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**Japanese beef production system: an overview of quality
characteristics of Wagyu beef and Kobe Beef Geographical Indication**

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1) Brief history of meat eating culture in Japan

1.1) Introduction

From scavenging to hunting, human practices evolved to domesticating animals in order to use their products such as milk and meat in their diet. Raising livestock for meat eating purposes then developed in the Eurasian continent and gradually spread all over the world (Felius, et al. 2014).

Including meat in the human diet is regarded as one of the most important adaptation steps in human history since it enabled many developments leading to improvement of our race (Wyness, et al. 2016) (Nam, et al. 2010).

The meat eating wave spread to the Western parts of Europe, North and South America, and far to the East, reaching the Korean peninsula but not Japan. Indeed, Japanese diet has been affected by many factors during hundreds of years, in particular by environment, climate and history (Watanabe et al. 2008).

First of all, Japan is an archipelago consisting of more than 6000 islands rich in marine and fluvial resources that have been used as the main basis for the Japanese diet for 5000 years. Some of the Pacific currents indeed carry small fish close to the coast, attracting packs of larger fish in pursuit. Looking inland, one can also see how a mountain range runs along the center of the island, which favors rain to fall and flow down to the coasts, giving birth to many rivers rich in fish (Jiao et al. 2019).

Then one can see how in Japan the climate influenced the typical landscape which was also made up of marshes, which have been turned into reservoirs and rice paddies by the Japanese, giving rice the main role on their tables.

Not having lush grassland to feed the cattle, animals have been mainly used as draught animals to help in works (Jiao et al. 2019) (Watanabe et al. 2008).

1.2) The first period

A meat eating culture did exist in ancient Japan but it mainly derived from the hunting of wild animals such as wild boars and fowls. With the introduction of Buddhism in the 6th century the meat eating society changed. Buddhism brought the idea of reincarnation meaning that the soul of dead people survives and we can live again wearing the shape of people or animals too. Therefore, humans must avoid killing any other living being as those could have been the reincarnation of family members (Hopkins et al. 1907).

In 675 AD the Emperor Tenmu prohibited the killing and the eating of meat throughout Japan excluding that of wild animals. In the following Kamakura period (1185-1382 AD) Ise Shrine's law was so strict that eating beef was not even conceptually possible. The social taboo against eating every kind of domestic livestock in Japan was quite unique in comparison to other religions, which forbid only the eating of beef or pork.

When in 1549 AD some Christian missionaries first came to Japan, they learned this great taboo about meat consumption and decided to behave according to this rule in order to avoid developing any kind of potential hostility. They therefore found great favor with the lords of Kyushu and Yamaguchi region in the South of Japan and thus they were converted into Christianity. Buddhism temples and Shinto Shrines were destroyed and the ban over meat disregarded. The wave of eating meat slowly spread throughout Japan, not only brought by missionaries but also by allowing few trades with foreign countries (Watanabe et al.2008).

Following this period, with the prohibition of Christianity and Japan's isolation demanded by the Tokugawa Shogunate in 1625, a new Buddhist culture was instilled. Along with that, the ban over meat eating was restored too, even with stricter rules (Knight et al. 2010).

Japan became therefore famous because it was the only nation in the world where no indigenous species had become extinct until the 19th century.

The ban on eating meat was followed by the common people of the time, at best it was considered a special food with restorative power but many never even tasted it. With the excavation of the residences of lords from the Edo period, bones from wild animals were found. From that discovery it was then deduced that animal meat was occasionally eaten (Knight et al. 2010).

1.3) The Westernization of Japan

In 1854 the Tokugawa Shogunate signed many peace treaties followed by the opening of Japan's borders. This period was seen as the beginning of the integration of Western customs into Japanese culture. The removal of the ban over meat consumption and the longstanding taboo against it became a symbol of this change.

During the Meiji Period (1866-1912) the Westernization officially began and Japan was finally able to overcome centuries of prohibition on meat consumption. The Restoration Government made big efforts to emphasize this Westernization movement and remove the deep rooted taboo with many initiatives, one of which was by telling people that the diet of the Emperor himself included meat.

In 1872 the Meiji Emperor broke the 1200 year ban over meat consumption by eating meat to celebrate the new year. The same year witnessed some changes in Buddhist religious law which permitted monks to eat meat (Watanabe et al. 2008)

Ten years after the end of the ban almost 34,000 cows were slaughtered for beef and almost a century later, this number increased up to 750,000. The meat consumption was quite low as compared to that of the Western countries, probably linked to the high prices, but there has been a continuous growth in the Japanese livestock industry. This was supported by increasing of demand, which had to be supplied with both the domestic production and imports from foreign countries.

Following the end of world war two, meat prices rose exponentially and the daily per capita intake of meat was 5g/day in 1947. Soon after the demand increased significantly, and both the number of cattle bred for beef purposes and that of the farms increased along with it. The Japanese economy started to flourish and meat intake was 88g/day in 1970. In the 1980s though the number of farms and animals raised for beef purposes declined and leveled off despite the continuous increase of pork consumption. Then the number of head per farm increased meeting a new need for efficiency and the change of the family farm to a bigger scale.

After quantitative import restriction on beef was removed, beef consumption patterns rose annually by an average of 6% from 1990 to 1995. This might be due to the modest economic growth that, along with a greater availability of imported beef, led to fulfill the desire for grain fed beef. The domestic production also increased and peaked in 1994 while the number of farms kept decreasing, suggesting a completed transition

towards an industrialized model for meat production. From the mid 90s however increases in productivity reached saturation as the number of herd started to show a slight decline (Obara et al. 2010).

1.4) Recent times: food scandals and the evolution of meat consumption in Japan

From 1996 many food safety scandals occurred both in the domestic market and in most of the countries Japan sourced meat from. Starting from the 1996 O157H7 E.coli outbreaks in Japan, which affected more than 6,000 children from 62 different elementary schools resulting in two deaths and many more in the Kyoto area (Michino et al. 1999)

BSE, also known as “mad cow’s disease” then hit Japan’s herd in 2001 damaging beef reputation, even if it had no significant effect on domestic cattle numbers. The restriction on trade from the countries that were affected, such as the United States and Canada (Japan’s main exporters), caused an insufficient availability of cheaper grain fed beef for Japanese markets. This, along with the fact that Japanese production did not succeed in filling the gap left by those restrictions because of the high cost of breeding, caused a decline in beef quantities that became significantly more expensive. Consumers’ trust was eroded and this gave the possibility to other competing protein sources to be chosen, such as pork and chicken (Kamisato et al. 2012)

After BSE, consumer confidence in food safety was undermined by other events in the food industry. Firstly by some labeling scandals relating to foreign beef being packaged and sold as domestic product, then later on the outbreak of Foot and Mouth disease in the Miyazaki Prefecture in 2010 which had a severe impact on local breeding herds as not even elite cattle were spared by the mandatory slaughter to eradicate the disease. Last but not least, consumer confidence was also undermined by the Fukushima nuclear disaster (Jones, et al. 2002) (Muroga, et al. 2010)

In those years Japan’s population grew slowly until 2005 when growth hit zero. Since then until 2017, population change has been negative (The World Bank, Population).

All those events led not only to a decreasing demand for beef products but also to a deep mistrust in Japanese consumers.

The Japanese government has responded by implementing a series of new regulations and creating the new Food Safety Commission in 2003, which is a risk assessment organization for science-based assessment of food safety risks to human health (Food Safety Commission of Japan website)

To track animal movements back in case of food safety problems, a law relating to special BSE countermeasures was enacted in 2002. This law requires cattle to be traced from the breeding farm to the packing plant through an ear-tag and data about date of birth, gender, breed, name and address of owner, location of fattening, date fattening commenced and date of slaughter to be displayed.

In 2003 another law, the Beef Traceability Law, required an even stronger traceability system from the farm through the retail sale (Godo, et al. 2015).

To ensure the validity of this system, muscle tissues are sampled and stored in case that some problems may occur and verification required. With this system, it can be possible to quickly locate the herd of diseased cattle within 24 hours if needed. Also in the same year the Ministry of Agriculture, Forestry and Fisheries set up a new standard called “Japan Agricultural Standard” (JAS) program to certify traceability for imported beef (Sugura et al. 2008).

Traceability has been incorporated into assurance programs as a way to create trust, easing consumer anxiety. To date, farm-to-fork traceability systems have been implemented for high-value products such as domestic Wagyu beef, for which consumers are already paying premiums (Clemens, et al. 2003).

After this period consumer requirements for beef quality in Japan became higher, and safety and price were found to be more significant than marbling and leanness. Producers and breeders had to focus on their target quality that was then not only marbling or leanness but also safety. This was in order to have their product's accepted by consumers and now Japan is better managing the safety of beef production (Sasaki, et al. 2005).

