Cattle

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ASIA-PACIFIC ECONOMIC COOPERATION

AGRICULTURAL TECHNICAL COOPERATION WORKING GROUP

Indigenous Bali Cattle: The Best Suited Cattle Breed for Sustainable Small Farms in Indonesia

Harimurti MARTOJO

Laboratory of Animal Breeding and Genetics, Faculty of Animal Science, Bogor Agricultural University, Indonesia

Introduction

Indonesia has a total population of around 206 million with 4.5 million households keeping livestock. About half of the cattle farmers are small farmers. The Indonesian archipelago is a land area of 1.8 million km^2 consisting of over 13,000 islands stretching from the Western tip of Sumatra to the Eastern border of Papua. The largest island, Kalimantan (Borneo), covers 28% of the total land area. Java, with only 6 – 7% of the total land area, is inhabited by around 60% of the total population and is the most densely populated island. The agro-ecological zones vary from the humid coastal wetland swamps in Sumatra, Java, South Sulawesi and Bali, to the sub-humid and semiarid dry land in the eastern part of Java, Sulawesi and most of the Nusa Tenggara islands. There is a wetter to a drier climate from the west to the east. Approximately 60% of the archipelago has about 7 – 9 consecutive months of rain in the wet season and less than two months with no rain in the dry season. The eastern islands have the lowest rainfall with the dry season varying from 3 to 8 months. The average temperature stays within a constant range differing in only a few degrees centigrade between the hot and cool months. The farming systems are regulated more by rainfall than temperature. The plantations and food crop areas are located primarily in the western wetter regions. Extensive marginal grasslands are in the drier eastern islands. Rain forest areas are found in Sumatera, Kalimantan and Papua, with limited areas on Java, Madura, Bali and Sulawesi. An alarming deforestation process is still occurring caused the illegal logging activities.

The soil fertility varies greatly, strongly affected by the climate and active volcanoes found in many of the large and small islands. The heavy rainfall causes soil erosion and high temperatures resulting in chemical weathering.

The eastern islands generally have very poor soils that prevent intensive farming. The animal production systems involve both ruminants and non-ruminants. Crops and animals are integrated with the benefits associated with the complementary interactions between these products. The economic benefits of these integrated systems contribute to their sustainability (Devendra, 1993).

Animal production systems

Only three major cattle production systems will be described (Devendra *et al.*, 1997).

1. The extensive grazing systems

   These are primarily low-input-low-output systems with less opportunity for improvement through the application of new technologies:

   - Native grassland grazing
   - Upland forest and forest margin grazing

2. Arable crop land and pasture combination systems

   The interactions between crops and animals are important in these systems, and the opportunities for interventions are significant:

   - Roadside and communal grazing combined with stubble grazing
   - Animals tethered or allowed free access
   - Grasses, crop residues and agro-industrial by-products stall-feeding

3. Systems integrated with perennial tree crops

   - Grazing under coconut, rubber, oil palm and fruit trees

In the first major system, the farmers are primarily small landholders with occasional tribal herds of a few hundred head owned by a tribal-head. In the second system, nearly all participants are small landholders. In the third system, the oldest traditional system, traditional small coconut plantation grazing is practiced. The third system is a relatively new effort, still being tried, to integrate large commercial plantations (rubber, oil-palm and fruit trees) with small landholder animal production (small and large ruminants).

Feed resources

In the Eastern islands, Nusa Tenggara Barat (NTB) and Nusa Tenggara Timur (NTT), large areas of native grasslands occur, and are grazed continuously throughout the year by buffalo, cattle and goats. These grazing areas are communal and no one is held responsible for the land maintenance. Most of these areas currently have fast growing weed infestation problems, namely *Chromolaena odorata*. Latest unofficial observations stated that about 80% of the edible native vegetation in the grazing lands in the NTT are covered by weeds, creating serious feed resource problems for the cattle and other ruminants.

The overall availability of feed for the ruminants is probably adequate, however the problem is unequal distribution. Sumatera is over-supplied, while deficiencies can be found in Java, Madura, the eastern Islands and Papua. Trials on forage integration with perennial tree crops such as the oil palm, rubber and fruit trees are in progress.

Most cattle feed on the native forages on wastelands, roadsides, unplanted land and crop-stubble. Cattle are stall-fed year-round in systems that are more intensive. In extensive systems, cattle are herded or let out to graze in the natural common grazing areas during the day and corralled at night.

The Bali cattle breed

The Bali breed is one of the four existing indigenous cattle breeds (Aceh, Pesisir, Madura and Bali) in Indonesia. The Sumban-Ongole and Javan-Ongole may also be considered local breeds. Although no official historical records exists, it is generally accepted that the Bali cattle is the domesticated direct descendant of the wild Banteng still surviving as an endangered species in three National Wild Reservation Parks (Ujung Kulon, Baluran and Blambangan) in Java.

Taxonomy of the Banteng / Bali cattle

Many taxonomical names have been given to the Banteng/Bali cattle. Some of these names are, *Bos sondaicus, Bos sundaicus, Bos javanicus, Bos bantinger, Bos banten, Bos bantinger, Bibos banteng and Bibos sondaicus* (Merkens, 1926). The last two names using Bibos are based on the opinion that the

Banteng belongs to a separate species (Bibos) from the other cattle groups (Bos). The Banteng are more closely related to the Gaur and Gayal. The earliest documented report on the Banteng was by Schlegel and Muller in 1836 (Merkens, 1926). They stated that the Banteng was found wild in small herds with a single bull and several cows and calves in the forests of Java and Kalimantan (Borneo). The Banteng is a large animal according to this report. The bulls have a withers height of 1.76 meters. The t'Hoen has a smaller wither height of 1.4 to 1.5 meters, and a chest girth of 2.0 to 2.1 meters. There is no recent report on the measurements of Bantengs still surviving in the Wild Reservation areas. This is because of the difficulty in catching these animals in the wild. The few samples in the Zoos in Java have no authentic records of their origin and dates of capture, casting doubt on whether they were actually wild Bantengs or just domesticated Bali cattle. The distinguishing difference between the Banteng and Bali cattle is the size and some behavioral traits.

The more recent taxonomical names adopted by the IUCN/SSC Asian Wild Cattle Specialist Group (Byers *et al.*, 1995), naming three subspecies of wild Banteng are the Burma banteng *(Bos javanicus birmanicus),* the Javan banteng *(Bos javanicus javanicus),* and the Kalimantan (Borneo) banteng *(Bos javanicus lowii).* How many subspecies should be recognized and included in captive breeding programs remains an unresolved problem. There is a need to further assess the genetic and phenotypic variations within the global population of wild Banteng utilizing new DNA technologies to determine the validity of the above three traditionally recognized subspecies.

Additionally, there are unresolved questions about the purity of the genetic status of the captive population. Many founder animals for the captive populations were Bali cattle, which is the domesticated form of the wild Banteng. Because Banteng can interbreed with common cattle, there exists the possibility that zoo populations may contain genetic material from Bali cattle X *Bos taurus* crosses. Domestic and feral Bali and other breeds of cattle are also a threat to the genetic integrity of wild Banteng populations in the National Wild Reserves in Java.

Conservation

Both the IUCN Red Data List and the U.S. Endangered Species Act classify the Banteng as endangered. This is based on an overall decline of at least 20%

over the last three generations. The Banteng is not currently listed by CITES, although the IUCN/SSC Asian Wild Cattle Specialist Group (Byers *et al.*, 1995) is seeking to have them listed as Appendix I.

There is no immediate concern for the Bali cattle considering the current total population estimate of 2.3 million head. There is some concern about the purity because of intensive crossbreeding programs using natural mating and AI using exotic breeds that may cause extinction because of indiscriminate crossing.

Current population estimates and distribution

The Banteng

No subpopulations of more than 500 Banteng are known and only six to eight subpopulations of more than 50 Banteng are known to remain (five or six on Java). The population trend on Borneo is unknown. The Banteng populations on Java are relatively stable, although there are threats due to illegal hunting, habitat destruction and diseases from domestic livestock.

The Bali cattle

The current population estimates (of 2000) for the Bali cattle in the five major resource areas are as follows (Talib *et al.*, 2002):

Resource area	Estimate of population size (in 2000), head
Bali	529,000
NTB	377,000
NTT	443,000
South Sulawesi	718,000
Lampung	255,000 (recently added resource)

There are other provinces with fast growing population numbers managed by small landholders. One of the most promising provinces is Southeast Sulawesi with a recent population of 300,000 head. These herds were started using small numbers of imported Bali cattle in 1923 and larger numbers during the five-year plans. Propagation was conducted through governmental owned cattle distribution to participating farmers and redistribution of the offspring to a growing number of participating farmers. This is another example of the

superior quality of Bali cattle as a pioneer breed for the farming system in many new cattle production areas (transmigration projects).

There is however some concern for the negative population growth trend of 12.3% on average in due to extraction during the monetary crisis years. Measures to halt this negative trend have been taken by local governments. The total populations of the major local breeds are as follows:

Breed	Population size, head
Ongole	1,033,000
Bali	2,632,000
Madura	1,131,000
others	4,980,000 (including exotic and crossbreds)

The Bali cattle have the largest number, showing it as the local cattle breed most suitable for small landholder cattle farming.

Characteristics

The Banteng is considered one of the most beautiful of all wild cattle species. They are most likely the ancestors of the domestic cattle of Southeast Asia. The Banteng are a sexually dimorphic species, with mature males being dark bluish black and cows and juveniles reddish brown. Both sexes have white rump patches and stockings. Both sexes carry horns, although they are much heavier and larger in the males. The Banteng are smaller and have a more even temperament than the gaur. There is a well-defined narrow dark stripe along the backbone, only seen in the calves and females. In bulls, the red hair on the body begins to darken at 12 – 18 months of age and by maturity, the animal becomes almost black. In castrated bulls, the black hair on the body changes to red again within a few months of castration. The body is relatively large-framed and well muscled. Adult males weigh between 600 – 800 kg, whiles adult females weigh between 500 – 650 kg. Their average lifespan in the wild is 11 years, although they can live to 20 – 25 years of age. It is very common for captive Banteng to live into their late teens or mid-twenties (Byers *et al*., 1995). These are humpless cattle.

Productivity traits of the Bali cattle

The Bali cattle are similar to the Banteng, differing only in size and temperament. Domestication has brought about smaller, easier to handle and docile animals. The average production traits of the Bali cattle females under the extensive farming system showed in Table 1 (Talib *et al.*, 2002)

Table 1. Production traits of the Bali cattle females

Trait	Bali	NTT	NTB	South Sulawesi
Birth weight, kg	16.8	11.9	12.7	12.3
Weaning weight, kg	82.9	79.2	83.9	64.4
Yearling weight, kg	127.5	100.3	129.7	99.2
Weight at puberty, kg	170.4	179.8	182.6	225.2
Mature cows weight, kg	303.3	221.5	241.9	211.0

Average mature bull weights for NTB, NTT and South Sulawesi range 335 – 363 kg and the corresponding weight for the Bali is 395 kg (Talib *et al*., 2002). Table 2 shows the reproductive performance and milk production of the Bali cattle (Talib *et al*., 2002).

Table 2. Reproductive performance and milk production of the Bali cattle

Trait	Bali	NTT	NTB	South Sulawesi
Age at puberty, yr.	2.0	2.5	2.0	2.5
Calving age, month	32	41	36	36
Calving interval, month	14	15.4	16	15.7
Calving rate, %	66.3	66.6	51.7	60.4
Calf mortality, %	8.5	48	15	8
Milk prod., kg/6 month	274.5	165	--	164

Those average figures for the cows are considered low compared to figures from the *Bos taurus* cattle in the intensive production systems in temperate zones. However, these figures are the highest among the indigenous cattle breeds in Indonesia, especially the calving rates. The figures in tables 1 and 2 were cited from the latest article presented in an ACIAR-CRIAS organized Bali Cattle Workshop held in 2002 (ACIAR-CRIAS, 2002). The data was based on

field observations and measurements in four areas from a limited number of animals. The measurements are likely influenced by the differences in environmental and management systems, thus making comparisons between these performances may not valid.

The Unique pioneering traits

A harsher environment induces smaller/lower performance in several traits such as lower calf birth weight, low milk production, lower calf growth rate and earlier calf age at foraging as well as cattle health resilience. A herd will also show lower birth rate (calving percentage/crop) and higher calf mortality under stressful climatic conditions. The smaller average growth rate and weight at different ages are also a herd survival adaptation. If necessary, a herd could revert to its wild ancestor feral/wild animal traits to survive in the wild without any human intervention. The proof of this can be seen in the feral Bali cattle populations in several small-uninhabited islands in Indonesia. The most extreme example of feral Bali cattle is the thriving population on the Coburg peninsula in Northern Australia.

