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Preservation of Animal Genetic Resources in Japan

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Abstract

This paper reviews the current status of animal genetic resources in Japan. The animal gene bank project of the Ministry of Agriculture, Forestry and Fisheries, Japan was initiated in 1985. The project covers cattle, horses, pigs, sheep, goats and chickens for farm animals, field vole, mouse deer, etc. for laboratory animals, and silkworms and honeybees for insects. The total of 830 animal genetic resources will be collected until 2000. These animal genetic resources have been preserved in the form not only of live animals but also of frozen semen and embryos to reduce preserving costs. The characteristics of these resources have been analyzed on the basis of reference manuals, the records of which are stored in a data base. It is required to further develop more effective methods for preserving animal genetic resources. It is very necessary to build up a closer connection will home and overseas organizations.

Discipline: Animal industry
Additional key words: data base, gene bank, native breeds

Introduction

The world's animal husbandry is sustained by small groups of livestock breeds which have proved to be economically valuable. For example, almost all the dairy cattle raised in Japan are Holstein Friesian and the share of the other breeds such as Jersey occupies only 0.35% of the total in 1989. Middle Yorkshire had been raised in the country as purebred pigs and the rate of this breed reached 82.3% in 1963. However, in accordance with the introduction of imporved breeds and the increased crossbreeding, Middle Yorkshire has drastically decreased, reaching the level of less than 0.03% in 1989[1]. As a smaller number of local breeds were raised, the genetic variability within such breeds was reduced, accordingly. It is essential for the improvement of animal breeds and research development of animal genetics to maintain genetic variations of animal resources in the country. For this reason, every effort has to be initiated immediately to preserve local breeds, especially those in an extinct position.

Outline of the MAFF gene bank project

In order to preserve a wide range of animal genetic resources for practical use, the MAFF (Ministry of Agriculture, Forestry and Fisheries) gene bank project was initiated in 1985. The project aims to survey, introduce, classify, identify, evaluate and preserve those genetic resources from Japan and overseas, and further expand the genetic resource information stored in a data base.

As shown in Fig. 1, the central gene bank for the animals located in the National Institute of Agrobiological Resources and the two laboratories: i.e. Animal Germplasm Evaluation and Animal Germplasm Preservation, were newly established in 1986 to undertake this project. The subsidiary gene banks consist of the National Institute of Animal Industry, the National Institute of Animal Health, the National Institute of Sericultural and Entomological Science, and the National Livestock Breeding Center. The project is implemented in collaboration of these central and subsidiary banks, each of which shares responsibilities in charge of genetic resources of