Recently, the amount of meat production and consumption of the Eastern countries has grown rapidly by the globalization of the food industry and rapid economic growth of the countries themselves (Nama, et al. 2010).

This also happened for Japan, a country in which the quantity of imported beef overtook domestic production since 1990s so that it rapidly became the world's second largest beef importer after China, and the first one in 2017.

With food security and safety at stake and considering the beef demand is not yet to decrease, it is important to recover national production. Even if meat consumption levels may not reach the level it has in other countries, Japan is still a valuable market (Wang, et al. 2018).

2) The Wagyu beef

2.1) The beef market in Japan

The Japanese beef market is mainly composed by four different types: two domestic types, Wagyu and dairy, and two imported types, from the US and Australia. These beef types are specifically identified at retail outlets by type of beef for domestic cuts (Wagyu is specifically identified) and country-of-origin labeling on imports (Saghaian, et al. 2004).

Japanese consumers prefer domestic beef and dairy beef to imported ones and the reason is that domestically produced beef is considered as higher quality when compared to imported beef (Matsuishi, et al. 2001).

In this sense high quality management of beef production is needed in order to maintain and expand beef cattle farming in Japan. In particular, marbling has been an important factor in the grading of Japanese beef. Therefore, beef cattle breeders and producers have improved their production systems in order to produce more highly marbled beef. Another important trend in recent years is the increasing diversification of consumers' requirements for food quality. Increasingly, individual consumers have specific demands for the beef they purchase, and these demands involve not only marbling but also the healthiness of the beef, the price, the brand, and the origin (Sasaki, et al. (2005).

2.2) Wagyu

After the assignment of the UNESCO's status of cultural heritage in 2013, Japanese traditional cuisine has become more and more popular among gourmets around the world. Among all Japanese products Wagyu beef is the product that, along with sushi, became the symbol of Japan's high quality food standards.

Wagyu is considered the highest quality beef for Japanese consumers, followed by dairy beef and by US grain fed imported beef. Australian grass fed beef is perceived as the lowest quality beef. In general domestically produced beef is viewed as more fresh; this characteristic is one of the most valued by consumers when purchasing meat.

Wagyu beef and high-quality cuts of Japanese dairy beef are called “super beef”. The best Wagyu beef is well marbled and it is normally used for traditional beef dishes such as sukiyaki, shabu-shabu, or other alternatives known as nabemono. The marbling and texture of Wagyu beef allows its use in these dishes; other beef types are much less desirable for these cooking techniques (Reed, et al. 2004).

Wagyu literally means “Japanese cattle” and Wagyu beef now has burst into the niche market of luxury food, not only in Japan but all over the world. This kind of beef is setting new standards for quality in the assessment of beef products with its unique taste and look.

Even if the etymology of the word Wagyu is very generic, it has a very specific meaning. If one wants to label a beef “Wagyu” it must fulfill some conditions.

The first condition is the breed. Cattle must be purely Japanese. Their crossbreeds in all forms must also be purely Japanese.

Japanese pure breeds are:

- Japanese Black
- Japanese Brown
- Japanese Shorthorn
- Japanese Polled

Proof of this condition must be evidenced by means of the calf registration system, in accordance with the Improvement and Increased Production of Livestock Act, and the Beef Traceability System.

The second condition is about the breeding environment. The cattle must be born and bred in Japan and the Ancestry of the cattle must be able to be confirmed by a traceability system (Introduction to Universal Wagyu Mark, JLI website)

The most famous Wagyu beef characteristic is the intense marbling that differ from most of the well known Western beef. The quality of this beef though depends not only on its appearance but also on its unique production system. This system includes a strict genetic management, small scale family farms, a beef traceability system, a nationwide grading system and specific meat cutting techniques. Apart from that it is also mandatory to pay close attention to the origin of the cattle itself, especially the terroir linked characteristics (Japanese Beef Products Guidebook, 2008).

A special comment goes then to the chemical and organoleptic properties of this particular kind of meat, which has been enhanced during the years to set a new standard for palatability through genetic selection.

2.3) The Wagyu hallmark

The only cattle and beef fulfilling the two qualifications we reported before (breed and breeding environment) are licensed to bear the public hallmark, which certifies that the beef comes from genuine Wagyu.

Wagyu is a breed of cattle boasting unrivaled, superior quality meat, a legacy unique to Japan. The “Universal Wagyu Mark” (Fig.1) was established when Japan began exporting Wagyu meat products overseas in 2007. Along with the mark, advertising slogans were also set up: “A taste of Japan” and “Let’s eat delicious Wagyu!” emphasizing authentic Japanese Wagyu in an attempt to expand export and advertising activities (Introduction to Universal Wagyu Mark, JLI website).

To use the Universal Wagyu Mark an application must be sent to the Chairperson of the Japan Livestock Industry Association in accordance with the licensing guidelines. The Association was founded as a directing organization to promote technical innovation and stable livestock management among livestock farmers (Application form, JLI website).



Fig. 1 Wagyu official mark (29)

The mark must be displayed only as specified in the Universal Wagyu Mark usage manual and not in any other different way. The sizes and proportions are strictly regulated as are the colours, which are indicated by the Pantone scale. The mark cannot be

deformed, or be displayed with another font or size different from the official one, or without some parts of the original design (Fig.2). The colors have to be the original ones approved without changing shades or intensity, or scheme (Wagyu Mark, JLI website).



Fig.2 No official Wagyu Marks (29)

2.4) History of Wagyu breeding

For over 1200 years there was no demand for animal products such as milk or meat, this is because Japan did not use to domesticate big animals for any purpose.

The first evidence of breeding cattle, pigs and chickens go back between 500 B.C. and 300 A.D. with the first immigrants from the Asian continent through the Korean peninsula (Namikawa, et al. 2001).

Since then, cattle has been used as draft animals to help in rice paddies or transportation to carry heavy loads helping farmers in their work.

Some of them, though were used for milk production as several books refer to it in the 7th century and the prohibition of slaughtering animals, cattle, horses, monkeys and chickens in 675 AD suggested that the people of this period did eat meat.

Cattle was used also for hackeries (cattle drawn car) for nobles of the imperial family or aristocrats in Kyoto during the Heian period (794 to 1185 AD).

After this prohibitory edict, the slaughtering became much less common and cattle were mainly used for transporting raw materials such as charcoal and sand for the iron manufacturing industry which was raising in the Edo period (1603 to 1868 AD).

Several kinds of domestic cattle was bred and raised for different purposes according to their physical characteristics. Until the Meiji Restoration in 1868 though there had been no meat consumption culture in Japan (Motoyama, et al. 2016).

Around the 19th century, during the Edo period cattle started to be genetically enhanced on purpose, following similar techniques to those they use now.

Some inbred strains were thus built-up by wealthy farmers, which later on became breeders (Namikawa, et al. 2001)

The Japanese native cattle strain was known as “Tsuru” which means “Vine plants”; then from the oldest inbred strain of native cattle groups of related cattle were born. Those groups had superior and common productive traits of the originating strain but differed for some external traits (Hirooka, et al. 2014).

The first strain, Takenotan-zuru, was build up in 1830 in a famous producing area in Okayama and Atetsu Prefecture. This strain had large size, good udder, soundness, longevity, serial reproduction. Horn color, strong backline and loin, mild disposition and fullness of hind.

Then the other three strains followed:

- Bakura-zuru in Nita and Shimane region, fixed in 1855 which had similar characteristics to the Takenotan-zuru;
- Iwakura-zuru strain in Hiba and Hiroshima area, fixed in 1843, which had mild disposition, lovely look, longevity, serial reproduction, superior body conformation and good udder and last;
- Shusuke-zuru strain fixed in 1845 in Mikata and Hyogo area which had great quality, serial reproduction, soundness and longevity.

Those inbred strains were built basing on dam lines by the first Japanese breeders, which were wealthy farmers and cattle dealers in the west side of Japan’s main island, Honshu (Namikawa, et al. 2001).

After the Meiji Restoration the imports commenced along with the willingness to introduce Western habits and culture, food included.

The opening of the ports to foreign ships led to the shipping of Japanese cattle to fulfill continental people’s desire to eat beef, the uniqueness of which allowed it to become popular. Those ports were mainly Yokohama and Kobe. The name Kobe linked to the beef became famous among foreigners.

To cope with this new increasing demand for beef the import of live animals for breeding started in 1868. Most of them were cattle planned for pure breeding, while the rest were bulls planned to be used for crossbreeding with native cattle. Since crossbred cattle was sold at a premium price, crossbreeding became common in the beginning of the 19th century (Hirooka, et al. 2014).