The Bali cattle are a species that has the ability to show different phenotypes under different circumstances, also known as phenotypic plasticity. This ability may not be beneficial for intensive management systems. However, it is favorable for the small landholder system.

Genetic improvement (Breeding programs)

Pure breeding, cross breeding and selection programs was applied utilizing local and exotic breeds in Indonesia. The following is a concise report on the efforts started in the early 19th century (Merkens, 1926; Fordyce *et al.*, 2002; Martojo, 2002).

Ongole and Hissar breeds

Local breeds (Aceh, Pesisir, Madura, Bali, Javan-Ongole and Sumban-Ongole) were improved using Ongole bull from India. This was recorded in the 19th century using Ongole bulls and small sized local Javan-breeds (now considered extinct) in East Java. Ongole bull imports by several private plantation companies to produce larger draught cattle continued in small numbers. This was terminated at the end of the century due to rinderpest disease outbreaks in India. Massive Ongole cattle importation from India continued until 1920 on

Sumba island. In 1923, the number amounted to about 1,500 head. Sumba has been a source of breeding stock for other regions since then. The Hisar breed was also imported and used in Sumatra and Northern Sulawesi.

Madura breed

Starting early in the 20th century the Madura breed was maintained pure in Madura by closing the Madura from other breeds. Trials were started to propagate Madura cattle in Java and Flores Island. However, these cattle did not thrive and a gradual change was made to the Bali breed.

The Bali breed

In 1926 the Bali breed numbered 275,000 head in Bali and 125,000 in the Lombok islands. The Bali breed was then distributed to Timor, South Sulawesi and other regions in the eastern islands. After a century of effort, the highest population among the other breeds (local and exotic) totaled 9.8 million head of cattle consisting of 2.6 million head of the Bali breed. This has proven the superiority of the Bali breed for most agro-ecological zones in Indonesia. Most of theses cattle are in the hands of small farmers. The Bali breed is the best for small landholders.

Exotic breeds

Beginning with the second five-year plan in the 1970's, frozen semen from exotic cattle breeds was imported. Many crossbreeding programs using exotic bulls (*Bos taurus, Bos Indicus* and *Bos indicus* derivatives) or frozen semen (artificial breeding) in these regions were failed to yield desirable results. Success occurred only where zebu or zebu derivative crossbreeding was utilized. It is likely that such programs will never succeed in the harsh zones unless adequate fodder availability is assured and the farmers can afford the feed and concentrates required by the crossbred cattle. Most of the eastern island regions have plenty of grazing lands, but such lands are communal and not properly managed. Grazing on these lands is uncontrolled, leading to poor land productivity. Fodder cultivation is not in practice in these regions. The local Bali cattle survive primarily on fodder trees; grasses cut from forests, or graze in nearby forests. Fodder cultivation is not a priority for the small, marginal farmers that are the majority in the eastern regions.

Breeding programs for the small landholder farming system

The unique conditions in the small landholder cattle farming system has drawn special attention because efforts to improve productivity by introducing new technologies developed in the developed world ended in failure. New breeding approaches (Martojo, 2002; Talib *et al*., 2002), nutrition (Bamualim and Wirdahayati, 2002) and management programs (Fordyce *et al.*, 2002) were suggested in the ACIAR worshop.

The most current recommendation was the "Contribution to sustainable livelihood and development; Realising Sustainable Breeding Programs in Livestock Production" (INRA and CIRAD, 2002). This recommendation is based on the presence of three production levels: Level 1 – Subsistence-based Production, Level 2 – Market-based Production and Level 3 – High-input Production. The small landholder system fits in Level 1 and requires a special method for the planning and application of various improvement efforts.

Disease resistance

It is also a known fact that exotic and crossbred cattle are less resistant to parasitic infestation and diseases in comparison to local cattle. Poor transportation, communication, and marketing infrastructure make these regions inaccessible. Extension services are therefore poorly equipped to meet the requirements for the efficient technology transfer needed for most input-intensive improved breeds. Thus, after several five-year trials plans the government of Indonesia should have been able to determine a best breeding policy for the best suited cattle breed for the small landholders system. The Aceh breed for Aceh province, Pesisir for West Sumatra, Javan-Ongole for provinces in Java, Madura for Madura province and most importantly the Bali cattle for the other provinces and the Eastern Islands and Kalimantan were considered (Borneo).

Weaknesses of the Bali cattle

Despite it's superior qualities as a pioneer breed, this breed has weakness. The Bali breed has a unique susceptibility to the Malignant Catarrhal Fever, which is contracted through sheep as a vector. In provinces with a high sheep population, such as West Java, the Bali cattle cannot survive. Another disease

unique to the Bali cattle is the Jembrana disease. This disease also has a high morbidity rate. No economically effective vaccines have been developed for these diseases. Only Bali cattle originating from Bali island (which may have a higher rate of inbreeding as a result of decades of isolation due to conservation) and non-Bali cattle from the other areas (NTT, NTB and South Sulawesi) have this susceptibility. This major weakness has not influenced the government against using the Bali breed to improve existing populations or start new cattle populations utilizing the Bali breed.

Role of the Bali cattle in small landholder livelihood

Under harsh environmental conditions indigenous animals performed much better than the improved stock. It would not be a sustainable practice to improve the genetic potential of this breed by breeding under artificially improved conditions for higher production. Scientists and decision-makers in the regional and central government have underestimated Bali cattle. Local Bali cattle have been acclimatized over the years in these regions and have been integrated into the rural small landholder economy in marginal areas for various reasons. The important contribution of these cattle has been studied and reported as follows:

- As source of progeny (calves)
- Weight gain
- As a safe deposit (source of cash in emergencies)
- Insurance for crop harvest failures
- Draught animal in tillage work and hauling farm products
- Manure for fertilizer

The first two roles are biological production traits most studied and given the highest attention. However, the second trait may not be important in a harsh environment where survival is most important and faster growing animals may have a reduced chance for survival. In the grassland areas where crop planting is minimal, only the first and third traits are important.

Organic farming system

Environmental issues are becoming increasingly important internationally. The indigenous cattle are an important and integral component of the small landholder cattle production system. This cattle production system is

essentially “organic” in nature and the most sustainable system. The farmers also prefer indigenous cattle because they are less demanding and less prone to the problems usually associated with most of the 'improved' and/or crossbred cattle.

Ecological or organic farming is seen as an alternative to chemical intensive agriculture. One of the important points in this direction would be the development of indigenous technologies for ecological and economical farming methods. It has not been argued here that crossbreeding or external genetic interventions are non-sustainable. However, the rural small landholder regions in Indonesia cannot sustain these interventions because the agricultural production method in these regions is essentially low external input in nature. Thus, any external intervention calling for input-intensiveness would cause ecological imbalances that damage the long-term sustainability. Policies re-oriented towards maintaining the indigenous Bali breed and improving their efficiency, not through external genetic intervention, but through within breed genetic improvement are required. Effectively harnessing locally available resources is also an essential requirement.

Conclusions

Based on the facts discussed in this work, the Bali cattle can be considered the most suitable indigenous cattle breed for the low-input, high stress production system still practiced by millions of families in Indonesia.

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Fig. 1. A traditional Bali cattle market near Kupang, the capital of Nusa Tenggara Timur Province

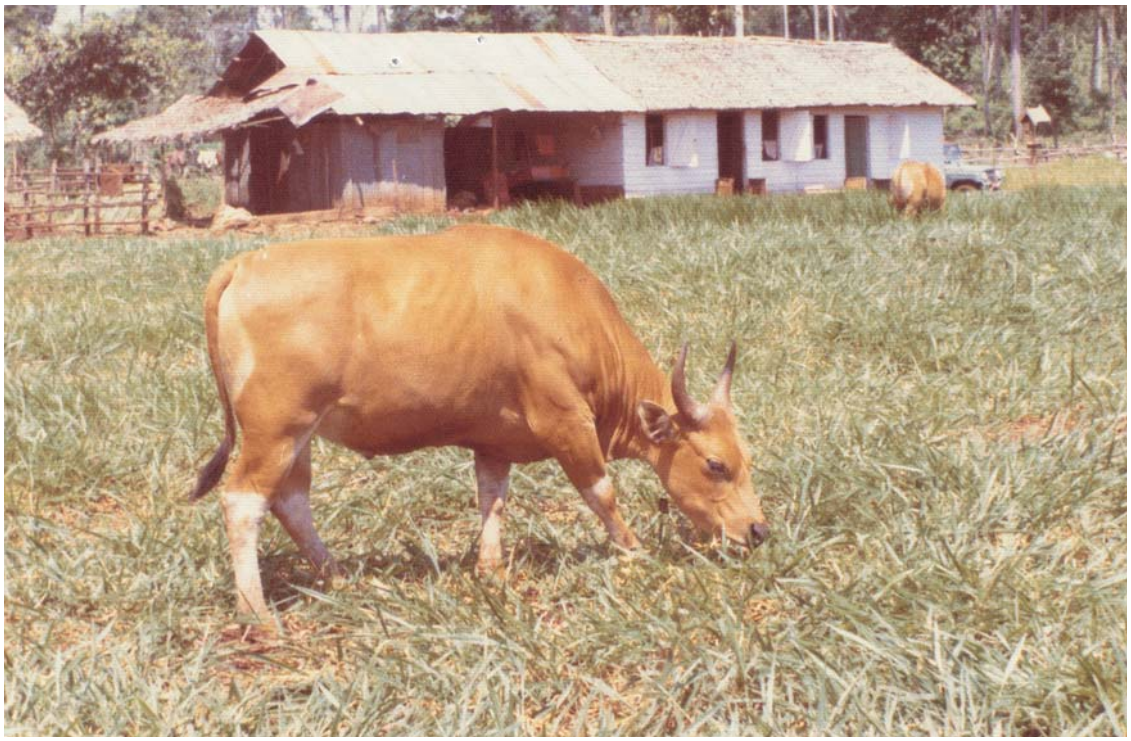

Fig. 2. An adult Bali cattle

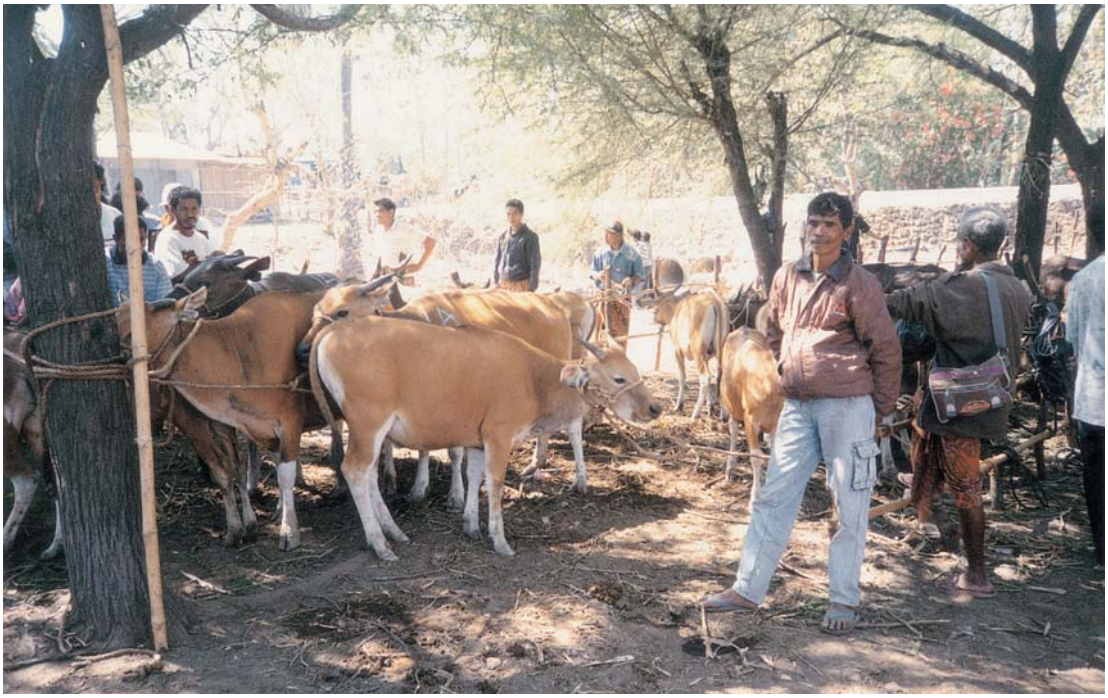

Fig. 3. Bali heifers in the foreground and young bulls are the ones with darker brown coats

