Application of Reproductive Biotechnology in Farm Animals: Case Study in Indonesia

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ABSTRACT

Several techniques in the animal reproductive science have been applied to accelerate the increasing of farm animal population. It is generally accepted that the reproductive biotechnology has a potential role in the expanding animal population. Recently, the use of biotechnology is more popular after "Dolly" born which was produced from the cloning technology. Until now it is recognize there are four generations of applied animal reproductive biotechnology such as artificial insemination (AI), transfer embryo (TE), in vitro embryo production (IVEP) and genetic engineering.

Parallel with these development, many researcher from developing countries have been deepen these technology in several developed countries. The aim of these program is to support the acceleration of expanding animal population. However, the application of these biotechnology has been hampered by several factors, such as (1). a high cost of the equipment, chemical and hormone ; (2) farmer education; (3) politic and economy situation in the countries and (4) an environmental factor. It is therefore that an application of the reproductive biotechnology in the developing countries is still limited only in the simple and cheaper technology such as artificial insemination, meanwhile the others rest technologies are still considered as a high cost technology.

Based on the field experience, it is concluded that the most still reliable applied biotechnology for farm animal in the developing countries is an artificial insemination. However others biotechnologies such as transfer embryo and in vitro embryo production can be applied in the developing countries in a certain research goal to promote the "genetic bank" especially to safe endangers species under government control.

Key words: biotechnology, animal population, developing country.

Introduction

Indonesia is one of developing country in South East Asia with 219 Million population. Agriculture still plays an important role on the main generating income for most of Indonesian peoples. However, agriculture management especially in animal husbandry is still managed in small scale.

Along with the improvement of human resources, the demand of animal protein such as meat and milk is increase rapidly. Number of livestock in Indonesia are not able to fulfil this demand. It is therefore, it could not be avoid to import livestock and milk from some countries. Furthermore, the Directorate General Livestock Services, Ministry of Agriculture resolved to struggling to fulfil these demand. Even, in year 2005 is targeted that Indonesia can fulfil himself meat consumption need.

Several effort has been conducted such as imported some proven bulls and high quality female cattle, improvement of the instrument facilities, improvement human resources by following

some training, and also to make the effort selection of high quality local cattle (Anonimus, 1999).
The purpose of this paper is to review the application of reproductive biotechnology in farm animals in Indonesia as representing a developing country and to analyse several factors involving the successful these technologies.

Reproductive Biotechnology terminology

Animal biotechnology definition covers an exploitation process of the animal or its component commercially. Based on that criterion, it is now widely recognize there are fourth generation of animal reproductive biotechnology such as an artificial insemination (AI), multiple ovulation and embryo transfer (MOET), in vitro embryo production (IVEP) and genetic engineering included transgenic and cloning technology.
Artificial insemination is regarded as representing the first step in the application of biotechnology to animal breeding (Polge, 1993). AI is the most important single technique devised for genetic improvement of animals. This is possible because a few highly selected male produce enough spermatozoa to inseminate thousands of females (Hefez, 2000). The successful of this technology was have influenced by discovery a method for the preservation of semen by deep freezing and a long- term storage at a low temperature. By frozen semen industry, it is possible to transport over long distance of frozen semen safely. Now it is widely recognized, that genetic improvement has been mainly achieved by AI breeding program and by selection of potential AI bull from superior population (Kraüßlich et al. 1997).
The history of second generation of animal biotechnology dates back to 1891 when Heape performed the first successful embryo transfer in rabbit. Since then successful embryo transfer have been reported in all farm animals. Commercialization of the embryo transfer technology began in North America in the 1970s (Jainudeen et al. 2000). Contrasted with the artificial insemination, embryo transfer can be used to obtain more offspring from valuable females and to accelerate genetic progress by facilitating progeny testing of females and thus reducing the generation interval.
The basic requirements for an ET program consist of : (a) a source of embryos, (b) a reliable method of transferring the embryos and (c). suitably synchronized recipient. Source of embryos normally produced in vivo from animals of superior genetic merit (donors) by multiple ovulation/embryo transfer (MOET) program (Siedel and Elsden, 1998). The basic science these process based on the mammalian ovary contain thousands of oocytes, but domestic ruminants shed only one or two eggs per estrous cycle. Superovulated donors are usually inseminated with frozen semen of proven bull. It is therefore, resulted embryo are expected have superior genetic merit.
Another technique to support ET program is in vitro embryo production (IVEP). IVEP in cattle can be obtained from oocytes of slaughtered donors or from live donors by ultrasound guided aspiration (Setiadi, 1996: Galli et al. 2001). The procedure involves collection of ovarian follicles, then completing three biologic steps: in vitro maturation (IVM); in vitro fertilization (IVF) and in vitro culture (IVC). Conflicting data have been reported concerning in vivo and in vitro development derived embryo and relatively poor in vitro development oocytes from live donors in comparison to slaughterhoused-derived oocytes (De Loos and Pieper, 1997). It is therefore, several culture system have been adopted to improve embryo quality (Setiadi, 2002).
The efficacy of embryo transfer depends on maintaining the viability of embryos from time of collection to the time of transfer. Now are widely recognized of successful cryopreservation of embryo. With these success, it has enable an international trade in cattle embryos. The transport of frozen embryo over long distance can be an inexpensive means of exporting livestock. Additionally, zona pellucida`s ability to prevent the entry of viruses into the embryo makes the export of embryos considerably safer than exporting live animals or semen (Hafez and Hafez, 2000).