Various continental breeds such as Shorthorn, Brown Swiss, Devon, Simmenthal and Ayrshire were thus imported into Japan and were crossbred with native cattle in order to make some improvement in body size and milk production. Even if some beef was consumed because of the Westernization, cattle was still mainly reared for working purposes, someone started paying attention to the feed (Fig.3).

Although the crossbreeds were bigger animals with great capability of producing milk, their draft performance was quite scarce. None of those crossbreeding efforts was considered successful and if at the turning of the 20th century high prices were paid for crossbreeds, by 1910 cattle were considered inferior for working performances and thus their price suddenly fell.

It is to underline that the working performance (expressed by the willingness to have larger body) and milk production were the main concerns for cattle improvement, while no one paid attention to beef quality and as a consequence it became poor.

No more crossing practices have been repeated since then because many farmers had been economically damaged (Namikawa, et al. 2001).

Nevertheless, because of this great import and crossbreeding practices, the genetic diversity of native cattle was greatly expanded. The imported continental breeds were different among Prefectures and also among Regions in the same Prefectures. The core breeds, which became known as Wagyu, had evolved while only two native cattle breeds remained isolated and not crossbred with foreign breeds, but they were not considered Wagyu. Characteristics of pure native cattle would only be able to be estimated from old documents and “Mishima” cattle that are preserved under governmental protection as a natural monument. These animals are reserved in “Mishima”, a small island located in the Sea of Japan, and are acknowledged as a group of isolated native cattle from crossing with foreign breeds (Namikawa, et al. 2001).

Name of Modern breed	Prefecture	Crossed Foreign Breeds
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

Fig.3 Crossings with foreign breeds by Prefecture (30)

For the fixation of modern breed a new program started in 1912 called “Improved Japanese cattle”, meaning that the continental breeds and the native breeds superior traits have been brought together to build up a new kind of breed with uniform conformation and quality (Motoyama, et al. 2016).

Through these processes new breeds were fixed in 1944 and acknowledged as the origin of the current Wagyu breeds: Japanese black, Japanese brown and Japanese polled, while Japanese shorthorn was acknowledged in 1957 only (Hirooka et al. 2014).

Since the culture of eating meat only became so popular only in the mid 1950’s, no law was stipulated before that date to improve meat production. The “Law for Improvement and Increased Livestock Production” was issued in 1950 and stated that the Ministry of Agriculture, Forestry and Fisheries sets specific goals by species concerning the improvement and propagation of cattle, horses, sheep, goats, pigs and others, complying with the related rules (Minezawa et al. 2008).

In addition, considering that the Japanese economy was growing and draught animals were no longer needed because of the mechanization of crop production, the number of working cattle diminished. The primary objective now was to improve the quality of the beef: “Wagyu, can it still be a beef cattle?” was the subject of the first national competition for Wagyu beef production in 1966 (Motoyama et al. 2016).

A performance and progeny testing program started officially in 1968 with an on-station beef bull testing program. Each Livestock Improvement Association or Prefecture has its own breeding station in which male progenies from the planned mating are sent at

weaning to be tested on their performance. The criteria are: growth rate, 365-day weight, feed efficiency, semen quality, type score etc.

Then the selected candidate bulls are crossed with commercially bred cows and the progeny tested in the progeny testing program. In the test male animals are fattened for one year and then slaughtered to assess: marbling score at the eye muscle at the level of the 6-7th rib section, rib eye areas, fat thickness, growth rate etc. In this way they selected excellent breeding stocks but at high production costs while not prioritizing the performance of carcass quality traits.

Later on, new reproductive technologies, innovation in computer science, standardization of carcass grading in 1988 and optimum utilization of Japanese cattle led to change the conditions of the testing program. Information on genetic potential of cows were required too, to better predict progeny performances. In this sense, the use of personal computers and the development of informatics systems which predicted the breeding value, represented a milestone in genetic improvement. BLUP (best linear unbiased prediction) has been the main tool through which those significant changes happened. BLUP analyzed national official carcass data records and the results enabled the identification of superior carcass-quality bloodlines. Therefore the breeding of a new crop of Japanese best sires through the progeny test (Obata et al. 1996).

In the 90's the field progeny testing program was introduced so that all feeder calves in this scheme were ear tagged with a specific code at weaning age. When they reached the age of slaughtering at the meat markets, data on the carcasses were collected and used to estimate the breeding value for the sire and the dam using also the information already collected on their personal pedigree. In this way more cattle could be tested more cheaply but this system did not develop nationwide yet.

The new reproductive technologies such as in vitro fertilization and multiple ovulation and embryo transfer were used to improve developmental programs of breed improvement. With those methods they improved reproduction rates in females so that a more intensive and accurate selection could have been carried out along with having a faster rate of genetic change (Obata et al. 1996).

The breeding of the Japanese Black is now led by local government units, which are referred to as Prefectures. Dozens of bull calves are purchased by Prefectures, and then they are performance-tested and progeny-tested to select the best sires. A Prefecture

may introduce bulls from other Prefectures to accomplish the breeding objective. All other calves except for replacement heifers are sold at 8 to 10 months of age and purchased by fattening farmers at the calf market (Obata et al. 1996).

2.5) Breeds of Wagyu

There are two types of cattle in Japan: traditional beef breeds (Japanese black, Japanese brown, Japanese polled and Japanese shorthorn) collectively called Wagyu, and dairy breeds (mainly Holstein).

The Wagyu beef, especially from the Japanese black breed, is high quality and more highly valued than the beef from dairy breeds or imported beef. While lower quality dairy animals are exposed to strong competition from imported beef, the market for Wagyu beef is more strongly differentiated from imported beef.

Wagyu is a general term used for native Japanese beef breeds ('wa' means 'Japanese' and 'gyu' means 'cattle'). Wagyu cattle consist of four beef breeds, all of which belong to *Bos taurus*: Kuroge (Japanese black), Akage (Japanese brown cattle), Tankaku (Japanese shorthorn) and Mukaku (Japanese polled). There are 229 kinds of regional WAGYU in Japan (March 2005), and some of them are registered as Regional Collective Trademarks (Kimura 20015).

The Japanese Black cattle is the predominant breed and accounted for 97% with nationwide distribution. The other three breeds are minor and regional breeds; the Japanese Brown is mainly distributed in Kumamoto Prefecture in Kyushu island and Kouchi Prefecture in Shikoku island, the Japanese Shorthorn in Tohoku region (north-eastern areas in main island) and the Japanese Polled only in Yamaguchi Prefecture (western area in main island) (Fig.4) (Hirooka, et al. 2014).



Fig.4 Geographical names related to Wagyu. Prefecture names are in uppercase and regional or city names are in lowercase. Prefectures colored with darker grey have larger Wagyu herd size. (31)

2.5.1) Japanese Brown

Also known as “Akaushi”, with “Aka” meaning “Red” and “Ushi” meaning “Cattle”, because of its uniform brown coat colour, it was approved as a breed in 1944. Japanese Brown origin traces back to a crossbreeding between Korean cattle with European breeds (Fig.5).

Depending on the Prefectures in which those crossings took place, two main strains were built up: the Kumamoto line, on Kyushu island, the most common, and the Kochi line, on Shikoku island. These strains are produced mainly in Kumamoto, Kochi and Hokkaido Prefectures and have had different improvement processes that resulted in different gene pools so that now they can be easily distinguished (Porter, et al. 2016).



Fig.5 Japanese brown (35)

Japanese Brown is the second most common domestic breed accounting 3,2% of the total reproduced cows but pressure from Japanese Black breed is causing additional numerical reduction so that genetic biodiversity along with effective population size is expected to decrease for the two sub-breeds. The effective sizes in 2006 were estimated to be 25.5 and 6 for Kumamoto and Kouchi respectively.

Japanese Brown was estimated to count more than half a million in 1960 (22% of the native herd). By 1990 the share dropped to 8% and the number is still declining.

Even though current domestic beef production depends mainly on Japanese Black, Japanese Brown possess many superior traits as for example a high grow rate, feed utilization efficiency and grazing aptitude. Those characteristics could represent future breeding material even if meat quality is still relatively inferior. In this sense some standards have been set so that the weight, the marbling and the yield could increase during the years (Honda, et al. 2006).

Some cattle from the herd have been exported to the USA and Australia where they are known and bred as Red Wagyu (Wagyu International Association website).

a) Kumamoto line

Kumamoto line was improved crossbreeding indigenous Japanese cattle, descendants of those imported from Korea, such as Korean Red, with Simmenthal and Devon cattle during the Meiji Era and formerly used for draught work.

The cattle have a red coating and relatively large body size, the average weight for cows is 600kg and the average height at withers is 130cm.