Fig. 4. Cattle market and yellow trucks, transportation tools, in Kupang traditional Bali cattle market

Image of Taiwan Cattle

Yuan-Hui CHIU

The Center of General Education, Kao-Yuan Institute of Technology, Kaohsiung, Chinese Taipei

Introduction

Water buffalo and cattle might look slightly differ in their appearance or in biology classifications, but Taiwanese did not consider any culture difference between them seriously. Cattle and buffalo share the same character, "牛", in Han dictionary. Therefore, in the following paragraph, "cattle" were used as "牛", if not be referred intentionally. Cattle played an important role in the traditional village life in Taiwan society and had a substantial function, economic value, culture and historic meaning. Cattle carts were used by farmers to transport goods, as a vehicle, and the cattle were even sometimes straddled and ridden like a horse. Prior to the emergence of the farming tractor commonly named as "iron cattle", cattle were indispensable laborers in the paddy fields and sugarcane orchards. Cattle, in addition to their intrinsic value were essential players in a family's livelihood. Taiwan's development progressed from south to north, and was cultivated from the west to the east. As the cultivated land increased, the number of cattle increased rapidly from a few thousand to more than 200 thousand. On the Taiwan map made by Ching Dynasty, cattle were drawn with the homes that represented villages to indicate the developed areas. Cattle were therefore used as an index in the developed history of Taiwan and were internalized as a part of Taiwan culture and history. Taiwanese farmers used tilling cattle for three hundred years. Proverbs were written detailing the intimate life relationship and feelings between farmers and their cattle. Taiwanese farmers often referred themselves as cattle, thereby indicating the fundamental character of the farmer. The Taiwan Governor Headquarters looked upon the buffalo as the Taiwan image used in paying tribute to the Japanese Royalty during the Japanese Reign. A stage photograph of a Taiwan entertainment troupe performing in Japan shows the cowboy striding the ox as "coming from Taiwan". The cowboys astride the ox and cattle carts were sighted everywhere in the village forming a particular

spectacle in Taiwanese villages. Cattle's place in the village life of Taiwan was an index that could never be overemphasized. Cattle were not used merely for labor in the traditional village. They were livelihood animals closely related to the farmer's life. The Taiwan cattle (Fig. 1) have become a totem for Taiwanese.

Netherlander herding cattle

Netherlanders migrated from the Peng-Hu Archipelago to Taiwan in 1624. The Netherlanders occupied Taiwan as a stronghold for trade in the Eastern Hemisphere. Later on, Taiwan was discovered as a productive and potential virgin land for development. Cultivation was begun in southwest Taiwan. The Netherlanders began with livestock breeding, ushering in numerous cattle and establishing the Department of Cattle Husbandry. Then cattle were pastured to make profits in southern Taiwan (today Kaohsiung and Tainan areas). Picture was painted by a Spaniard in 1626, with two head of cattle bearing testimony to Netherlanders raising cattle in the City of Pu-Luo-Min-Che (today Chih-Kan, Tainan, Fig. 2).

Buffalo

The Taiwanese have a legend for why the buffalo and yellow cattle differed externally. The legend has it that once upon a time a buffalo and a yellow ox were taking a bath in a brook. They suddenly heard the sound of a tiger while bathing. They both hurried ashore to put on their garments to escape. Out of impatience, the yellow ox put on the buffalo's garment and scurried. Because the buffalo's garment was larger, a spare piece of cloth hung around the yellow ox's neck. This is the reason why there is a dewlap around the yellow ox's neck. However, the sluggish buffalo is larger than the yellow ox in stature and could not fit the small garment left by yellow ox. The buffalo put it on, leaving his neck uncovered. The Kuan Yin Buddha saw and took apart her puttee near the hem (customarily called Chiao Pai) to patch the buffalo's uncovered neck. This is why there is white skin surrounding the buffalo's neck. When the tiger moved away, the buffalo came back the brook and waited for the yellow ox to return. The yellow ox did not return so the buffalo shouted, "Change! Change!" ("Huan" is the word "change" in Taiwanese). The yellow ox cried, "No! No!" ("Mun" is the word "No" in Taiwanese). To this day the buffalo is still shouting, "Huan! Huan!" and the yellow ox is still crying back "Mun! Mun!". The buffalo was once the major draft animal

used by farmers to cultivate rice and greatly appreciated by Taiwanese before the "iron cattle" (farming tractor) arrived (Fig. 3).

Yellow ox

The yellow ox is strong in body and docile in nature. It is light brown or brown in color (Fig. 4). The male yellow ox is rather stout at the shoulder and rhombic muscle whereas the female has a slender rhombic muscle. The adult male yellow ox weighs about 340 kg. The adult female weighs about 250 kg. The yellow ox can plough non-irrigated fields 20 to 25 acres per 4-hour working period.

Ploughing the field

Four procedures are used in soil preparation; ploughing the field (Fig. 5), rough raking the field, fine raking the field and final mixing. The plough is the first-stage tool for scarifying the soil. Because rice must grow in soft soil saturated with water, the soil must be prepared after cultivation. Ploughing the field involves turning the soil in the lower earth levels and covering the surface soil used in the last season. By doing so, the surface soil used in the last season can recover and the rice straw and green manure are simultaneously merged into the soil to become fertilizer.

Procedure for raking the field

After the field soil is rough raked, fertilizer is sprayed once into the soil. Fine raking is then performed (Fig. 6). The farm implement used for raking the field is a rake shaped like the Chinese word "而". The farmers in Taiwan call this rake the "hand raker". This rake is more than 0.6 meter high, 1.2 meters wide, with 7 – 11 iron teeth. The number of teeth in the rake is increased or decreased according to the size of the farmland. There are two straight posts above the rake. Across these posts is a handle that the farmer holds. The farmer draws this tool with the ox. In doing so, the soil in the field can be raked into smaller fragments. The rake teeth collect weeds while fragmenting the soil. A piece of board is placed horizontally ahead of the rake in some districts. This board allows raking the soil and mixing the field simultaneously, saving the job of final mixing.

Cattle bamboo muzzle

The cattle muzzle used in Taiwan is made of bamboo strips or iron lines (Fig. 7). Muzzling can prevent the cattle from grazing on the crops ahead, ignoring tilling the soil or eating the green crops cultivated by the next-door neighbor. To extend in meaning, people call gluttonous children “cattle with no muzzle” in idioms.

Old picture of a cattle cart

The Cattle Cart has been available in Taiwan for more than 300 years. Taiwanese depended on it no less than the cars used in modern life (Fig. 8). In addition to tilling the soil and towing heavy objects, people “take cattle carts at any moment” for traveling, watching operas and so on.

Board wheel cattle cart

The greatest feature of the cattle cart was the wheels made of boards. This wheel consisted of three pieces of solid board with no distinction between the axle and the spoke (Fig. 9). The board wheel was some 5-6 feet high (the diameter of board wheel is 150-170 cm). A cattle cart with a high wheel makes much noise when the cart is traveling on bumpy roads. Uncomfortable hubbub, sounded like turning a wheel without oil, would keep going as the cart moved.

Iron leather wheel cattle cart

Improvement in the roads, the two-wheeled cattle cart was replaced by a four-wheeled cart with spoke wheels covered with an iron hoop (Fig. 10). The improved four-wheeled cattle cart could “carry more” than two-wheeled carts. However, it was no faster than two-wheeled carts on jolting roads.

Rubber wheeled cattle cart

The rubber wheeled cattle cart appeared post World War II, replacing the iron leather wheel cart (Fig. 11). The rubber wheeled cattle cart is still in use in the Taiwan countryside today.

Cattle cart and children

Not many modern Taiwanese children had the opportunity to ride in cattle carts as their parents had (Fig. 12).

Sugar refining

The stone-grinding wheel was the major equipment for old sugar refining (simple factory of making sugar). The grinding wheel was placed in the center of a house covered with cogon grass (Fig. 13). The grinding wheel was made of two parts, a "male and female stone" over a stone floor. Large-scale sugar refineries used three grinding wheels made of granite. The grinding wheel was operated using a cow drawing the wheel. Because turning grinding wheels required a large amount of strength, several cows turn doing the chore. Sugarcane with the tails removed was placed into the space between the two wheels while the cow turned the top wheel. Sugarcane juice was squeezed out, treated and processed.

The farmer's cattle market at Shanhua, Tainan

The "farmer's cattle market" is an open temporary market for the regular buying and selling of cattle. There were more than 80 farmer's cattle markets during the Japanese reign. Today only the Pei-Kang and Shanhua farmer's cattle markets exist (Fig. 14). The fixed dates for transactions at the Pei-Kang farmer's market in Chia-Yi are on the 3rd, 6th, 9th of each month. At the Shanhua farmer's market in Tainan the transaction dates fall on the 2nd, 5th and 8th. The main purpose of purchasing cattle in early times was for tilling and cultivating farmland. Four steps were involved prior to selecting tilling cattle to determine if a given cow was suitable for tilling and cultivating farmland. The four steps were touching the cow's teeth, testing the cow's steps, having the cow pull a cart and having the cow pull a plough.

Touching teeth

Adult cattle normally have 8 front teeth in the lower jaw. A cow with less than 8 teeth is considered too young or unhealthy. The purchaser identifies the cattle's healthy condition by counting the teeth, observing the color of the teeth and the degree of wear on the teeth to discern the cow's age (Fig. 15).

Dragging carts

Dragging carts could be a formidable challenge for a cow. Two or three cattle carts are generally joined together in a test of cart pulling. The front wheels of the carts are tied firmly with hemp rope. The cow is then whipped to make it drag the carts without the wheels moving. The buffalo drags the carts painstakingly with its' head nearly touching the ground (Fig. 16). The cattle harness is stuck deeply into the cows flesh. Only cattle with sufficient strength are able to drag carts with locked wheels.

Testing the cow's steps

Specialists observe the step test. Laymen only watch this exciting "hustle and bustle". The ox in the picture is having its steps tested. The owner leads the ox to circle around two or three times at the farmer's market. An experienced cattle dealer or farmer will probably judge whether this ox is docile or hardworking and assiduous. If it is a lazy ox it will "conceal itself behind the plough". If it is untamed, it will pay no attention to the owner's commands. After observing the ox's stride and appearance, the purchaser arrives at a decision regarding buying this ox or not (Fig. 17).

Negotiating a price and make the deal

After the procedures above, the buying and selling negotiation begins (Fig. 18). More often than not, a professional "cattle umpire" will initiate a compromise bargain on the scene. In early times, farmers went to the farmer's market to purchase cattle for tilling fields and hauling carts. Today the purchasers are butchers who buy cattle for meat sales. After the transaction, mark was made on the back of "sold cattle" (Fig. 19). As shown in figure, there seems an innocent look on the buffalo "man as cutting-tool, cattle as beef".

Cattle license during the Japanese occupation era

The farmer had to take his "Cattle license" card, an identification card for cattle, while leading the cattle into the farmer's cattle market in early times. During the Japanese Occupation Era, it was stipulated that each animal must receive a

cattle license identification card (Fig. 20, 21). The front side of the card showed the registered owner's name, address and four drawings of the front, back, left and right of the cow or buffalo's conformation. The hair whirl shape of the cattle was stamped to display the characteristics of the cattle. The overleaf side of cattle license showed the names and addresses of the previous cattle owners. The owner of the cattle had to have the cattle license with him at any time for immediate examination during the Japanese Occupation Era.

Taiwan cattle identification card after World War II

Cattle registration remained in effect long after World War II. The new cattle identification card is not different from the cattle license implemented during the Japanese occupation era (Fig. 22). Later on, the "iron cattle" (farming tractor) replaced ordinary farming cattle. Farming cattle gradually became unnecessary. The cattle identification card system was abolished in 1967.

Buffalo bath

The buffalo is heat intolerant by nature. Its temperature rises 2.7 degrees centigrade, pulse increases 131 times and respiration increases 27 times after being exposed to the sun. The buffalo must be coated with mud or sprinkled with water to survive high heat conditions. The effects of being sprinkled with water last for 20 minutes. A mud coating could last for more than 2 hours. The buffalo takes baths to reduce heat exposure while the farmer is herding it during leisure hours (Fig. 23). Fig. 23 shows two buffaloes gossiping while taking a bath.