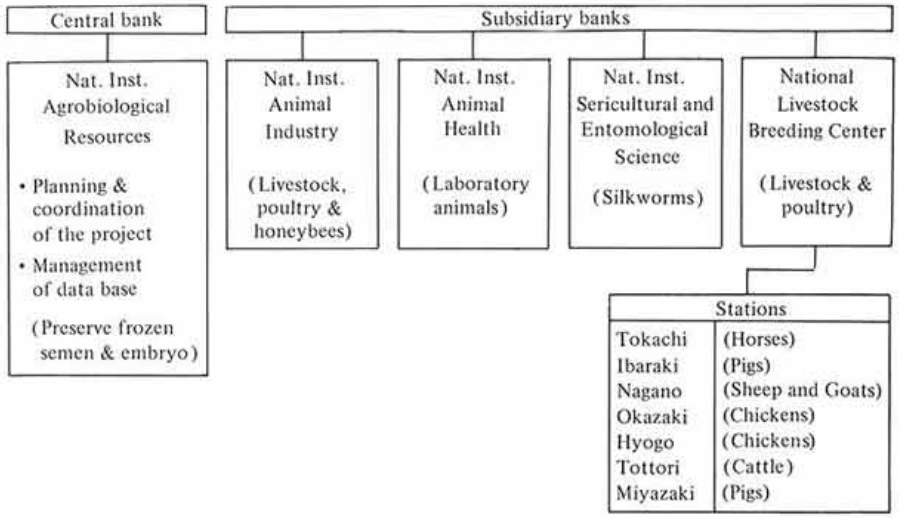

Fig. 1 Structure of the animal gene bank project in Japan

Table 1. Major native animal breeds in Japan

Species	Name of breed	Location for rearing	Estimated number
Cattle	Kuchinoshima Wild Cattle	Kagoshima	80
	Mishima Cattle*	Yamaguchi	68
	Japanese Black	Hyogo etc.	657,000
	Japanese Brown	Kumamoto, Kochi	64,000
	Japanese Poll	Yamaguchi	478
	Japanese Shorthorn	Iwate etc.	21,000
Horses	Hokkaido Pony	Hokkaido	2,561
	Kiso Pony	Nagano	90
	Misaki Pony	Miyazaki	84
	Miyako Pony	Okinawa	19
	Noma Pony	Ehime	35
	Taishu Pony	Nagasaki	89
	Tokara Pony	Kagoshima	118
	Yonaguni Pony	Okinawa	112
Goats	Shiba Goat	Nagasaki etc.	190
	Tokara Goat	Kagoshima	100

* A natural monument.

Table 2. Major native poultry breeds in Japan[4]

Name of breed	Location for rearing	Estimated number
Chabo*	Chiba, Gunma, Kanagawa Kumamoto, Osaka, Saitama Shizuoka, Tokyo	more than 5000
Hinaidori*	Akita	2000~5000
Jidori*	Mie, Kochi, Gifu	less than 500
Jitokko*	Kagoshima	less than 500
Kawatiyakko*	Mie	less than 500
Koeyoshi*	Aomori, Akita, Iwate	500~1000
Kurogashiwa*	Shimane, Yamaguchi	less than 500
Minohiki*	Aichi, Shizuoka	500~1000
Minohikichabo*	Kochi	1000~2000
Onagadori*	Kochi	less than 500
Satsumadori*	Kagoshima	2000~5000
Shamo*	Aomori, Akita, Chiba, Kochi, Ibaraki, Tokyo	more than 5000
Shokoku*	Mie, Kyoto, Shiga	1000~2000
Toumaru*	Niigata	1000~2000
Toutenkou*	Kochi	1000~2000
Ukokkei*	Hiroshima, Kagawa, Mie Osaka, Tokyo, Yamaguchi	2000~5000
Uzurachabo*	Kochi	1000~2000

* A natural monument.

designated animal species[2] (Fig. 1).

Native breeds in Japan

The main native animal breeds which have been reared in Japan are shown in Tables 1 and 2. A native breed is here defined as follows: a breed that was introduced to Japan before the Meiji era (1868) and its offsprings have survived there ever since. A majority of those breeds are designated as natural monuments in Japan, and they are rarely used for animal husbandry at present. The conditions for

Table 3. Major animal genetic resources preserved by the gene bank project, Japan

Species	Name of breed	Method of preservation
Cattle	Mishima Cattle	Live animal, Frozen semen & Embryos
	Kuchinoshima Wild Cattle	Frozen semen
	Japanese Brown	Live animal & Frozen semen
	Japanese Poll	Live animal & Frozen semen
	Japanese Shorthorn	Live animal & Frozen semen
Horses	Kiso Pony	Live animal & Frozen semen
	Taishu Pony	Live animal & Frozen semen
	Tokara Pony	Live animal
Pigs	Middle Yorkshire	Live animal & Frozen semen
	Berkshire	Live animal
	Bouso Landrace Strain	Frozen semen
	Tateyama Landrace Strain	Frozen semen
Goats	Tokara Goat	Live animal
	Shiba Goat	Live animal
Rabbits	Japanese White	Live animal
Chikens	Tosa Native Fowl	Live animal
	Nagoya Native Fowl	Live animal
	Toutenkou Fowl	Frozen semen
	Koeyoshi Fowl	Frozen semen
Honeybees	Native Honeybee	Live animal

preserving them are quite inadequate, since rearing of those breeds has mainly been entrusted to small groups of charitable persons without any systematic support from others.