Slaughter age is around 25 months, this due to the lower level of marbling averaging a Japanese Grade of BMS 3.2. Among its characteristics is its high weight gain rate, large rib eye area and low fat content (11% or less) with fine texture and mild taste.

b) Kochi Line

It is thought to have been less influenced by European import because of the shorter period in which crossbreedings took place. Since the European influence was reduced, this strain retained some of the native cattle characteristics.

Coat colour is yellow-brown, much lighter than the Kumamoto one with black coloration on the eyelid, hoofs, muzzle, tongue, horns and above the nose, also typical of Korean breed. Cows average weight is 475kg and 130cm withers height.

The beef production performances are similar to the Kumamoto's (Porter, et al. 2016).

2.5.2) Japanese Shorthorn

Japanese Shorthorn, or Nihon Tankaku Washu, is bred in Japan only and raised mainly in Tohoku Region north of Honshu island. The native Nambu cattle developed from 1603 to 1868 to number 15000 and they were used as beast of burden to carry salt, iron and fishes from the coast to the inland and rice and supplies to the opposite direction (Fig.6).

From 1871 they were crossbred with the continental dairy American Shorthorn and thereafter it was continuously improved by means of mating plans until they were mostly raised as beef cattle. The official recognition as Wagyu came in 1957 and The Japanese Shorthorn Cattle Registry Association was established (Porter, et al. 2016).

These bovines are found in the Northern parts of Japan, especially Tohoku region and Hokkaido, where they perfectly fit in the cold climate and they are well known because of their reputation of hardiness and foraging ability. The original herd shrank from its peak of 3% to the 1% we have today. The coat colour of this breed is deep red-brown, darker than Japanese brown the withers height and body weight of both males and females are 128cm, 500kg and 140cm and 800kg respectively.



Fig 6: Japanese Shorthorn (35)

Regarding beef quality, Japanese Shorthorn has not been selected with a focus on marbling score because they originally have been crossed with dairy cattle. They thus seem superior to the Japanese black for milk production, forage intake and growth rate. Anyway, their beef contains much lean meat and low fat with mild and savory flavor due to inosinic acid and glutamic acid content, which enhance umami taste.

The average grade for BMS was 3 or below but it is preferred by many for its different taste. The national target set for 2010 for Japanese Shorthorn steers was a slaughter age of 19-20 months, live mass of 650-675 kilogram from an average daily gain of 1.10 kilogram per day. A BMS score of 3.0 was set (Hirooka, et al. 2014).

Speaking about a very close herd, typical of a specific area, some traditions are still maintained so that the main system to breed Shorthorn is called natsuyama fuyusato, meaning “summer mountain, winter village”. This is a system in whereby the cattle spend summers grazing on grasslands up to the mountains and the winter feeding in stalls treated as quasi member of the household. The mating also is different from the usual as it is accomplished by natural mating and the calves are firstly raised grazing and then fattened in the studs until the age of 22 to 25 months (Kazuto, et al. 2009).

2.5.3) Japanese Polled

Japanese polled was built up by crossbreeding between Aberdeen Angus from Scotland with the native Japanese black in the 20's. The breed was thereafter improved to obtain a higher quality meat and certified as pure Japanese cattle in 1944. This is a breed originated in Yamaguchi Prefecture and compared with Japanese Black it has deeper black coat and an inferior degree of marbling. The main characteristics include hornless and dark coat with withers height and body weight being 23 cm, 450 kg and 137 cm, 800 kg in mature cows and bulls respectively (Fig.7)



Fig.7: Japanese Polled (35)

Head number are very limited at present moment with only 200 head currently bred and reared in Yamaguchi Prefecture (Porter, et al. 2016).

2.5.4) Original Japanese Native Breeds

Some of the true original Japanese breeds can still be found. These are Mishima ushi in Mishima Island in Yamaguchi Prefecture and Kuchinoshima ushi in Kuchinoshima Island in Kagoshima Prefecture (Fig.8).



Fig.8: Mishima cattle and Kuchinoshima cattle on the back (35)

Mishima cattle

Mishima island is very small, with an area of 7.8 km² covered in terraced rice fields suitable for small and good temperament cattle only. Mishima cattle can be thought of as the original type of Japanese black cattle and they were designated a natural monument in Japan in 1928. The breed has never been crossed with any foreign breeds and maintained its black coat and good meat quality with exceptional marbling. The cattle is physically small with a mean weight and height of 260 kg and 113 cm females and 490 kg and 130 cm males.

The small herd has been kept since then as farm animals and for in situ conservation and in 2002 the number of female cattle has increased to nearly 100 in 2002 (Minezawa et al. 2008).

Kuchinoshima cattle

The population size of Kuchinoshima cattle was 44-66 individuals in 1999 and all the herd is located in a small island of about 13 km² in far South of Japan. The body size of these cattle is smaller than Mishima's and the average wither height for female cattle is about 110 cm. The coat colour is black or brown with some white spots on the belly and limbs (Minezawa et al. 2008).

2.5.5) Japanese Black

Among all the four domestic breeds, the Japanese Black is the more widespread accounting 610.000 reproductive cows in 2008 and representing 98% of the total Wagyu breeds in Japan (Fig.9).

After a period of crossbreeding with foreign cattle, the breed has been maintained pure. Many continental breeds have been imported and crossed with the native ones in South Western Japan: in Kyoto and Hyogo Prefecture in the Kansai region and in Hiroshima, Okayama, Shimane, Tottori and Yamaguchi in the Chugoku region, in Kagoshima and Oita on the island of Kyushu and in Ehima on Shikoku island.

The foreign breeds used for the improvement of the natives were different according to the specific plans and standards set up by the Prefectures, they mainly were Simmenthal, Ayshire, Brown Swiss, Devon and Shorthorn (Honda, et al. 2002).

Japanese breed then was approved and registered as purebred by the government in 1944 and since then, in response of the mechanization of farming and the more westernized habits of eating meat, the cattle was raised especially for beef production. Accordingly, the progeny testing started in 1968 when each calf was born by artificial insemination by selected sires. In the 80's then the main objective of the improvement plan was the marbling, or intramuscular fat deposition.

Japanese Black has a brown or black coat, black hooves, muzzles and grey skin. It is considered to be a very tame animal, easy to domesticate. Its most notable feature among all the other breeds is the high degree of marbling and meat tenderness.

Japanese Black is representative of Wagyu and the improvement of its typical traits have been carried out since the breed establishment by public institution, working together with farmers (Honda, et al. 2002).

Since the domestic production of high quality beef has received more attention because of the growing interest on western diet, a more deep evaluation of mating plans occurred with the BLUP system from 1991.

However, because of the intensive and nation-wide use of a few sires with high predicted breeding values for marbling, the population structure has been drastically changed.

A remarkable thing about the breeding plans carried out in the last century was that almost each Prefecture had its own standard and project and they built it up within the same area. This meant that semen migration was limited to some extraordinary case for males only and thus the breeds used (prior to the breeds establishment) and the crossing degree varied among Prefectures (Honda, et al. 2002).

The main Japanese Black breed was so divided into several local subpopulations with characteristic abilities and traits which made them famous across Japan. Those subpopulations of Japanese black resulted into five most important groups in Chugoku and Kansai district: Hyogo, Tottori, Okayama, Hiroshima and Shimane.

In the 80s, these subpopulations still had their unique characteristics because of the limited migration that occurred among them. The high meat marbling in Hyogo and the high growth rate in Tottori and Shimane Prefectures are well known.

As of these subpopulation have played an important role in supplying breeding stocks to other Prefectures, the other subpopulations of Japanese Black in those years could be classified into several genetic groups according to the degree of relationship to the five subpopulations in Chugoku district.



Fig.9: Japanese black cattle, cow and finishing steer (35)

We have thus witnessed the disappearance of a clear genetic subdivision within subpopulations so that now the decline of genetic diversity is an increasing problem (Honda, et al. 2002).

In the period 1985-1990 the breed maintained an effective size of approximately 30. However, after 1991 the effective size sharply decreased. Although the effective size fluctuated, the mean between 1993 and 1997 was only 17.2. An increase of the effective size was observed in 1997, but this was temporary.

An additional analysis which covered more than 60% of the registered animals in 1998, showed that the effective size again dropped to 17.4. Furthermore, 42.9% of the registered animals in 1998 were the progeny of only five sires, indicating that the intensive use of a small number of sires became more prominent (Nomura, et al.2001).

In the last study about genetic subdivision of a population of Japanese Black cattle population conducted in August 2001, Honda T. et al. selected more than 2000 cows younger than or equal to 10 years out of 610.000 Japanese Black used for reproduction in that year. The main purpose of the study was to estimate the genetic relationship among the selected 25 subpopulations, each belonging to a different Prefecture (Honda, et al. 2002).