Black Drongo riding the Buffalo

When cattle are pastured, the Black Drongo (the name of a bird) often saddles the cattle to eat insects and other parasites on the cattle (Fig. 24). Taiwanese liken the "Black Drongo riding on cattle" to a match between "a husband of small build to a wife of giant stature".

Racing cattle

Modern juveniles enjoy motorcycle drag racing. In past times "village cowboys" "raced cattle" for pleasure. "Driving the buffalo" was considered a matter of great

fun! In the Ching Dynasty, riding male yellow cattle (stout yellow cattle) came into vogue. The back of the yellow ox is equipped with an ox saddle. One “could ride hundreds of miles (1 Chinese mile ≈ 0.6 km) a day" on the saddled back of yellow cattle, which was equivalent to 20 – 30 Chinese miles per hour. When riding cattle, one hand controls the halter and the other hand brandishes a whip or something to coach the animal on. The children driving the buffalo in Fig. 25 is an example.

Fig. 1. Taiwan cattle (photo at the Tong Hai University neighborhood in 1991)

Fig. 2. Netherlander herding cattle (from the cover of *Early History of Taiwan* by Yung Ho Tsao, Lenking Publishing Corporation)

Fig. 3. Buffalo (photo at Men-Li village, Niao-Sung Town, Kaohsiung in 1990)

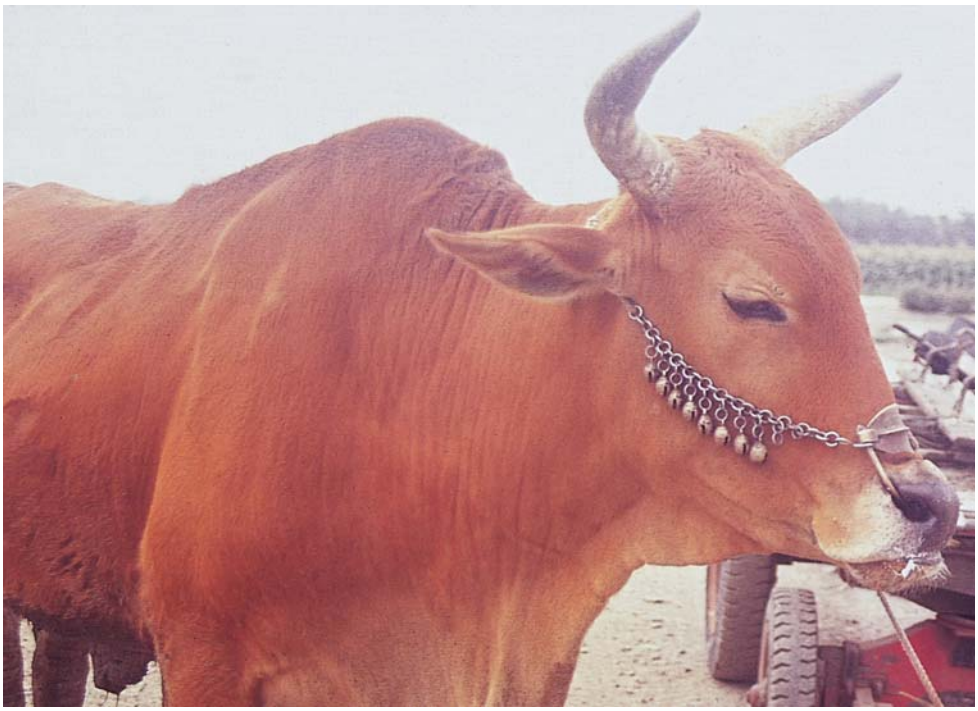

Fig. 4. Yellow ox (photo at Yuan Chang Town, Yun Lin County in 1999)

Fig. 5. Ploughing the field (photo at Tung Hai University neighborhood in 1999)

Fig. 6. Raking the field (photo at Kao Tan village, Jen Wu Town, Kaohsiung in 1990)

Fig. 7. Cattle bamboo muzzle (photo at Tung Hai University neighborhood in 1991)

Fig. 8. Cattle cart board wheel on an old painting (Photo from *Map of Taiwan* by Shu-Ching Huang during the reign of Emperor Kang - Hsi, Ching Dynasty)

Fig. 9. Board wheel cattle cart (photo at National Taiwan Museum in 1996)

Fig. 10. Iron leather wheel cattle cart (photo at the farmer's cattle market in Pei-Kang)

Fig. 11. Rubber wheel cattle cart (photo in Yuan-Chang Town, Yun-Lin County in 1999)

Fig. 12. Cattle cart and kids (photo at Tung-Hai University neighborhood in 1990)

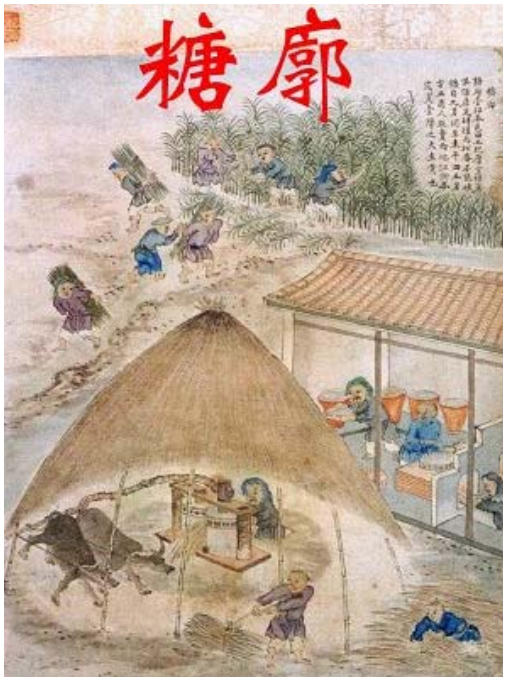

Fig. 13. Sugar refinery (*Fan She Tu Kao, History paintings of Natives)*

Fig. 14. The farmer cattle market at Shanhua, Tainan (photo by author in 1994)

Fig. 15. Touching teeth to judge the cow's age (photo at the Pei-Kang farmer cattle market in 1992)

Fig. 16. Dragging carts (photo at the farmer cattle market in Pei-Kang in 1992)

Fig. 17. Testing steps (photo at the farmer cattle market in Pei-Kang in 1992)

Fig. 18. Negotiating a price (photo at the farmer cattle market in Pei-Kang in 1992)

Fig. 19. Red paint marked a “sold buffalo“ (photo at the farmer cattle market in Pei-Kang in 1992)

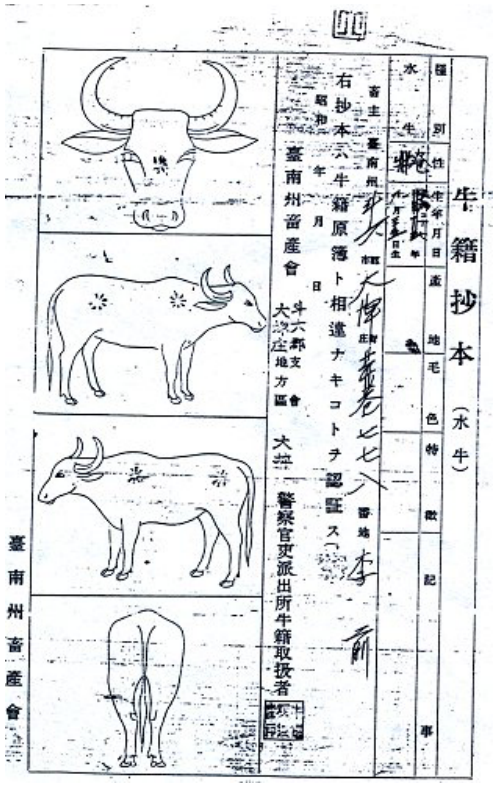

Fig. 20. Cattle license (front view) during the Japanese Occupation Era

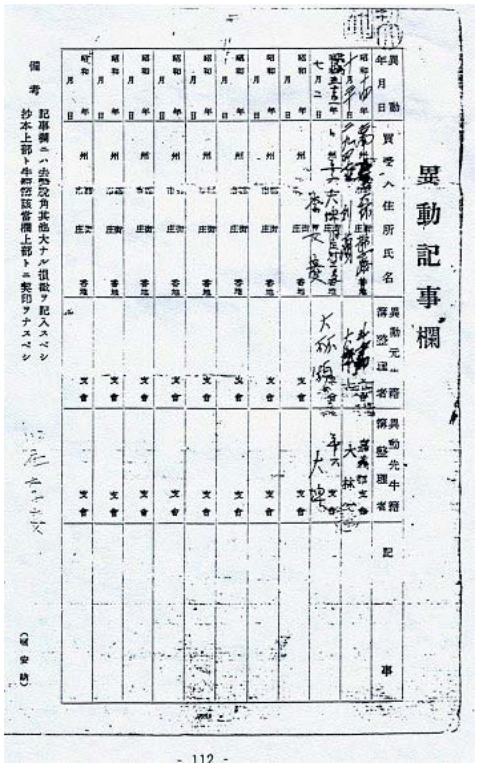

Fig. 21. Cattle license (overleaf) during the Japanese Occupation Era

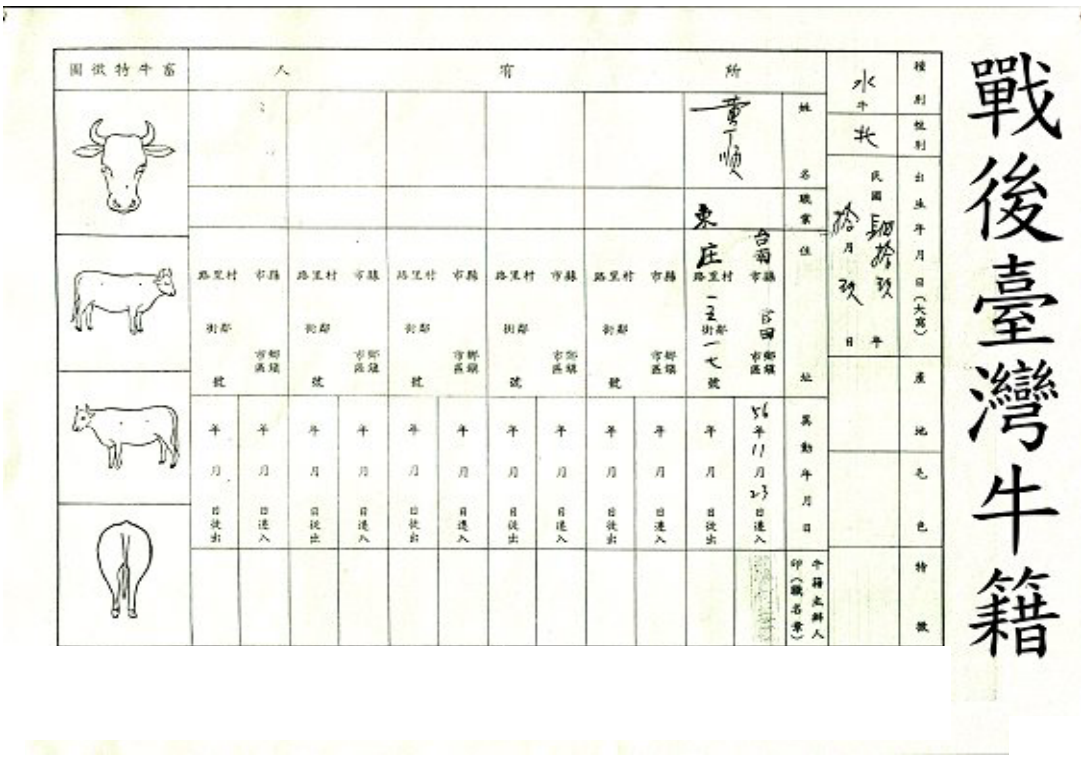

Fig. 22. Taiwan cattle identification card after World War II

Fig. 23. Spa or tub bath? (photo at Ta An Town in Taichung County in 1990)

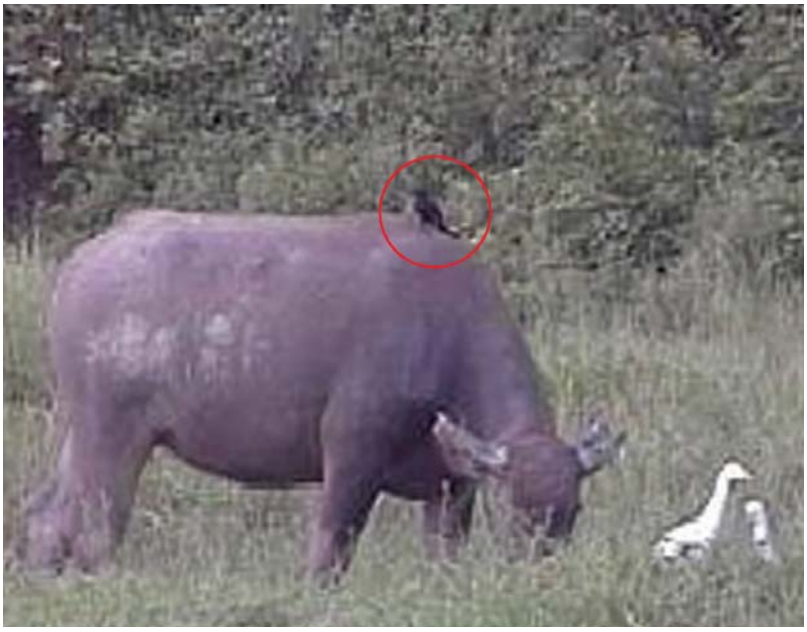

Fig. 24. Black drongo riding a buffalo (photo in Pei-Tou Town in Chang-Hua County in 1993)

Fig. 25. Racing buffalo (from Yuan-Hui Chiu. 1997. Taiwan Cattle. Yuan-Liu Publishing Corporation)

Like Cattle, Like Industrial Culture

Yung-Yi SUNG

Emeritus Professor of Animal Science Department, National Taiwan University, Chinese Taipei

Different breeds of cattle are suitable for different environments and thus results diversified cultures. Agricultural development manifests the social and cultural changes within a country and can result in multiple cattle breeds.

