# Improvement of indigenous cattle to modern Japanese Black (Wagyu) cattle

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**Abstract**

Wagyu cattle have been improved from indigenous cattle raised in Japan since the country was opened 100 years ago. Characteristics of the breed were formed during that period. Here, the process of the breeding is described**,** and recent topics about breeding studies are discussed.

## 1. Introduction

The Japanese Black cattle (Black Wagyu) provides a distinct quality of meat characterized by well-marbled beef. The origin of this characteristic is unknown, however. For example, how and when the characteristic became manifest in Wagyu cattle is an unresolved mystery in terms of meat traits of this breed. Another mystery is the prolificacy of Japanese quail!

Modern breeding of Wagyu cattle began 150 years ago after the opening of the country, when numerous exotic breeds were introduced from Europe and North America and crossbred with indigenous cattle, which over time developed into the Wagyu breed. Wagyu cattle is one of the examples of newly developed Asian breeds. The objective of this study is to introduce the process of breeding and to discuss recent topics on genetic improvement of the breed.

## 2. Dawn of breed development

The roots of indigenous cattle in Japan can be traced back to the Heian period, around one thousand years ago. Before that, records of cattle feeding were based only on archeological evidence. On the other hand, documented records of breeding were found later in 1700s, the mid-Edo period (1603-1868), when the lineage of animals was recorded in several areas of the Chugoku region (western part) of Japan. Each valley or river course had its unique lineage of animals. The practice of breeding seems to have been a repeating cycle of inbreeding and outbreeding based on lines of male animals.

After the opening of the country, a large number of foreign customs were introduced into Japan, exotic breeds being one of them. Because such breeds had distinct characteristics lacking in domestic cattle such as large bodies, high milk yield and muscular power, crossbreeding of domestic and foreign animals became very popular during that period.

## 3. Establishing Wagyu breeds

The drawbacks of crossbreeding were recognized by cattle breeders because the diverse characteristics of crossbred animals, such as their large bodies, handling difficulty, lack of legerity and meat quality, were proving unfavorable in that crossbreeding was practiced without a well-organized policy. Crossbred animals were then gradually integrated into four Wagyu breeds, and a registry system was introduced to record and establish breed characteristics. At the same time, important social changes

were taking place in Japan: from animal power to the combustion engine as an energy resource. Accordingly, the object of breeding changed from stamina to meat value. To achieve this goal, performance, and later, progeny tests were initiated to genetically improve meat quantity and quality**.** Information technology (IT), such as best linear unbiased prediction **(**BLUP**)** once called state of the art, was then developed by Henderson (1975) and applied to dairy cattle first, then to beef cattle including Wagyu cattle, thus accelerating the rate of genetic improvement. During that period, the carcass grading system was formalized because various grading systems were used throughout Japan. Improvement of Wagyu cattle was propelled by a station-testing system; however, because of IT, field testing based in production farms has been the mainstream of the testing method since 1980's.

## 4. Recent topics in Wagyu cattle breeding

Since the introduction of genomic selection methodology proposed by Meuwissen et al. (2001), the focus has been on the application of genomic information to animal breeding. Genomic selection quickly replaced genome-wide association study (GWAS) in terms of methodology by incorporating genomic information into animal breeding. Trials in dairy cattle breeding have been carried out for over ten years with genomic selection, resulting in 10-20% higher genetic response by genomic selection than by evaluation without genomic information. Generation interval can be shortened for traits the measurements of which are time consuming or are possible only in the latter half of the animal's productive life. Nonetheless, recent research has revealed that progress in terms of inbreeding has doubled compared with non-genomic breeding. Single-nucleotide polymorphism (SNP) genotyping is still costly. In Wagyu cattle breeding, the use of genomic selection is still under investigation.

## 5. Change of traits targeted in Wagyu breeding

Traits targeted in Wagyu breeding have been changing for over 100 years. The first major change from size/conformation traits to carcass traits occurred with a change in objective use of cattle: from draft animals to beef producing ones. Next, for Wagyu cattle priority was given to genetic improvement of meat quality in an environment of market opening and global competition. Visual evaluation of marbling promoted improvement of meat quality around 2005. Nonetheless, well-marbled beef did not necessarily satisfy consumers' taste. For example, the score for savor (umami) evaluated by panel tests reached a peak on beef with a modest content of fat (Iida et al., 2015). Although new traits of meat quality have been studied, no definite candidates have as yet been found**.** Among promising factors are fatty and amino acids, Suzuki et al. (2017) have demonstrated that inosinic and glutamic acids as promising candidates.

Secondary traits, other than meat quantity and quality, include important ones for the production of Wagyu cattle: feed efficiency and reproduction, both of which have a conductive effect on the production of Wagyu cattle, resulting in more profitability for cattle farmers. Such traits have been investigated for genetic improvement.

Feed efficiency has for long been measured as the rate of feed conversion; however, it involves deficiency of ratio traits. Therefore, residual feed intake was investigated as an alternative trait because of its linear index in nature. Heritability and genetic correlation of residual feed intake were studied to determine genetic improvement by feed efficiency of Wagyu cattle. Our studies demonstrated that the trait of residual feed intake was replaceable to feed conversion ratio because it showed higher heritability and favorable genetic correlation with weight gain and feed intake. Furthermore, residual feed intake shows favorable correlation with the marbling score and the depth of subcutaneous fat.

Recent performance of reproductive traits has shown a downward trend in cattle. Reproduction by females is the basis of stable beef production. To investigate possible genetic improvement of reproductive performance, reproductive traits were collected from registry records. Heritability of age at first calving was higher (0.17) than that of calving interval between parities

(0.01-0.05). Nonetheless, heritability of the calving interval based on a repeatability model with pooled calving intervals was higher (0.18) than individual heritability. Thus, pooled records show potential as a tool for genetic evaluation of reproductive traits.

Reproductive performance of Wagyu cows shows seasonal fluctuations, and heat stress is one of the factors lowering reproductive performance of Wagyu cows in Okinawa, the southernmost region of Japan, in an oceanic sub-tropical climate. The phenotypes of age at first calving and the calving interval were analyzed by a linear model. Responses of age at first calving and calving intervals against heat stress were significant on different days. A negative response was observed against an upward trend in heat stress and a reverse one against a downward trend. For example, in age at first calving, day -2 showed an upward trend, whereas both day -3 and day +33 showed an upward trend after the first calving interval. In later parities, the responses were more complex, probably due to the effects of previous parities. The reasons may be availability of feed resource, physiological adaptability of the animal and seasonal variations of heat detected by the farmer.

Throughout studies on Wagyu cattle, breeding objectives have changed with the demands of the end user, ex animal, with more power and legerity to animals with high meat values. In terms of method, evaluation of animals has changed from visual appearance to core values. The future breeding objective of Wagyu cattle will be determined depending on the definition of the real value of an animal.

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