The genetic relationship between subpopulations and within them has been expressed by two different measurements that pointed out that a genetic subdivision still

exist within Japanese black breed but it has almost disappeared within the same subpopulation.

From the study it resulted that the Chugoku district subpopulations still maintains their unique genetic compositions on some level, while most of the subpopulations formed a single cluster.

In particular, Hiroshima would be of special importance, because of the unique genetic composition, as a resource for recovery genetic variation in the breed. Hyogo instead joined to the cluster in the earliest stage. This means that Hyogo influence as a supplier of breeding stocks has increased during the past two decades. The situation could be a reflection of the current emphasis on the standards about meat quality in the breeding of Japanese Black.

The objective of breed improvement with a high performance is only possible using several strains (subpopulations) with different genetic characteristics. Possessing several strains will also contribute to the maintenance of diversity within the breed.

However, the maintenance of many different population with distinctive genetic characteristics occurs only if the management is carefully designed.

The most important factors to have a well designed breeding management plan which increases genetic differences are the number and the size of the subpopulations, also considering the migration rate among subpopulations.

For a population with a given size, the genetic diversity in the whole population is maximized when the population is divided into numerous isolated subpopulations.

This kind of strategy though is difficult to be implemented in livestock population because of the high rate of inbreeding in the same subpopulation. In addition, each subpopulation has to maintain a high level of quality traits suitable for commercial objectives (Honda, et al. 2002).

Currently the main blood strains used for breeding are:

- Tajima strain in Hyogo Prefecture
- Ketaka strain in Tottori Prefecture
- Itozakura strain in Shimane Prefecture

Almost all the Japanese Black in Japan have a pedigree which includes a combination of those three strains. These were established in the Takenotani-zuru,

Bokura-zuru, and Shusuke-zuru regions, respectively. Cattle in the different Prefectures were selected for varying carcass and body conformation traits. Hyogo cattle were selected for carcass quality, which is reflected in their greater amounts of intramuscular lipid (i.e., marbling) at the 6th and 12th ribs. Tottori cattle were selected for large size and a strong back line, which apparently selected against carcass quality. Shimane cattle were selected for traits similar to the Tottori cattle (being a sub-line of the Takenotani-zuru line); however, Shimane cattle apparently retained greater carcass quality than Tottori cattle (Honda, et al. 2002).

Among these blood strains Tajima is the most famous one. This is because of the marbling of the beef and all the attention given to the genetic management in Hyogo Prefecture. Only Tajima cattle can be eligible to become Kobe beef, one of the most famous beef in the world (Honda, et al. 2002).

3) Production management

3.1) Introduction

Japan is a mountainous island archipelago and only 30% of Japan's area is suitable for agriculture or urban use. At the same time, the population of approximately 128 million people makes Japan the tenth most populous nation on earth. Given this, it is not surprising that land scarcity remains a challenge for agriculture and breeding. Because of the lacking of proper space to breed in larger scale farms and the aging of the farmers, if the number of head per farm slowly increased during the past decades it still was 44.6 in 2014.

The past habit of keeping cattle in small-scale family farms is still very common nowadays, and farm size is struggling to increase. Growth in the demand for labour from other sectors made young people leave farming, and people from the cities do not tend to move towards the countryside or replace the elderly doing hard physical work every day. This resulted in a lack of working men for the cattle industry and in a scarce perspective of increasing the production. These movements have also led to an agricultural workforce that is older than in other sectors (Kimura, et al. 2009).

Cattle farmers are currently making efforts to raise cattle in a comfortable environment according to guidelines which cover keeping, health and hygiene. In 1987 the Ministry of the environment issued the "Proper-handling guidelines for raising and keeping industrial animals" which gives recommendations about hygiene at farms, avoiding animal abuses and how to conduct animals shipment. There is no formal system to check whether or not these indications are respected though. The "Standards of rearing and hygiene management" and the "Act on Domestic Animal Infectious Diseases Control" were then released by MAFF to assess and prevent risks in the livestock industry. Moreover the "Feeding management guidelines for beef cattle complementary with the concept of animal welfare" were made by Japan Livestock Technology Association (MAFF website, Wagyu Japanese beef).

Through these practices, Japan is at a negligible risk for BSE (Bovine Spongiform Encephalopathy) outbreaks and free of FMD (Foot and Mouth Disease). In addition animal origin feed and growth hormones are not given to the animals in Japan (Motoyama, et al. 2016).

3.2) Japanese breeding system

The Japanese breeding system is very peculiar because to meet specific high quality standards, the total growth management is oriented to deeply satisfy nutritional requirements of each cattle at each stage of its breeding. Breeders design specially formulated ration with selected feed ingredients in order to have the optimum outcome in the marbling, fatty acid composition and flavor of the beef. The feeding lasts up to 33 months and can last more in some Prefectures. All the care and attention possible is paid to the cattle in order to minimize stress, this even by managing small groups of animals at a time and physically separating them by age (Interview: T. Tanimoto, Nov. 2018).

There are three types of Wagyu cattle farm in Japan: breeding farms (cow-calf), fattening farms (feedlots) and farms which comprise both breeding and fattening. Both phases are accomplished in small-scale realities under a confinement management system with a large number of cows managed individually. Since the total amount of time needed to raise and fatten a calf to a grown adult to send to the slaughterhouse is about 40 months, it is a huge economic risk that farmers owning only few bovines are not often willing to take. The share of farms which have the continuous management is thus very small as compared to the breeding and fattening farms' share (Interview: T. Tanimoto, Nov. 2018).

In the breeding farms artificial insemination is performed with selected sires according to the most suitable genetic plan. Soon after Wagyu calves are born, they are registered by registry association so that the history and genealogy of the cattle is easily traced back for at least three generations. The inspection for the registration acquires basic information for each calf included the pattern of the wrinkles at the nose head, as a fingerprint, the genotype testing if possible, sex, name of the breeders, date of mating, birth and any abnormalities. If the calf meets Wagyu standards and parameters, the Wagyu certificate is released and individual identification number is given to keep track of the calf history and to provide reliable information to consumers (Interview: T. Tanimoto, Nov. 2018).

Grazing in Japan is quite a rare event because of the geography and the population pressure. It is only possible in areas in which rice or other crops cannot be cultivated or in some traditional and unique breeding system. In addition, because of the extreme value of each Wagyu cattle and the small size of herd, no farmers want to bear the risk of having the cattle injured in grazing (Interview: T. Tanimoto, Nov. 2018).

Calves are produced by year-round artificial insemination, and calf milk replacer and starter are extensively used to achieve earlier return of oestrus and to accelerate calf growth. Calves are raised with their mothers confined to small barns or adjoining pens. They are hand fed with grains and many kinds of roughages and fodders, which may include freshly cut grass, rice straw, hay, barley and sometimes also agriculture by-products or waste. Almost all Wagyu calves are fed with special concentrate rations from about three months of age. Early weaning management has the aim to ensure calves' growth and to get them ready for grain feeding program.

Cows eat roughage mostly and have limited access to concentrate, that is mainly maize, barley and wheat bran (Interview: T. Tanimoto, Nov. 2018).

Both female and male calves are raised for beef production but while females are not castrated male calves destined for feed lots are normally castrated at two or three months of age. Given the high value of each calf, this operation is usually performed by a veterinarian or by a specialist employed by a livestock cooperative.

Once between the age of eight to ten months, calves are weaned and sold at auctions held in special calf auction centers in the breeding areas. They are sold one at a time on a per head basis, while selling a calf directly to the fattener farmer rarely happens.

The buyers could be fattener farmers who choose the most suitable calf for their farms. Some of the fatteners are good at raising small sized calves while other are better in raising fatter ones and so on. The buyers could be also other breeding farmers who wish to replace heifers for their breeding and thus increase genetic variation.

It is extremely hard to classify the different techniques used in the fattening system in Japan. This is the most complicated and important stage in the beef industry and it is managed differently between Prefectures, and also within them. Normally steers enter the fattening period around 8-10 months of age and they are slaughtered when they reach the age of 27-33 months but there is a great deal of variation (Interview: T. Tanimoto, Nov. 2018).

On a fattening farm, a group of animals (usually a few to several) are managed together in a barn. Fattening can be divided into two or three stages, and the animals are given suitable amounts of roughage and concentrate for each stage.

The fattening period is very delicate and important phase of the breeding and it is managed by experts. The diet has to be changed at each stage of the fattening and the

length of the stages is not fixed so each decision is made up by farmers according to many different factors (Interview: T. Tanimoto, Nov. 2018).