I. Taiwan Buffalo

There are two cattle breeds in Taiwan – buffalo and cattle. Both categories are not in the same genus, the genus *Bubalus* and genus *Bos*. These two genuses, therefore, cannot mate with each other. Buffalo genus is comprised of the Indian and African buffalo. The Indian buffalo consist of swamp and river buffalo with distinctive heads and appearances. The swamp type buffalo are distributed over Southeast Asia and are used to till farmland. The river type buffalo are popular in India, Italy and the Middle East for dairy purposes.

The Dutch brought the swamp buffalo from Java to Taiwan in 1624, whereas Chinese ancestors also introduced buffalo from Mainland China to Taiwan too. The buffalo in Taiwan are all swamp type buffalo. In the 1630s, between the end of the Ming Dynasty and early Ching Dynasty, the Chinese Emperor encouraged the Fukienses refugees from Fukien Province to immigrate to Taiwan with three taels of sliver for each refugee and one buffalo for every three refugees as incentive. This was known as the "one buffalo, three taels of sliver system". These swamp buffalo then became the Taiwan buffalo (Fig. 1). These Chinese ancestors worked with their buffalo and contributed to Taiwan's agricultural development, and thus brought changes to the aboriginal culture.

Buffalo domestication started in 2000 B.C. in China. Buffalo are adapted to water and are tolerant to heat. With large hoofs, mighty joints and steady steps, buffalo can move around easily in muddy soil and paddy fields. Buffalo

are excellent helpers in the rice paddies and, therefore, are perfect for Taiwan. The aboriginal Taiwanese used to grow calla taro as their staple food. Buffalo were used successfully to help farmers transformed the calla taro paddies into rice paddies. Without the buffalo the Han people would have to live the same way as the aboriginal Taiwanese. The buffalo were used to help farmers carry rice, sugar cane and sweet potatoes, in addition to tilling the rice paddies and breaking the soil. The farmers also used buffalo to crush sugar cane, peanuts and sesame seeds. Buffalo were also used to the mix soil for producing brick at brick furnaces.

By the time the Japanese occupied Taiwan in 1895, the number of buffalo had grown to more than double that of the Taiwan Yellow cattle (Fig. 2). From this agricultural development the number of buffalo continued to grow. The number of buffalo grew to more than several times that of the Taiwan Yellow cattle. According to Fig. 2, the number of buffalo was 6 – 7 times greater than the Taiwan Yellow cattle in Taiwan before the end of the Second World War. According to Fig. 3, the Taiwan Yellow cattle were sacrificed for food purposes due to the food shortages during the war but not buffalo. After the war was over, the number of buffalo and Taiwan Yellow cattle increased as agricultural development resumed. In October 1959, 3 male and 4 female Murrah – the river type buffalo used for dairy purposes, were brought from the Philippine to Taiwan by the government to attempt to cross them with local buffalo to upgrade the dairy productivity of local buffalo. However, the Murrah were quite different from the local buffalo in appearance, and thus farmers were reluctant to see their buffalo change (Fig. 4). The government plan eventually failed. Tractors replaced buffalo in the rice fields, as mechanical mobility became popular in the rural areas in the 1960s. The buffalo were gradually retired after they made remarkable contributions to Taiwan culture and economic development (Fig. 1). The 1st January 1985, All Taiwan Buffalo Show was resuscitated and held in Meilun, Hualien. However, which was the last buffalo show even summon up a lot of people in crowd to met buffalo and fling round with gratitude sign (Fig. 5) but means Taiwan buffalo no more were a work stock with Taiwanese like a family again.

The number of buffalo dropped significantly and only a few can be seen in Taiwan now. The Hualien Animal Propagation Station, Livestock Research Institute, Council of Agriculture, Chinese Taipei maintains buffalo (Fig. 6) for the research and work with zoos around Taiwan to prevent the ancestors'

friends from disappearing.

II. Taiwan Yellow Cattle

In addition to the Taiwan buffalo, there are Indian cattle (hump cattle; zebu; *Bos indicus*) and European cattle (*Bos taurus*) that originate from the northern and southern hemisphere. The Indian and European cattle are different with respect to their function and appearance. With large humps and dewlap, the Indian cattle are suitable for tilling and tolerant to heat with less succulent and rough taste in meat quality but less cooking loss. Imported European cattle were raised for dairy or beef purposes and commonly referred to as "cattle" with the features of tender and juicy meat. In the western world “cattle” is the collective term for livestock. The word cattle has the same origin as chattel and capital. In English, the first alphabet "A" is a hieroglyphic standing for ox head. In Greek, the first alphabet "α" originated from the "*Alef*" meaning “cattle” in the Semitic language. Both allusions stress the importance of cattle in ancient western culture. In Taiwan cattle represents the big animals and the person that becomes the “ox head” is a leader with great activity. In Taiwanese culture this would be stated, as “I would rather be a cock head than an ox’s tail”.

II-1. Crossing with various cattle species for improvement

Most Taiwan native cattle known as Taiwan Yellows belong to the same genus of Indian cattle, *Bos indicus*. The appearance of these cattle is similar to the British dairy cow Jersey breed (*Bos taurus*) (Fig. 7, 10). Results of blood typing indicated that Taiwan Yellows shared some genealogy with European cattle. Furthermore, Taiwan Yellows have tastier meat than that of the Indian cattle and thus many noodle shops in Chinese Taipei claim "Genuine Taiwan Yellow Meat" serving.

The Taiwan Yellow belongs to the same genus “zebu” as the cattle in the Philippines, Thailand, Vietnam, Cambodia and China' Yunlan Province. Taiwan Yellows were in Taiwan before the Chinese ancestors immigrated and thus recognized as the orthodox cattle in Taiwan compared to the buffalo. When the Dutch occupied Taiwan in 1624, there were more Taiwan Yellow cattle than buffalo. However, the Taiwan Yellows were crossed with various cattle breeds over the last 300 years. Therefore, both the appearance and function of these cattle have changed drastically.

Now Taiwan Yellows have changed completely from what they were a long time ago. Farmers in Taiwan were reluctant to cross buffalo with others and, therefore, the buffalo have remained unchanged. Evidence showed that the selfish Han race thought that the buffalo belonged to their ancestors and the orthodox Taiwan Yellows not. The Taiwan Yellows therefore faced various hybridizing attempts and appearance changed.

Changes in Taiwan Yellows reflect the evolution of agriculture in Taiwan. When the Dutch occupied Taiwan in the 17th century, many Indian cattle were brought to Taiwan from Indonesia in an effort to improve the cargo delivery efficiency. Indian cattle were then crossed with the Taiwan Yellows. The Brown Swiss, an improved breed of European dairy cattle, was brought to Taiwan together with dairy and beef dual-purpose breed known as the Devon in 1896 while Taiwan was under Japanese rule. Shorthorn cattle were also brought to Taiwan in 1906 and crossed with the Taiwan Yellows to improve the dairy productivity of the latter. However, this plan failed. The Indian zebu, Kankrej and Sindhi cattle, with large body size, humps and dewlaps were introduced to Taiwan and crossed with Taiwan Yellows. As a result, both the body size and hump of the Taiwan Yellows became stronger and larger and thus the agricultural efficiency improved. Since then, Taiwan Yellows have only served in agricultural purposes and helped farmers with tilling and shipping agricultural products (Fig. 10). The meat characteristics of Taiwan Yellows became more and more different from that of the European cattle, and thus, were no longer suitable for beefsteak production. However, it is perfect for stewing and braising of the Chinese cooking style. To cope with a severe food shortage, Taiwan Yellows were sacrificed for food in the last few years before World War II over (Fig. 3). After World War II, the ratio of the numbers of the Taiwan Yellows to the buffalo dropped to 1:7, a historic low (Fig. 2). The number of dairy Holstein cattle also decreased tremendously as the Japanese moved out of Taiwan after World War II. However, in the Taiwan recovery period after World War II, the number of buffalo and Taiwan Yellows increased greater than that of dairy cattle did (Fig. 2).

In 1962, the Hengchun Branch, Livestock Research Institute, Council of Agriculture, Chinese Taipei brought Santa Gertrudis, American beef cattle, to Taiwan for crossing with Taiwan Yellows. The plan worked

successfully and Taiwan Yellows were successfully transformed into beef cattle (Fig. 8). These cattle are no longer considered "work stock" only. Taiwan Yellows, in addition to conservation purpose and maintained in the Hengchun Branch, Livestock Research Institute (Fig. 9), was kept in rural areas for either beef or tilling purposes (Fig. 10).

II-2. All dairy cattle are artificially inseminated in Taiwan

Taiwan was developed based on agriculture but not livestock. Cattle were originally used for tilling purposes. Farmers used pig's excreta as fertilizer for farming. No farmers in Taiwan ever raised cattle for dairy purposes. In 1897, the Japanese brought the first dairy cattle to Taiwan and produced milk in the suburbs of Taipei. The scale of production was rather limited and far away from an industrial scale. Before World War II, the Taipei Emperor University's Ranch (now the Experimental Farm, National Taiwan University) kept a top milking record cow in Taiwan. The 5,003 kg milk with 3.15% fat was produced in 263 days. The highest daily production was 33.4 kg. In 1943, there were 75 dairy farms and 1,706 dairy cattle. This was the peak milk production period during the Japanese colonial period. Farmers lost their dairy cattle as World War II continued. By the end of World War II, there were only 47 dairy farms and 873 dairy cattle in Taiwan. The annual milk production amounted to 1,075 tons. Taiwan's dairy industry declined as the Japanese moved out of Taiwan. The US Relief Agency shipped 75 dairy cattle to Taiwan in 1947 and distributed to National Taiwan University and various agricultural improvement stations around Taiwan. Most of the 75 dairy cattle were Holsteins, with a few Ayrshire, dairy Shorthorn, Guernsey and Jersey. Later on dairy cattle donated by the USA were mated with Holstein bulls because no bulls of the same breed were available. As a result, all cows were up graded using Holstein bulls. In the 1950s, Taiwan's economy started recovering from the shadows of World War II. Taiwan's dairy industry resumed in 1957. The government assisted farmers in developing dairy production in addition to the traditional agriculture to cope with the increasing demand for dairy products.

On April 7, 1960, an artificial insemination research team led by Professor Teng-Yen Lee from National Taiwan University successfully inseminated a Holstein cow with frozen semen from the USA. Lee's achievement set a

milestone for the dairy industry using 100% artificial insemination with frozen Holstein semen in Taiwan. Taiwan's economy boomed and the national income started increasing from 1961. The people's living standard increased and, as a result, the demand for milk and beef increased tremendously. At the same time, mechanical mobility became more and more popular in the rural areas. Consequently, cattle were needed less for tilling and were raised for both meat and dairy purposes. The number of Taiwan Yellows decreased and the buffalo (Fig. 1) were no longer needed for tilling or work stock. However, beef consumption increased. With its milk production capability and tasty meat, Holsteins replaced the Taiwan Yellow cattle. Taiwan Yellows, buffalo and Holsteins reflect the changes in Taiwan local culture. With the growing popularity of Holsteins (Fig. 2), Taiwan is developing in a manner similar to European countries. The Holstein has replaced Taiwan Yellows and buffalo (Fig. 2). This speaks for the prosperity of Taiwan rural areas.

