

Of Machines and Men

from our Soviet Correspondent

LUNOKHOD-2, which was rolled out on to the lunar surface on January 16, 1973, has completed its working programme after a life of five lunar "days" in which it traversed some 37 kilometres (approximately 3.5 times as far as the less mobile and less manoeuvrable Lunokhod-1).

Although in many respects the Lunokhod-2 programme continued its predecessor's work—spectrometer and penetrometer investigations of the chemical and physical properties of the surface rocks, the investigation of solar and galactic corpuscular radiation, and a continuation of the Franco–Soviet laser range-finding research to determine the exact distance from the Earth to the Moon (see *Nature*, **228**, 795 ; 1970)—certain features of the programme appear to be new.

The choice of landing site, on the eastern edge of Mare Serenitatis, enabled a detailed television study to be made of the transition region between mare and highland. In all, over 80,000 television pictures were received, with a stereoscopic system providing detailed interpretation of the relief—a matter of especial importance during the investigation of a major tectonic fault on the fourth working "day" (April 11–22, 1973).

Special emphasis, too, was given to the magnetic experiments. The greater range of mobility of Lunokhod-2 enabled variations in the magnetization of the surface rocks and variations of the lunar magnetic field to be measured over a fairly extensive track.

Another innovation was the use of laser direction-finding apparatus to determine the luminosity of the lunar sky in the visible and ultraviolet regions.

According to Academician Boris N. Petrov (*Pravda*, March 25, 1973), the Lunokhod programme of automatic lunar exploration, with its potentialities for long-term and long-range study of the surface, is envisaged as one of the main projects of the Soviet Space Programme, equal in importance with the Saylut series of orbiting space stations. Academician Petrov is closely connected with the planning of both types of research (he is one of the chief organizers of the proposed Soyuz/Apollo flight, and is chairman of the IFAC Committee on Automatic Control in Space) and may therefore be assumed to speak with detailed knowledge of both branches. In view of the recent setback to the Saylut programme, however (see *Nature*, **243**, 181 ; 1973), and the undoubted success of Lunokhod-2, a rethinking of priorities in Soviet space planning may well be in progress, with even greater emphasis being given to automata.