It was planned to collect a total of 830 breeds by the end of 2000, the numbers of which were estimated on the basis of 557 collections covered at the initial stage of this project. The gene bank project has made significant progress, under which project a total of 677 animal genetic resources have been collected until 1992. They consist of: 18 cattle, 1 water buffalo, 8 horses, 28 pigs, 4 sheep, 4 goats, 5 rabbits, 96 fowls, 34 laboratory animals, 477 silkworms and 2 honeybees. One of the distinctive feature of animal genetic resources in Japan is that silkworms occupy a majority of the collections or 70.5%. Major collections under the gene bank project are shown in Table 3. The work plan of the project envisages further collections of the typical native farm animals by the end of 2000.

Status of preservation

In most countries, rare farm animals are usually preserved under natural conditions, while under the gene bank project of Japan, it is a basic principle for preservation that live animals are reared in a closed space of the subsidiary gene banks. The preservation of live animals causes various problems: i.e. high costs in keeping the animals, increased homozygosity within small groups, and depression of fertility through inbreeding.

To alleviate these problems for ensuring sustainable preservation of animal genetic resources in a live form, simulation models and computer programs[5] have been developed to predict genetic changes of animal populations of a small size. Fig. 2 shows changes in the expected genetic variances until 25th generation of selections[6]. Faster reduction of the genetic variances is estimated in a small population compared with that in a large one.

A cryogenic storage system has been developed to store sperms and embryos for a long period of time with a low operation cost. At the initial stage, frozen storage of spermatozoa has been employed for cattle, horses, pigs and fowls under this project. The viabilities of frozen-thawed semen of these breeds vary in a range of 50 to 90%, which does not cause

any serious problem in collecting ejaculated sperms to make frozen semen. On the other hand, as far as storage of embryos is concerned, there are great difficulties in various aspects, especially in storing a large number of embryos. In fact, in the case of farm animals with a high rate of inbreeding, the ovaries have no superovulative reaction, and quality of the recovered embryos is generally poor. For this reason, it is not easy to collect a sufficient number of embryos of the animal genetic resources. For example, in Mishima Cattle, which is designated as a natural monument in Japan, only 11 embryos could have been cryo-preserved so far, despite of every effort in superovulation embryos recovery treatment.

To overcome the difficulties involved, an advancement of new technologies in managing female gamete are required. They may include transgenic, embryonic stem cell, nuclear transfer and reconstituted embryos produced by fusion.

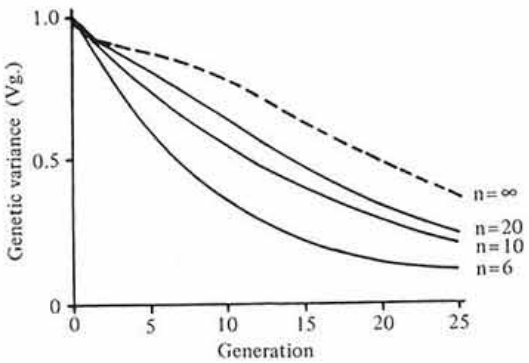

Fig. 2. Changes in expected genetic variances until 25th generation of selections for n=6, 10, 20 and ∞[6]

The assumptions are as follows: the number of individuals n=10, number of loci $l=20$, initial gene frequency $P_0=0.5$ for all loci, initial heritability $h_0^2=0.5$, and selection intensity i=1/2.

Evaluation and data bank of animal genetic resources

Evaluation of the characteristics of these animal genetic resources is based on the animal genetic resources characteristics investigation manual[3]. The characteristics concerned are divided into three classes, and the subjects for investigations in each class involve two items: essential and optional. The numbers of characteristics to be investigated vary owing to various conditions under which animal genetic resources are reared (Table 4). The primary characteristics of genetic resources are morphological, such as coat color and presence or absence of horns. The secondary items are developmental and physiological characteristics which have important scientific implications in utilizing those animal genetic resources. The characteristics in this category, such as blood components and chromosome numbers, require highly specialized technics for analyses. The tertiary items are the characteristics that are concerned with economic benefits, such as age of first calving and meat production.