Fig.1. Taiwan Buffalo

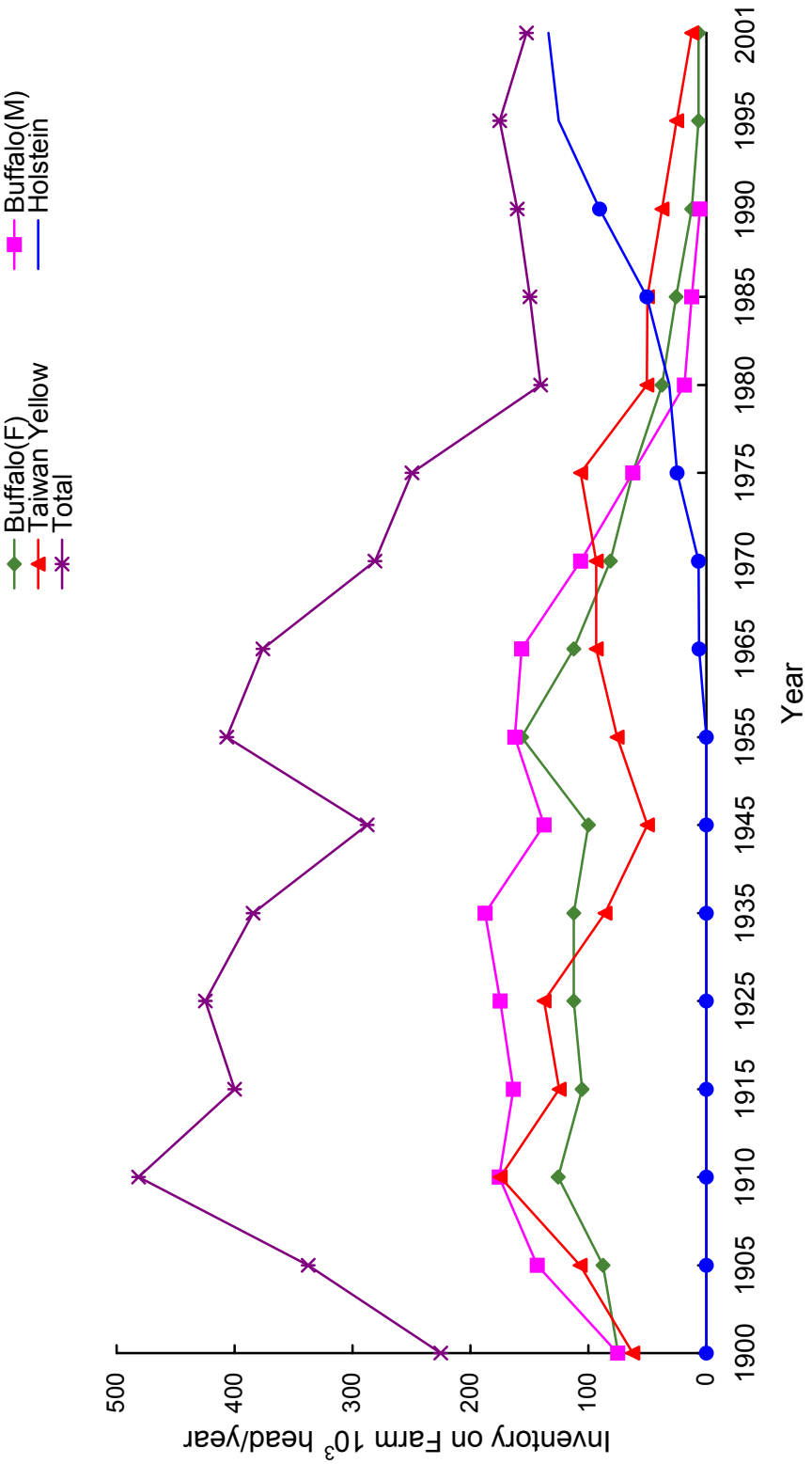

Fig. 2. Cattle inventory changes on farms over the last century in Taiwan

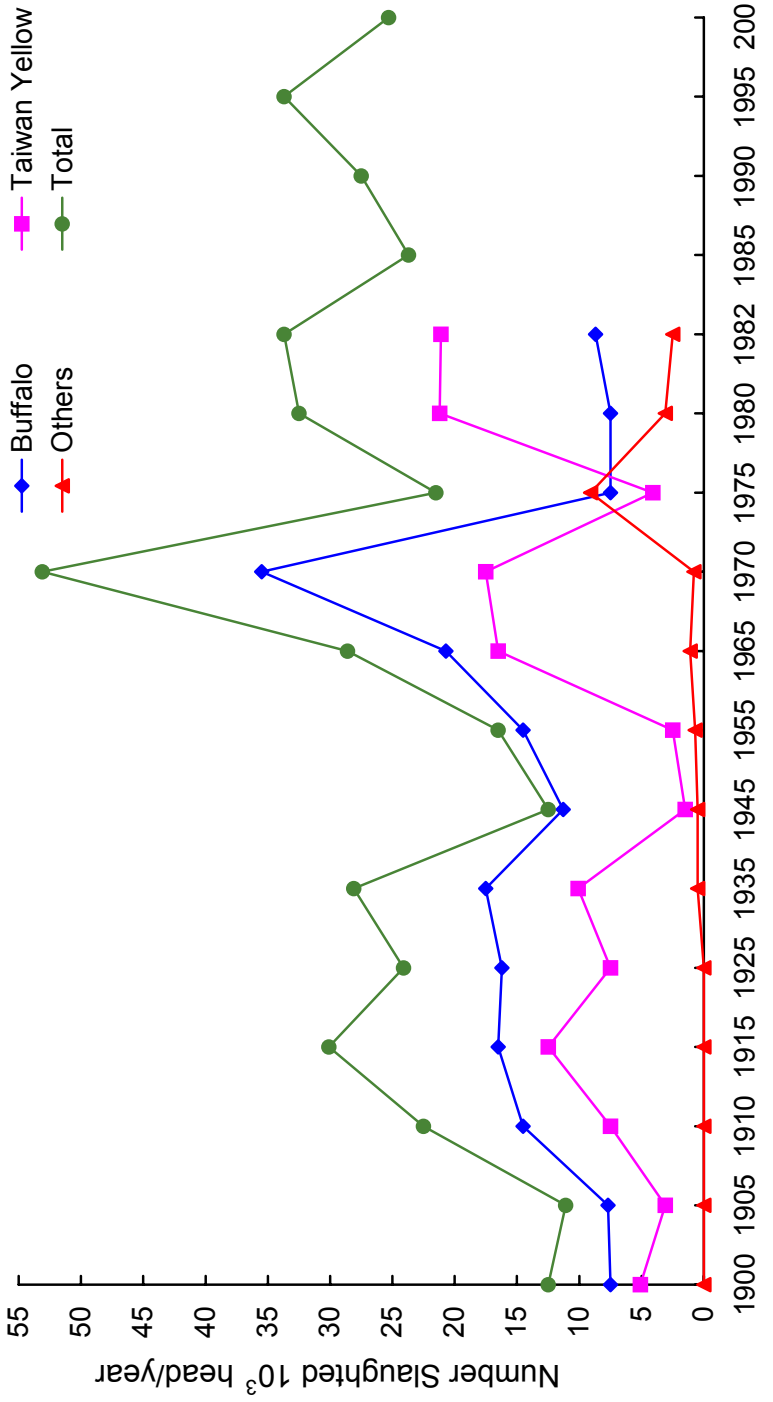

Fig. 3. Changes in the number of cattle slaughtered over the last century in Taiwan

Fig. 4. Murrah river buffalo

Fig. 5. All Taiwan Buffalo Show was held on 1st January 1985 in Meilun, Hualien

Fig. 6. Buffalo stock conserved at Hualien Animal Propagation Station, Livestock Research Institute, Council of Agriculture, Chinese Taipei

Fig. 7. Taiwan Yellows and Jersey Cattle

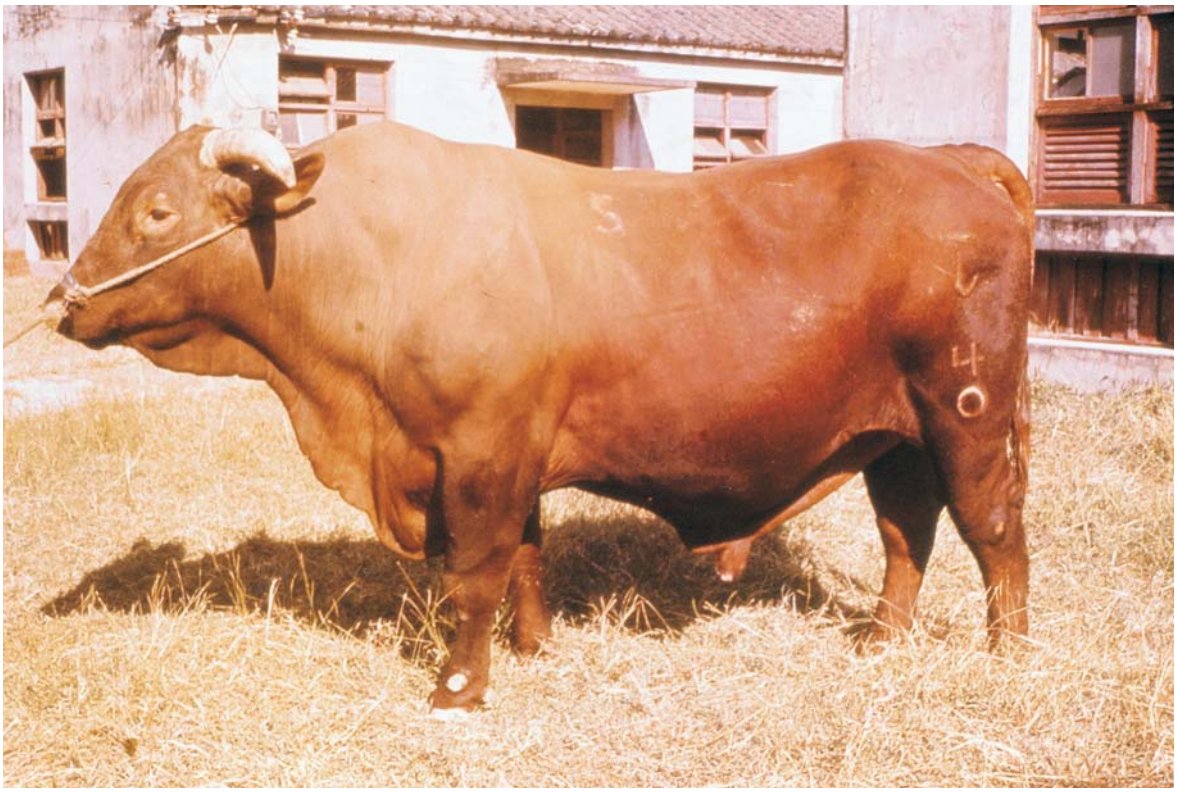

Fig. 8. Santa Gertrudis used in upgrading breeding system

Fig. 9. Taiwan Yellow Stock conserved at Hengchun Branch, Livestock Research Institute, Council of Agriculture, Chinese Taipei