Some hints for the feed are given by JA (Japan Agricultural Co-operative) a national organization of farmers established in accordance with the Agricultural Cooperative Society Law. The organization is based in every Prefecture and municipality and with the principle of mutual cooperation it is involved in farm guidance, marketing of farm products, supplies of production inputs, credit and mutual insurance businesses, while they are referred to as "multi-purpose agricultural co-operatives" (JA Cooperative website).

Some further support comes from the Prefecture in which the breeding area is located. Each Prefecture has specific manuals and recommendations used as specific plans for feed.

If the bred cattle is due to get a Geographical Indication quality sign, the farmer must follow the rules written in the product specification. Those rules could regard breeding techniques, keeping management, feed, and so on.

At the end the farmers themselves decide which is the right ration for the fattening period, taking into account the above mentioned factors and adding their personal experience in the field.

Often it is their specific "know how" that is considered the most important factor which comes to help them in making the right blend of feeds needed for the diet of each calf at each growing stage of its life.

During the first half of the growing period (weaning and the beginning of fattening), cattle diet is relatively low in concentrate and high in roughage in order to prevent excessive fat to lay down. This is made to ensure the roughage consumption to develop rumen size and muscle growth. Farmers mostly use the grower ration and hay.

Then, in the fattening period, animals are kept on high energy rations by raising the concentrate share. This induces a great accumulation of fat: subcutaneous, intermuscular and intramuscular so that the carcass contains about 40% of fat or more. Farmers tend to restrict Vitamin A consumption and maximize feed consumption until last minutes to develop marbling.

During the finishing period of fattening, the most common practice is to give as much concentrate as possible and rice ad libitum (Interview: T. Tanimoto, Nov. 2018).

The most common source of grain are barley (steam flaked) to provide high crude fiber and corn (steam flaked and hominy feed) with high energy. Regarding the source of protein, soybean and canola meal are often used. Other products regularly used are wheat bran, okara (a by product of soy milk, nuts husk and barley husk. Minerals are given by stones like lime stone which provides calcium and phosphorum.

Speaking about roughage grasses hay (Ryegrass and Bermuda), Alfalfa hay for diet in which vitamin A is comprised and rice straw or wheat straw, products without vitamin A (Interview: T. Tanimoto, Nov. 2018).

For example, cattle is fed a high-energy diet twice daily starting at 11 months of age until slaughter (28 to 30 months of age). From 11 to 18 months of age, the diet comprises increasing amounts of concentrate (36.8 to 86.4%, formula feed) and decreasing amounts of roughage such as Jamboree (beer bran), hay, and rice straw. During the final stage from 18 months to slaughter, the diet comprises 86.4 to 84.2% concentrate and 13.6 to 15.8% roughage. All cattle have constant access to water and mineral salt blocks containing minerals, salt, and a diuretic.

The total feed consumption during fattening is normally 4,000 to 5,000 kg/animal. For fattening until 26 and 30 months of age, 4,344 kg and 5,167 kg of concentrate was needed (Gotoh, et al. 2018).

In Japan in recent years, farmers have also considered manipulating vitamin A level to improve marbling during fattening of Japanese Black cattle. Currently, farmers keep the vitamin A concentration low only during the middle fattening period; during the finishing period, low vitamin A concentration often induces severe hepatic disease and swelling (Krukab, et al. 2018a).

Some management practices comprise feeding some special food such as beer to stimulate the appetite that comes less when the animal is on the high energy ration in the finishing period. This, along with the deliberate restriction of exercise, which prevents muscle toughness, results in a carcass with bright red meat finely marbled with pure white fat. Japanese Black cattle usually get a higher degree score in marbling than other Wagyu breeds, but it's more expensive to breed since cattle eat more, recording very low daily gain.

It's very hard to have detailed feed conversion index or growth rate data on Wagyu cattle because there are so many different strains, feeding system and fattening period

management that meaningful evaluations are not easy to make (Interview: T. Tanimoto, Nov. 2018).

On average, the slaughtering age is 30 months, the mean body and carcass weights of Japanese Black cattle at slaughter were 756 kg and 476 kg, male, female respectively, while the mean daily weight gain to slaughter was 0.77 kg. Recently, the percentage of intramuscular fat in longissimus muscle from Japanese Black cattle has averaged more than 30% (Gotoh, et al 2018b)

When the fattened cattle reaches the age (28-32 months), it can be sold either live or as carcass. For live animal, marketing buyers bid on cattle by predicting the carcass quality through visual assessment. When marketed as carcasses, animals are sent to the slaughterhouses within the Prefecture. The animal is slaughtered and the half carcasses are brought to auctions to be sold at buyers who could come from all over Japan. Many abattoirs in Japan are built along with auction houses and are called ‘carcass markets’.

The cattle slaughtering process is undertaken in two steps. The first one is the stunning through percussion stunning producing a physical shock to the brain leading to the unconsciousness of the animal eliminating pain and stress. Some cattle undergo electrical stunning or CO₂ gas stunning. The second step is the bleeding which consists in severing aorta and other neck blood vessels so that the animal dies from cerebral anoxia caused by exanguination.

There are almost 90 registered slaughterhouses for beef cattle in Japan with the largest one that could handle 350 animals per day (Gotoh, et al. 2014).

3.3) Production, prices, markets

2.51 million cattle have been raised for beef production in Japan in 2018 (2.49 in 2017) and 1.70 million of these were Japanese Black cattle, 21,000 Japanese Brown, and 25,000 other Wagyu breeds. The remaining 834,700 non Wagyu cattle have been used for beef production (Holstein 313,000, F1 Wagyu-cross 521,600 and others).

The number of farms in Japan that raises beef cattle is declining: in 2018, there were 48,300 (50,100 farmers in 2017) producing beef and each farmer had 50 cattle on average. In 2017 35.6% of the cattle was raised on Kyushu, the main island and 20.7% on Hokkaido, the main Northern island.

In 2017, the mean price of calves at 9 months of age on average at market was 653.827 yen (5.141 euro), while the price of carcasses at the beef market was 1.313.694 yen (10.344 euro). The average total cost of production per carcass was 1.054.763 yen (8.305 euro) (MAFF Statistics VIII, 2017).

The average cost of Wagyu beef is too expensive for daily consumption for Japanese consumers so that Wagyu beef consumption is reserved only for special occasions and feasts. In January 2019 the average retail price for Japanese black beef was: 825 yen/100g for chuck, 785 yen/100g for brisket, 1409 yen/100g for sirloin and 804 yen/100g for round. The average price for domestic beef was 581 yen/100g for chuck, 591 yen/100g for brisket, 980 yen/100g for sirloin and 592 yen/100g for round.

Beef imported from Australia, one of the most important exporter for Japan, on average costs 265 yen/100g for brisket, 404 yen/100g for sirloin, 249 yen/100g for chuck and 251 yen/100g for round (ALIC website).

Superior Wagyu beef such as Kobe or Matsusaka could be even more expensive. For example the retail price for tenderloin from Matsusaka beef can be 120.000 yen/Kg (Motoyama, et al. 2016).

Wagyu beef has seen an exponential increase in exports over the last years probably due to the fame Japanese cuisine has gained for the certification as a UNESCO Intangible Cultural Heritage. Additional measures are going to be set to boost Wagyu exportation such as refined quarantine, food processing and food labeling measures as Japan sets its eyes on new markets (J-LEC website).

The prices vary according to the quality grade of the beef, the cut and the sales destination. In recent years, Japan has exported beef to several foreign countries such as the United States, Canada, Hong Kong, Macau, Mexico, New Zealand, Vietnam, Cambodia, Singapore, the Philippines, and, since 2014, the EU. However, Japanese Wagyu beef is sold at higher prices than local beef in foreign countries (MAFF Statistics VIII, 2017).

Animal quarantine is conducted when Wagyu beef is exported from Japan to foreign countries. This underpins international trust, proves exported Wagyu beef's safety and guarantees not causing any infectious diseases abroad.

When Wagyu beef is exported, applications of exporting inspection are filed to Animal Quarantine Service with necessary documentation. Having documentary

examination, actual inspection is conducted if necessary. Quarantine Certificate is issued for those passed exporting inspection. However, Quarantine Certificate shall not be issued in case the exporting destination country ceases importing Japanese livestock.

Strict thermal management is conducted for the exporting chilled Wagyu beef. Wagyu beef, immediately after being slaughtered, is packed with refrigerant at processing facilities of exporting meat, and its temperature is kept under five Celsius degrees. Refrigerated trucks are used for transporting meat from processing facilities to airports.

At major airports in Japan, most airline companies have indoor refrigerated chambers, which generally used for thermal management of meat.

Chilled Wagyu beef is kept in appropriate temperature while on passage by aircraft as air temperature is low. When discharged on the ground, temperature becomes ordinary but refrigerant packed with meat secures thermal management.