Table 4. Characteristics of animal genetic resources for data base, Japan[3]

Classification	Characteristics	Beef cattle		Pigs		Broilers	
		Essential descriptor[a]	Optional descriptor[b]	Essential descriptor	Optional descriptor	Essential descriptor	Optional descriptor
Primary	Morphological characteristics: Coat color, horns, hump	10	12	5	11	10	1
Secondary	Developmental and physiological characteristics: Body weight, withers height, blood type	26	31	24	23	6	10
Tertiary	Economic performance: Dressed weight, milk yield, gestation length	36	19	29	28	38	1

a): Essential descriptor means the traits which are indispensable in data recording.
b): Optional descriptor means the traits which are optional in data recording.

Cattle		No.	Class 1	Essential Descriptors									
Char. No.	Characteristics	Methods	Classification										Remarks
			0	1	2	3	4	5	6	7	8	9	
1	Hair Length	Measurement				Short		Medium		Long			Short:under 1cm, Medium:1-2cm, Long:over 2cm
2	Hair Color	Observation		Black	Red	Brown	Yellow	Gray	White	Spotted	Fawn	Other	
3	Skin Color	Observation		Colorless	Colored								

Cattle		No.	Class 2	Essential Descriptors									
Char. No.	Characteristics	Methods	Classification										Remarks
			0	1	2	3	4	5	6	7	8	9	
28	Birth Wt. (♂)	Measurement	Number of Animals, Mean(kg), Standard Deviation(kg)										Measurement within 24 hours after birth
29	Weaning Wt. (♂)	Measurement	Number of Animals, Mean(kg), Standard Deviation(kg)										Measurement between 5 to 7 months
30	Yearling Wt.(♂)	Measurement	Number of Animals, Mean(kg), Standard Deviation(kg)										Measurement between 11 to 13 months

Cattle		No.	Class 3	Essential Descriptors									
Char. No.	Characteristics	Methods	Classification										Remarks
			0	1	2	3	4	5	6	7	8	9	
85	Age at puberty(♂)	Observation	Number of Animals, Mean(months), Standard Deviation(months)										Age of months at first mating
86	Age at puberty(♀)	Observation	Number of Animals, Mean(months), Standard Deviation(months)										Age of months at first mating
87	Gestation Period	Observation	Number of Animals, Mean(days), Standard Deviation(days)										

Fig. 3. Example of descriptor lists for cattle
Characteristics investigation manual for data base on animal genetic resources[3].

As shown in Fig. 3, each of the relevant characteristics is classified by scores varying from 0 to 9. The characteristics under investigations are put in order in a data base through a personal computer. Any information stored in the data base on animal genetic resources will be accessible and available for all researchers in the near future.

Discussion

Genetic resources that are not currently in great demand may have valuable potential for scientific and economic uses in future. It is therefore very necessary to collect and preserve as many breeds as possible to meet the needs by animal researchers. Toward this end, it is recommended that a closer connection be built up among national research institutions, universities, prefectural research institutions and zoos in Japan. It would be particularly required to develop effective maintenance methods of live animals with a small population and to innovate techniques for preserving frozen embryos, especially for silkworms and chickens. It is expected that animal genetic resources can be preserved on a genic level, and that a research program on the storage of genes as somatic cells and DNA fragments will be initiated in the near future. More detailed information on molecular genetics related to the collected resources will have to be investigated in future.

At an international level, it might be a well-accepted idea to preserve the animal genetic resources in the respective countries where they are reared. For effective and efficient preservation of those resources, bi- or multi-lateral cooperation is needed, especially in the field of technical improvements for resource preservation. It is also very necessary to organize information networks for the purpose of establishing an effective worldwide data base system on animal genetic resources.

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