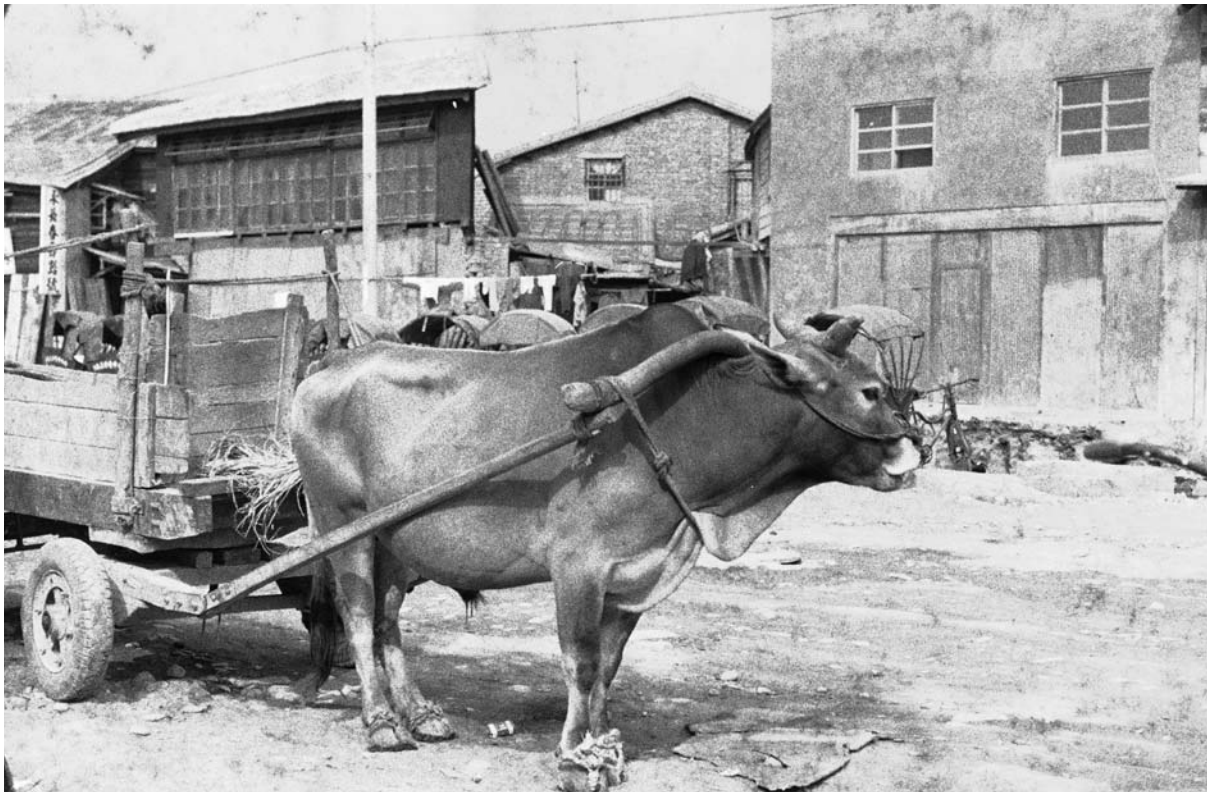

Fig. 10. Taiwan Yellow used as working stock

Cattle Genetic Resources in Japan: One Successful Crossbreeding Story and Genetic Diversity Erosion

Mitsuru MINEZAWA

Animal Genetic Resources Laboratory, Genebank, National Institute of Agrobiological Sciences, Japan

Kannondai 2-1-2, Tsukuba, Ibaraki 305-8602, Japan

I. Beef cattle production background

I-1. Historical features influencing cattle production

Besides pigs and ducks, *Sus scrofa* and *Anas sp.,* no ancestral domesticated animals naturally inhabited Japan. Domestic animals, such as pigs, cattle and chickens were introduced in the late Jomon (~ B.C. 500) to Yayoi Eras (B.C. 500 – A.D. 300). A Chinese historical book (~ A.D. 250) described that there were no cattle, horses or sheep in Japan. Because no descriptions of pigs and chickens were found in the book, the possibility of their existence could not be denied.

Several books written in the mid 7th century referred to cow's milk. Engishiki (A.D. 927), written in the Heian Era, is a description of the milk product, "So", surmised as condensed milk for medical purposes. A reference to a presentation of "So" to the government is made in this book. However, this habit was abolished at the beginning of the 12th century. The government banned the slaughtering of animals, cattle, horses, dogs, monkeys and chickens in A.D. 675. Cattle and horse slaughtering were abolished again in A.D. 742. This suggested that the people of this period ate meat.

After the prohibitory edict, meat and milk became less common. A pictorial book, written around A.D. 1700, introduced dairy products. However, the main use of domestic animals was for transportation of goods, farming, or military power. Some agricultural books introduced a feeding system aimed at manure production.

The history of domestic animals for practical food production in Japan is extremely short compared to most other countries. This seems due to two reasons. First, the climatic conditions in Japan are suitable for grain cultivation and the only purpose for cattle was to assist in rice cultivation. Second, for a long time Buddhism was predominant in Japan and prohibited the eating of meats; especially from four legged animals. The utilization of animal products did not become popular until the Meiji era; especially in the central region of Japan. Meat has been consumed in Japan for only about 130 years, the beginning of the Meiji era. Meat eating has only reached widespread popularity in the last 30 years. Therefore, Japanese cattle were not subject to improvement techniques for milk and meat production before the mid 1950's. The "Law for Improvement and Increased Livestock Production" was enacted in 1950. The law stipulated that the government was required to establish the goal of improving and propagating livestock, stating, "The minister of Agriculture, Forestry and Fisheries shall set specific goals by species concerning the improvement and propagation of livestock including cattle, horses, sheep, goats, pigs and other livestock stipulated according to the related ordinances and publicize each goal".

In the Meiji era, many foreign cattle were introduced to Japan and initially extensively crossbred with the native cattle under the leadership of the government. Through this, the gene pool for Japanese cattle were diluted and greatly expanded. After the initial frenzy of crossbreeding was over, cattle breeders began to improve and promote their own breeds without crossbreeding within prefectures. The unique characteristics of Japanese cattle were then established as found today. However, followed by the introduction and breeding efforts made in each region, most of genuine Japanese native cattle diminished and only Mishima and Kuchinoshima cattle remained in two islands, Yamaguchi and Kagoshima Prefectures, respectively (Fig. 1).

I-2. Domestic Animals in Japanese daily life

There are many traditional events related to a variety of livestock that are still held, particularly in relation to cattle and horses. These include "*ushioni*" at the Warei shrine, the cattle festival at Uzumasa, and sacred

rites relating to fieldwork (Tsuda, 2001) in rural Japan. At these events, living farm animals play a leading role, but unimproved indigenous livestock rarely appear. However, improved breeds are now being utilized even at these traditional events and festivals (Fig. 2).

Livestock production now takes place on a large scale. The presence and awareness of farm animals has gradually faded from ordinary life. Only a few species have been bred for specific purposes, such as cattle for bullfights, and Shamo, Onagadori and Naganakidori as fighting cocks and pet animals. Dishes using goat and pig meat in Okinawa Prefecture and "*kiritanpo-nabe*" using Hinaidori in Akita Prefecture are the forms of traditional cuisine utilizing traditional Japanese breeds. Most non-native species have already become familiar in ordinary Japanese life. With the exception of chickens, the handing down of these traditional recipes and breeds does not seem to have led to the protection of native animals.

II. Japanese native cattle breeds' description

In 2000, there were a total of 2,824,000 beef cattle and 1,764,000 dairy cattle in Japan. The beef cattle can be classified into two categories, indigenous and non-indigenous cattle. The former includes 1,700,000 Japanese beef cattle, named Wagyu, and the latter involves 461,000 non-indigenous dairy cattle and 663,000 corresponding crossbred animal. Wagyu includes four breeds, Japanese Black (93.9%), Japanese Brown (4.2%), Japanese Poll (trace), and Japanese Shorthorn cattle (1.0%). Each breed that developed its own history and distinct characteristics will be described follows. However, exotic cattle breeds contribute most milk production and more than 99% of the dairy cattle are Holsteins. Production from the two genuine Japanese native cattle is in trace proportions (Statistical Data Related to Livestock Improvement, 2001).

II-1 Mishima cattle (Fig. 3)

Mishima Island is situated at latitude 34°46' N and longitude 131°8' E with an area of 7.8 km^2 in the Sea of Japan. Mishima Island is small and with a restricted flat area. The rice fields are therefore small and terraced. Mishima cattle are suitable for small landholding farmers because of its small body size and good temperament. The first official record indicated that 350 cattle were annihilated for rinderpests in 1672. After that, a new herd was established. Four hundred thirty-three cattle were recorded in

1739 and about 400 cattle had been kept up to the Meiji Restoration in 1868. Mishima cattle can be thought of as the original type of Japanese Black cattle. They were designated a natural monument in Japan in 1928. After this designation, Mishima cattle have been kept as farm animals and for *in situ* conservation. More than 300 female Mishima cattle were kept up to 1961. The number decreased after that and only 33 females remained in the middle of the 1970s (Furukawa *et al*., 1997). The number of females has gradually increased to nearly 100 in 2002.

Mishima is classified as late maturing cattle with dark brown coat color and small horns as well as narrower body compared to the modern Japanese Black. The average wither height, chest girth and body weight of a mature Mishima female (60 months old) are 112.8 cm, 152.1 cm and 261.1 kg, respectively (Harada *et al*., 1996).

II-2. Kuchinoshima feral cattle (Fig. 4)

Kuchinoshima island is situated at latitude 29°58' N and longitude 129°55' E with an area of 13.3 km^2 at the north end of Tokara Isles 200 km south from Kyushu.

A record, written in 1727, indicated the existence of domesticated cattle in Kuchinoshima (Tomita, 1996). However, Hayashida and Nozawa (1964) suggested that these feral cattle were descendent from cattle of Kagoshima during 1918 and 1919 and that had escaped from pasturage.

The population size of Kuchinoshima feral cattle was 44 – 66 individuals in 1999. However, there were two Kuchinoshima cattle populations with 20 and 24 animals in 2001, respectively, conserved at Kagoshima University and Nagoya University. The body size of the Kuchinoshima cattle is smaller than the Mishima cattle. The average wither height and body length of a mature female are about 110 cm and 120 cm, respectively. The coat color is mainly black with a white spot in the belly and/or four limbs with brown color occasionally occurred.

II-3. Japanese Black (Fig. 5)

Most Japanese Black cattle were crossbred, producing a modern type of this breed. In the Chugoku district, several pre-crossbred strains (Tsuru) were developed during the Edo era (1600 – 1876). The primary function of these cattle was carrying firewood for steel production and used as

draft animals. After the Meiji restoration in 1867, the government encouraged the introduction of foreign cattle breeds for crossbreeding with native cattle to improve body size and milk production. As shown in Table I, various breeds were introduced and crossbred with regional native cattle. In consequence, the genetic diversity of the indigenous cattle was greatly expanded.

After the mid 1950's, agricultural machinery predominated and chemical fertilizer was more popular in agriculture, supplanting and reducing draft cattle use. This forced a shift in the reason for raising these cattle to beef production.

The Japanese Black is now found in all regions of Japan. This breed has increased in number in the Kyushu and Hokkaido regions. However, in the Chugoku region, which was once the main production region for this breed, the number of this breed has decreased.

The characteristics of the breed include dull black coat and skin, small to medium body size with withers height and body weight being 124 cm, 420 kg and 137 cm, 700 kg in mature cow and bull, respectively. This breed has horns, but no humps. The milk yield over 180 days is about 1000 kg. Compared to the other Japanese indigenous breeds, the Japanese Black are noted for their capacity to produce high degree of fat marbling beef with a thin fat layer beneath the skin and surrounding the internal organs.

II-4. Japanese Brown

The Japanese Brown breed has two distinct strains and reared mainly in Kumamoto and Kochi prefectures, respectively. The developmental processes of these strains are quite different and usually described separately:

II-4-a. Kumamoto strain (Fig. 6)

The Kumamoto cattle is a red colored strain in Kumamoto prefecture originally developed from imported Korean cattle. After the late 1900's, this breed was crossbred with many imported foreign breeds such as the Simmental and Devon breeds. A large body size crossbred cattle was produced when Simmental cattle was used. The features of this breed are high weight gain rate and large rib eye area. The body weight of mature females and males are 600 kg and 950 kg, respectively.

II-4-b. Kochi strain

The Kochi strain was developed from crossing the Simmental with Korean cattle introduced from Kyushu Island. This crossbreeding period was substantially shorter than that for the Kumamoto strain. This reduced the dilution of the original breed's characteristics, retaining important differences. These cattle have a yellow-brown coat, which is much lighter than the Kumamoto strain. The cattle with black skin at horns, hoofs, eyelids, muzzle, tongue, switch and anus are more valuable due to its similarity to typical of the original Korean breed. The beef production performance of this strain is similar to that of the Kumamoto strain. The body weight of mature females and males are 600 kg and 950 kg, respectively.

II-5. Japanese Poll (Fig. 7)

This breed has been developed since 1916 from a cross between the indigenous cattle with Aberdeen Angus bulls imported from England. Furthermore, Japanese Poll cows were crossed with Japanese Black bulls to improve meat quality in 1975. Therefore, it can be expected that not many pure bred Japanese Poll cattle remained currently. However, neither performance nor progeny tests have been practiced since 1986. The phenotypic characteristics include hornless and black coat color with withers height and body weight being 122 cm, 450 kg and 137 cm, 800 kg in mature cows and bulls, respectively.