Recent advances in genetic engineering enable scientists to uncover, rearrange and make copies or clones of genes. These technology was become popular after successful "Dolly Cloning" in 1997. It is now widely accepted that human or animal cell contain some 100.000 genes and at least 22,000 of these genes have been isolated and some specific function have been identified (Hafez and Hafez, 2000).
Originally, commercial interest in cloning technology centered on the production of a large number of genetically superior animals for biomedical and agricultural purposes (Stice et al. 1998). However, the research groups could not overcome embryo cloning inefficiencies and difficulties in producing multiple generation calves via recloning. Along with the lower pregnancy rates of cloned embryo, clearly cloning alone will not become commercially successful on a large scale until these problems are solved.

Biotechnology in Indonesia

This chapter will focused on the application of reproductive biotechnology in farm animal especially in large ruminant like cattle. The reason is that the technology on these animals is most advances compared with the other (Siedel, 1981).
Indonesia has more than 12,102,500 beef cattle and 334,000 dairy cattle (Anonimus, 1999). Number of these cattle can not fulfil daily need animal protein consumption of Indonesian people which more than 219 Million in year 2002. From these data, it is realized that to fulfil daily need meat and milk consumption, it can not be avoided to import livestock and animal product such as milk. At least 180,000 cattle and 62.5% milk consumption are imported per year (Anonimus, 2001). It is therefore, the government of Indonesia has been applied some animal reproductive biotechnologies to accelerate animal population.
Artificial Insemination as a first generation of biotechnology has been applied in Indonesia since 1953. To support these program, it has been developed in 1976 two AI centers in Lembang , west Java and in Singosari, East Java. The current production capacity of both AI Center is about 2,500,000 doses of frozen semen per year. It is therefore many of cattle in Indonesia have been inseminated with frozen semen. However, the frozen semen production is still not enough to serve more than 6 million AI acceptor (Anonimus, 2000) Even, in the era of decentralizing, many provinces proposed to build AI center to anticipated highly need of frozen semen. It is predicted that in year 2005 all AI center can produce 7,000,000 doses of frozen semen. Additionally, some trainings have been conducted to improve human resources qualification in handling the artificial insemination.
Different with AI technology, the biotechnology of Embryo Transfer (ET) and in vitro embryo production (IVEP) have been started to be applied for genetic improvement of cattle in Indonesia since 1995. The government has established the first ET station in Bogor, West Java.. Table 1. showed number of embryos produced period 1995 - 2001 by ET station either in vivo or in vitro.

Table 1. Number of embryos produced in Indonesia 1995 – 2001

Embryo Production system	Number of Embryos 1995	1996	1997	1998	1999	2000	2001
In vivo	319	587	587	472	206	410	201
In vitro	-	153	527	486	214	84	37
Total	319	740	1114	958	420	494	238

The peak of embryo production was happened in 1997, but after that year results of embryo production was decrease gradually. Several factors are involves to stimulate this situation such

as an economical crisis in Indonesia. As consequence, embryo production cost is more expensive than before.
It is reported that pregnancy rate of ET is still low. Table 2 showed the pregnancy rate of embryo transfer from field trial not more than 30 % (Siregar, 1999). Certainly these result are still lower than pregnancy rate after artificial insemination.
Many factors are involved the success of embryo transfer. Siedel (1983) suggested that important point to keep in mind the cause of low pregnancy is whether embryo or recipient are the limiting factors. On the Indonesian case, it seems the lower quality of recipient as the cause low pregnancy rate, since many embryos were transferred into different quality reproductive status of recipient derived from different farmers.

Tabel 2. Pregnancy rate of embryo transfer in Indonesia

	Embryo transfer period				
	1995	1996	1997	1998	1999
Number of transfer	221	207	292	868	267
Pregnant cow	62	57	66	148	47
Pregnancy rate (%)	28.05	27.54	22.60	17.05	17.60

Although cloning in a species such as dairy cattle has potentially effects on the efficiency of selection (Collleau and Biochard, 1997), but the application of this technology is not yet widely applied in Indonesia. This technology is still regarded very expensive. However, the research on genetic engineering in the laboratory animal to produce chimera has been started.

Conclusions

Although AI is only single technique devise for genetic improvement, but it is recognized that AI is still reliable technique for developing country to improve and accelerate animal population. The others biotechnology such embryo transfer and in vitro embryo production have been applied only in the limited Livestock area. Furthermore, the Government involvement in application of biotechnology is needed to support and conserve animal genetic resources by development “ Genetic banking”.

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