Storage under five Celsius degrees is available at flagship and hub airports at export destinations, at least in Asia, Europe and North America. However, there are some major airports in countries across Africa where refrigerating facilities are not available (Motoyama, et al. 2016).

3.4) The traceability system

The Wagyu Registration Project started in 1920 in Japan when Wagyu cattle were considered the mixture of native breeds with foreign ones. The aim of the project itself was that of producing the true Japanese breed by recording pedigrees, defining the standard proportions and other improvement objectives. This system would have excluded non-standard foreign breeds fixing the present four official Wagyu breeds.

In order to make the most out of Wagyu and secure it as a resource, it was seen necessary to record pedigree and advantages of each respective cattle. The calf registration certificate was then needed to have data for the building up of the Wagyu census register (J-LEC website).

In response to the first case of BSE in Japan in 2001, the Ministry of Agriculture, Forestry and Fisheries (MAFF) enacted “The Law for Special Measures Concerning the Management and Relay of Information for Individual Identification of Cattle”, also

known as “Beef Traceability Act” in 2002. It requires unified management of domestically raised cattle using an individual identification number.

The system was built to restore consumers’ trust in the beef consumption by improving transparency of all the production and marketing processes and providing reliable information about the origin of the cattle throughout the supply chain. This also led to the empowering of traceability and prevention measures for BSE outbreaks. The MAFF had to make sure the meat wholesalers, retailers, meat processors and restaurant owner to withdraw all the compromised meat products and through this system it made it possible (Motoyama, et al. 2016).

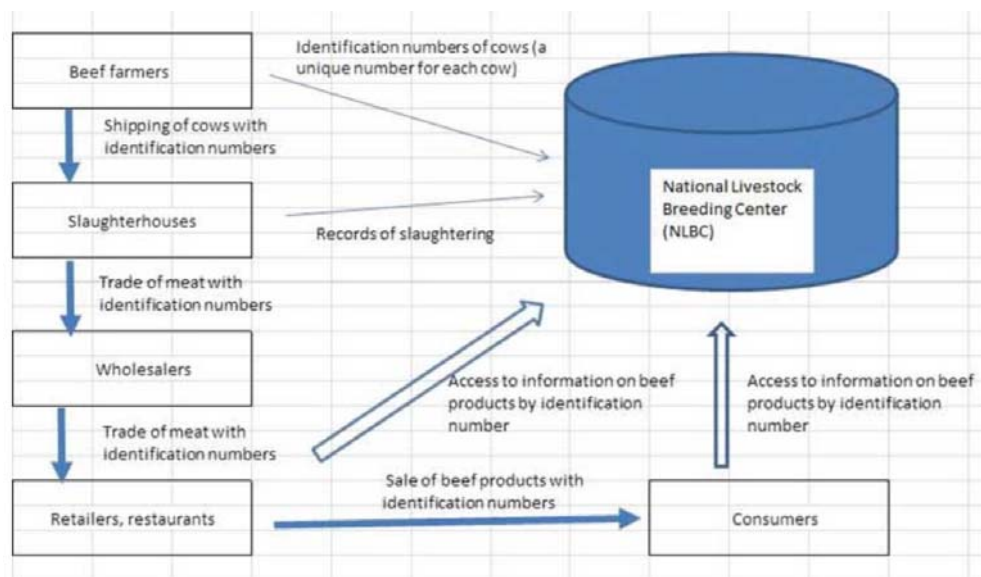


Fig.10: Beef traceability system (52)

The beef traceability system (Fig.10) requires all domestically raised cattle to be given an ear-tag with a specific individual Identification number of ten digits which will follow the carcasses to keep track of them from the breeding to consumption. Other information such as date of birth, gender, producer data, are added when cattle is registered to the National Livestock Breeding Center (NLBC). The NLBC is an independent administrative agency which is in charge of compiling and keeping the record of each beef cow in the electronic ledger for the beef traceability system.

At every stage of cattle life starting from its birth, slaughtering, including the process from carcass to saleable meat as well as the process of their retail sales, each supplier and distributor reports this change in the situation of the beef to the NLBC along

with Individual Identification Number, which is obliged to be indicated when being trafficked.

Consumers are able to trace the production history by Individual Identification Number indicated on the product. Information, based on the Law, recorded on Cattle Individual Identification Ledger are to be disclosed to public. Information regarding an individual cow can be looked up at the website of National Livestock Breeding Center by using Individual Identification Number (Gaukin, et al. 2015).

The NLBC keeps a record of the attributes of each beef cow: the individual Identification Number, date of birth, gender, individual Identification Number of maternal parent, raising location(s) (Name of prefectural and city governments), dates of outgoing and incoming of its raising facilities, date of slaughter or export, breed of cattle, name of the country of its import (for imported cattle), name and address of the slaughterhouse, name of the country of its export (for exported cattle). Consumers can access this information on NLBC's homepage by inputting the unique identification number labeled on the beef product they purchased (J-LEC website).

The Wagyu registration requires proofs of the pedigree and a copy of the respective muzzle pattern of each calf for the future inspection and evaluation. This system is very selective in order to exclude cattle that doesn't meet certain level of quality requirements. After the calf registration inspection (documentary confirmation, respective calf confirmation and abnormality check), the regional registration inspectors issue the official certificate proving the breed (Motoyama, et al. 2016).

From each carcass a sample is taken and preserved in case some tests are required later on. To make sure the Beef Traceability System is valid some samples are collected from carcasses at the slaughterhouse and spot tested. For example when the Fukushima disaster happened, radiation became an important risk to be assessed. Having samples from all the carcasses slaughtered, test were made quickly among cattle in the security area. If a diseased cattle or beef recalls come to light it's possible to tell the current location of the herd the cattle belonged to.

4) Quality grades on Wagyu beef

4.1) Introduction

Reliable and accurate measurements of phenotypes are required to conduct an efficient breeding plan. A uniform and well-organized carcass grading system is present in Japan, and the genetic improvement of carcass traits in Wagyu cattle relies on this system.

The standard has been released in 1988 by the Japan Meat Grading Association (JMGA), and then approved by the Agricultural Production Bureau of the Ministry of Agriculture, Forestry and Fisheries. The JMGA is a third-party association in between meat producers and distributors that conducts grading based on nationally standardized grades. The grading system is used as the nationwide unified transaction standard for Japanese beef. This standard guarantees that every carcass in the country will be evaluated in the same way having the same grade and then quality and price (Motoyama, et al. 2015).

The grading of meat animal carcasses is managed and carried out by the JMGA in the meat wholesale markets and at the meat centers in the major producing areas in Japan.

Carcass grading system assigns two indices to the beef: a yield grade and a meat quality grade. The yield grade is marked by letters from A to C, indicating how much high-quality meat one carcass provides, not counting parts such as skin and internal organs. The highest yield grade that can be attained is A. This letter is then followed by a number between 1 and 5, the quality grade. Four criteria determine how high the quality grade is: marbling, meat color and brightness, firmness and texture of meat, and color, luster, and quality of fat. The lowest of the four individual grades is the final grade given to the meat (JMGA website).

The grade assessment is performed by looking at the surface of the 6th-7th rib section for both the parameters at least an hour after ribbing. The carcass grading system results in 15 grades built up by the combination of the above two elements.

Beef cut trading standards have been stipulated too, as Japanese cut system is very particular. Carcasses are cut between and along muscles making linear cuts, which are relatively expensive because of the large area of the muscle section. These kind of cuts

are used in the preparation of traditional Japanese dishes such as sukiyaki and shabushabu (JMGA website).

4.2) Yield

Yield grade is the ratio of meat to dressed carcass weight. It is classified into three grades from A to C. The score is determined by estimated percentage thanks to the multiple regression equation which comprises four carcass measurements mostly made on the surface of the 6th-7th rib section. The categories of the measurements are about:

- Thoracic longissimus muscle area
- Rib area thickness
- Cold split carcass weight
- Subcutaneous fat thickness

Rib eye area is measured by grid, others by scale. Another measurement for the equation - the left side weight - is obtained from routine records (Fig.11).

Grade A is 72% of yield estimated percentage and above so the yield of total cuts is above average range. Grade B is from 69% to 72%, average. Grade C is under 69% and below average range. Since yield average value is determined to be normally distributed, the B rank is the more common to find (Cheng, et al. 2015).