II-6. Japanese Shorthorn (Fig. 8)

This breed is the result of crossbreeding begun in 1871 between the imported dairy Shorthorn cattle and indigenous cattle in the northern parts of Honshu Island (Tohoku region). It is claimed that this breed can utilize the rough summer grazing available in the mountainous parts of this region better than other breeds. They are distributed mainly in the Tohoku and Hokkaido regions. The coat color of this breed is a deep red-brown that is darker than the Japanese Brown. The Japanese shorthorn seems superior to the Japanese Black for milk production, forage intake and growth rate. The withers height and body weight of mature females and males are 128 cm, 500 kg and 140 cm, 800 kg, respectively.

III. Genetic analysis of Japanese native cattle breeds and populations

III-1. Genetic variability of Japanese Cattle

The genetic variability of three breeds, Japanese Black, Japanese Brown and Japanese Shorthorn, is almost the same as that of Holsteins from several indices estimated using the blood type, blood protein, milk protein and microsatellite DNA polymorphisms as genetic markers. Mishima cattle revealed low genetic variability, which accounted nearly half of the other breeds (Abe *et al.*, 1977; Kato, 2002). Kuchinoshima Feral Cattle also showed the same level of genetic variability as Mishima cattle using the same set of microsatellite DNA loci (Kato, 2002).

In the mtDNA, inherited through the maternal line, 24 haplotypes were observed based on 18 mutations in the Japanese Black (Mannen *et al.*, 2000). Only two haplotypes were found in the 6 maternal lines known for Mishima cattle (Shi *et al.*, 2002).

Abe *et al.* (1977) reported that the Japanese Poll possessed slightly lower genetic variability than the other Wagyu breeds. However, the population size of this breed has recently been drastically reduced. The level of variability also seems to have been decreased to a critical level.

P.poly, the average heterozygosity and average number of effective alleles in each breed and population are shown in Table 2. The values for these indices in the Japanese native cattle populations are clearly lower than that in the other three Wagyu breeds. The average number of effective alleles of the Holstein, Kuchinoshima Feral and Mishima were 2.51, 1.48 and 1.40, respectively. The average heterozygosity was 0.521, 0.242 and 0.209, respectively. It is clear that the genetic variability of Japanese pure native cattle is quite low (Table 2).

III-2. Genetic relationship among Japanese native breeds and populations estimated from genetic distance

One hundred forty two alleles from 23 microsatellite loci were found in the three Wagyu breeds, two pure Japanese native populations and the Holstein breed. Only 58 alleles were observed in the Mishima and Kuchinoshima population. Forty-five of 58 alleles are shared with other groups, the three Wagyu breeds and Holstein. Twelve alleles are shared

with only the Wagyu breeds. Only one allele was specific to the Mishima population. Therefore, it is suggested that many genes inherited from the past native Japanese cattle population still remain in the present Japanese beef cattle breeds.

The genetic distance estimated from the blood type, protein and DNA polymorphism shows that the Wagyu and Holstein have a close relationship. The Japanese native cattle, Mishima and Kuchinoshima reveal a relatively large distance from the Wagyu and Holstein groups. The genetic distance between the Mishima and Kuchinoshima is greater than that to the Japanese Black and Japanese Brown (Table 3).

Although many alleles shared with the pure Japanese native are still left in the Wagyu breeds, Japanese beef cattle breeds are rather close to the Holstein breed presumed from the genetic distance. While the Wagyu originated from native Japanese cattle, they differ greatly genetically from their origin because of crossbreeding with exotic breeds in the early breed development stage.

The large genetic distance between the two Japanese native populations is believed partially due to a genetic drift in different directions after introduction to both islands. This also suggests the existence of geographical differentiation in the past Japanese cattle population. Other phenotypical differences were reported in these two populations too. The coat colors of the two populations are different, as described above. The meat quality of Mishima cattle is similar to the Japanese Black, which is famous for marbled meat. The Kuchinoshima produce lean meat. The muscular marbling in the Japanese Black is deemed to have crossed with indigenous cattle in the Chugoku district where the Japanese Black developed and Mishima cattle originated.

IV. Perspective on Japanese native cattle

Four beef cattle breeds, the Japanese Black, Japanese Brown, Japanese Poll and Japanese Shorthorn were established in Japan and considered as indigenous to Japan, although they were initially extensively crossbred with foreign breeds in the early 1900's. The breeds used for crossing and the selection criteria varied significantly from prefecture to prefecture. Consequently, a number of distinct strains were established. At present,

however, the genetic diversity is decreasing due to the concentration around a limited number of Japanese Black strains noted for their superior meat quality. After the liberalization on beef importation in 1991, other breeds, with meat quality thought difficult to discriminate from foreign beef breeds, are decreasing steeply.

Japanese native cattle could therefore be categorized into three groups: (i) not at risk, Japanese Black; (ii) presently not at risk but potentially endangered, Japanese Brown and Japanese Shorthorn; (iii) at risk, Japanese Poll, Mishima and Kuchinoshima feral cattle. From the genetic conservation point of view, the systematic conservation of minor Japanese breeds and minor strains of Japanese Black is recommended using frozen semen and embryos for future genetic resource demands such as emergency measures or as supplemental measures for *in situ* and live animal conservation.

From the sustainable cattle breed viewpoint and for making full use of Japanese natural resources without environmental damage, it is necessary to develop appropriate rearing systems for these cattle breeds and the two indigenous populations. The Japanese Brown in Kumamoto and Japanese Shorthorn in the Tohoku region have superior grazing traits compared to the Japanese Black. The Japanese Brown was bred and grazed in grasslands located in mountainous-hilly areas. In 2000, direct payment systems to the mountainous-hilly areas started in accordance with the Basic Law on Food, Agriculture and Rural Areas. In Aso, this grant is used to promote animal production focusing on the maintenance and management of grasslands and the Japanese Brown cattle.

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Table 1. Foreign breeds crossed with native cattle in each Prefecture

Name of modern breed	Prefecture	Foreign breed
Japanese Black	Kyoto	Brown Swiss
	Hyogo	Shorthorn, Devon, Brown Swiss
	Okayama	Shorthorn, Devon
	Hiroshima	Simmental, Brown Swiss, Shorthorn, Ayrshire
	Tottori	Brown Swiss, Shorthorn
	Shimane	Devon, Brown Swiss, Simmental, Ayrshire
	Yamaguchi	Devon, Ayrshire, Brown Swiss
	Ehime	Shorthorn
	Ohita	Brown Swiss, Simmental
	Kagoshima	Brown Swiss, Devon, Holstein
Japanese Brown	Kochi	Simmental, Korean Cattle
	Kumamoto	Simmental, Korean Cattle, Devon
Japanese Poll	Yamaguchi	Aberdeen-Angus
Japanese Shorthorn	Aomori	Shorthorn
	Iwate	Shorthorn
	Akita	Shorthorn, Devon, Ayrshire

Table 2. Genetic variability of five Japanese native cattle breeds and populations

Breed	P.poly	Mean±SE		
		Nnumber of alleles	Number of effective alleles	Observed heterozygosity
Kuchinoshima	56.5%	1.78±0.85	1.48±0.59	0.242±0.248
Mishima	52.2%	1.78±0.90	1.40±0.48	0.209±0.236
Japanese Black	87.0%	4.09±2.21	2.28±1.09	0.446±0.281
Japanese Shorthorn	95.7%	4.13±1.74	2.51±1.17	0.516±0.234
Japanese Brown	95.7%	4.48±2.11	2.90±1.35	0.560±0.267
Holstein	87.0%	3.78±2.07	2.51±1.23	0.521±0.260

Table 3. Genetic distance (DA) among Japanese native cattle breeds and populations

Breed	Kuchinoshima	Mishima	Japanese Black	Japanese Shrothorn	Japanese Brown	Holstein
Kuchinoshima	*					
Mishima	0.349	*				
Japanese Black	0.249	0.225	*			
Japanese Shorthorn	0.382	0.383	0.196	*		
Japanese Brown	0.251	0.254	0.104	0.183	*	
Holstein	0.411	0.323	0.184	0.181	0.178	*

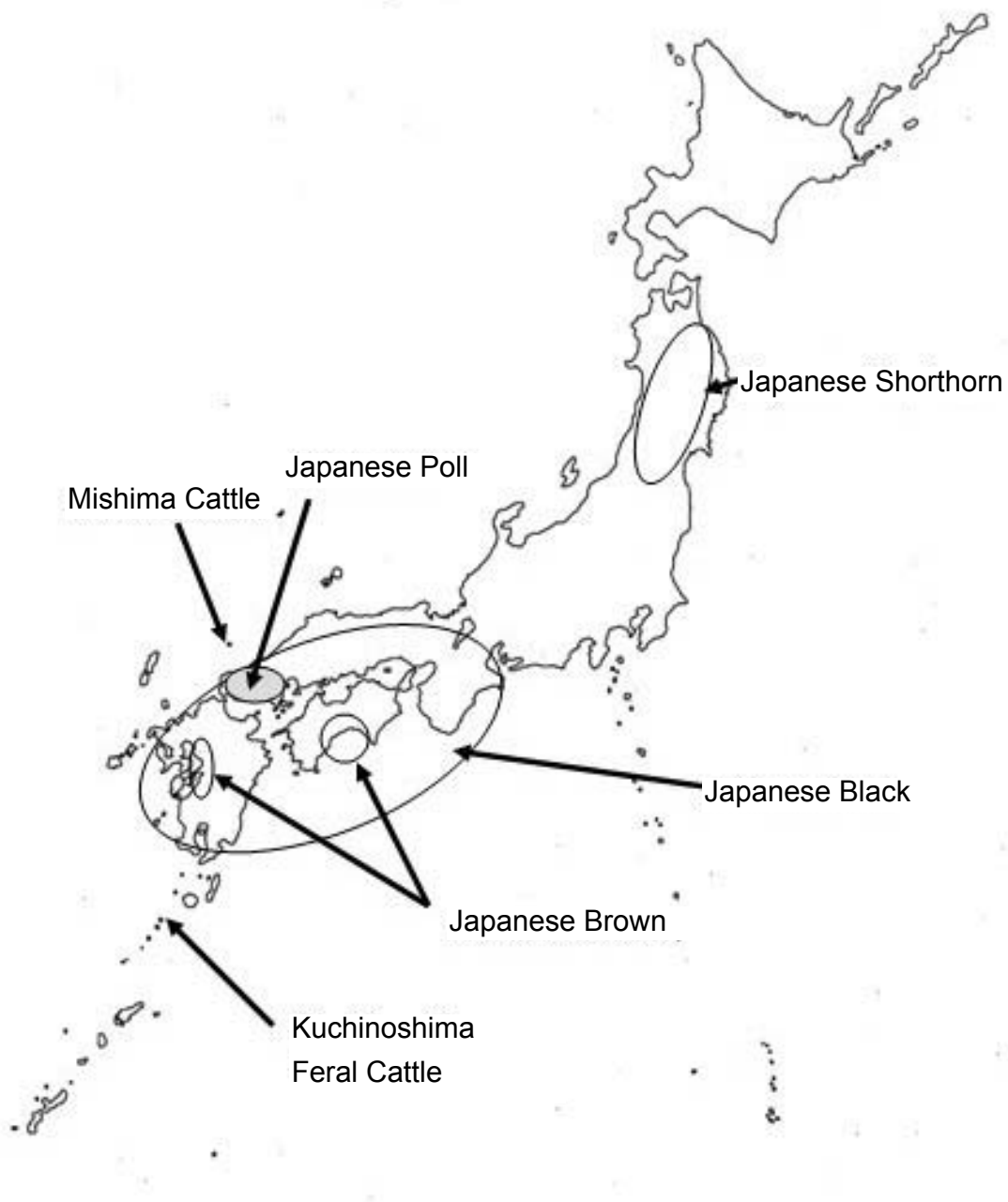

Fig. 1. Original Japanese native cattle breed and population locations

Fig. 2. Cattle in Japanese old fashion style festival

Fig. 3. Mishima Cattle (Bull)

Fig. 4. Kuchinoshima Feral Cattle

Fig. 5. Japanese Black (Bull)

Fig. 6. Japanese Brown, Kumamoto strain (Bull)

Fig. 7. Japanese Poll (Bull)

Fig. 8. Japanese Shorthorn (Cow)