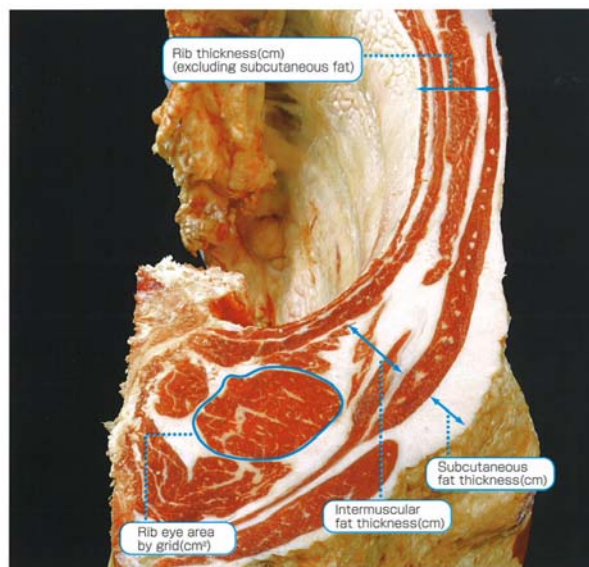


Fig.11: Parameters to assess the yield (53)

4.3) Quality grade

Beef quality score is determined by assessing beef marbling (BMS), meat color and brightness, firmness and texture of meat, color, luster and quality of fat.

4.3.1) Beef marbling

Marbling, defined as the quantity and the spatial distribution of visible fat within the lean in the longissimus dorsi muscle, is one of the most important attribute determining meat quality. High marbling improves the texture, the juiciness and the flavor of meat and therefore its acceptability. Consumers' consumption decisions are affected by the degree of marbling, representing one of the main assessment index for grading beef and set the price (Cheng, et al. 2013).

Beef cattle raised in Japan exhibit an unusual ability to accumulate marbling, which is given by a combination of intramuscular fat (IMF) and appearance of the beef, also called shimofuri or frosting. This characteristic is highly valued in Japan because since the IMF deposits are found mainly between fiber bundles, the perimysium disorganizes and contributes to the tenderness of the beef. In Japanese cuisine, soft and delicious beef with IMF and a good red color are requisites for cooking food in the traditional methods (Smith, et al. 2009).

Marbling in Japan is evaluated by visual assessment in the loin muscle at the 6th-7th rib interface. The marbling standard system has changed in the past years because of the dramatic increase of the intramuscular fat content of the longissimus muscle. This was due to the fact that genetic improvement focused mainly on the amount of the beef marbling (Fig.12) (Motoyama, et al. 2016).



Figure 12: from left to right: marbled beef BMS 7, macro appearance of marbled fat depots. Azan staining of transverse section in the Longissimus thoracis muscle of the best grade Japanese black marbled beef. Miofiber bundles (white arrows) look like islands in a sea of adipose tissue (black arrow) (48).

So far, visual appraisal is still the most preferred method used by the meat industry for the evaluation of marbling degree. From the silicon resin models used to be compared to the beef in 1988 to the 2008 implemented standard which utilized carcass photographs. A new marbling evaluating system is now carried out since 2014 (Gotoh, et al. 2014).

In this system the BMS score, from 1 the lowest, to 12 the highest, is determined by comparing the actual carcass marbling with the marbling standard photographs. Any larger areas of fat at the periphery of the rib eye are not considered as marbling in accordance with the Japanese grading system. The photographs have been selected using a combination of marbling percentage (fat to muscle ratio) and fineness index developed by Kato et al. in 2014. This system may become a global standard for assessing beef marbling worldwide (Fig.13) (JMGA website).

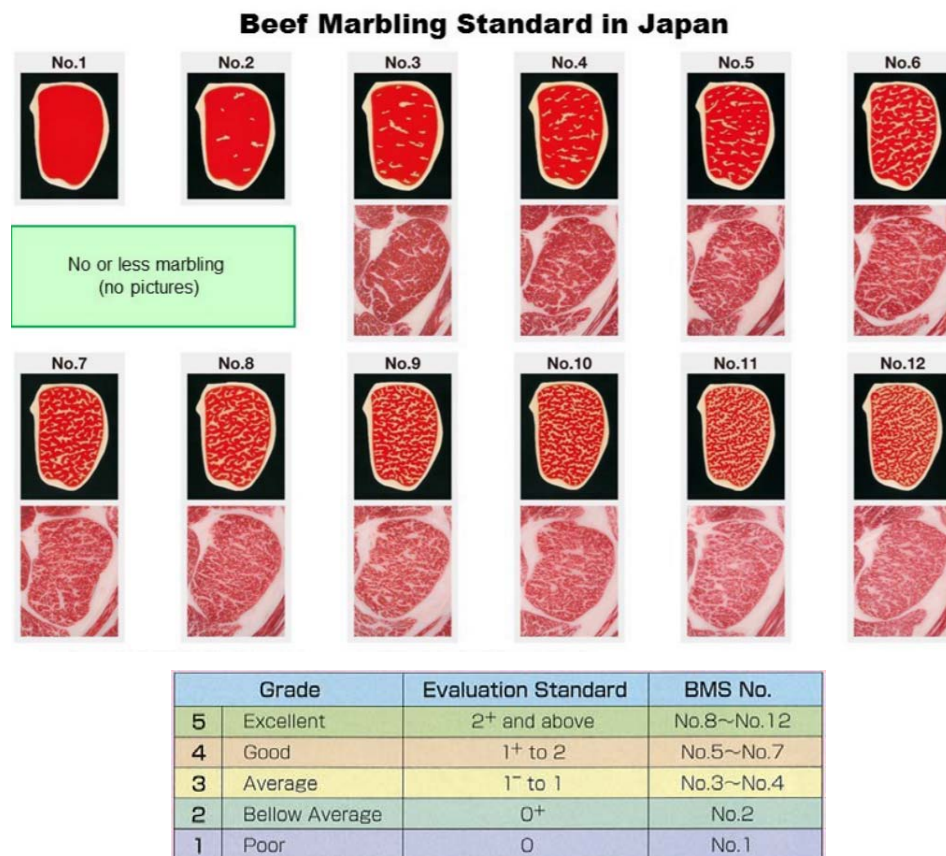


Figura 13: Marbling standards from JMGA and below the relationship between beef marbling standard (BMS) ad classification of BMS grade (48)

IMF accumulation is made up by a series of events that initiate and maintain preadipocyte proliferation, differentiation of preadipocyte into adipocytes and adipocyte

maturation along with the muscle growth declining. Looking at IMF with a microscope it appears as specific adipose depots, with adipocytes embedded in connective tissue in close proximity to a capillary. Chemically speaking, IMF is the sum of phospholipids, triglycerides and cholesterol. In muscles of mammals triglycerides are mainly stored not only within intramuscular adipocytes but also in myofibers as lipid droplets located close to mitochondria (Joo, et al. 2016).

IMF content has been the main focus of genetic improvement in the past decades and therefore it has been varying since the very start.

Japanese Black has long been selected for its IMF accumulation ability so that genetic efficiency and an intensive concentrated feeding system lead to more than 30% adipose tissue in the carcass of Japanese black in 1987. The Japanese Black in the study of Gotoh et al. accumulated about 40% adipose tissue in the carcass, which is much more than in European breeds (7–22%). These big differences can only partly be explained by the effect of feeding. The marbling degree of meat is largely variable and is affected by many factors together, such as feed, breed, sex, age, and weight (Smith, et al. 2009).

One of good strategy to increase IMF content in beef muscle is to extend slaughtering age which has been brought up to 33 months for Wagyu cattle.

It is clear that IMF increases with feeding time and growth of the cattles both in pasture fed and in grain fed animals, however the rate of the fat accumulation is faster in grain fed ones. Japanese black cattle fed on a high-concentration diet have higher expression of adipogenic transcription factors in the subcutaneous and intramuscular adipocytes than those fed on a high-roughage diet (Yamada, et al. 2012).

The IMF and the numbers of preadipocytes and adipocytes are higher in Wagyu than those in Angus.

The IMF contents in the longissimus muscle of Wagyu, German Angus, Belgain Blue, and Holstein Friesian are 23.3%, 4.4%, 0.6%, and 4.7%, respectively. The Wagyu and European cattle breeds are not different regarding their mechanisms of postnatal fat accretion but they differ in their efficiency of accretion of IMF. For every 1% increase of IMF in the longissimus muscle, the increase amounts of subcutaneous adipose tissue in Wagyu, Holstein Friesian, German Angus, and Belgain Blue were 3.0, 4.3, 7.9, and 10.7 kg, respectively according to Gotoh et al (2009)

Vitamin A and its derivatives play a key role in mammalian development and cell differentiation. In most cases, retinoic acid impairs adipocyte differentiation. Oka et al. (1998) and Nade et al. (2007) demonstrated the influence of vitamin A on beef quality in Japanese Black cattle pointing out that if serum vitamin A concentration is regulated, a higher marbling score could be produced without the increase of subcutaneous fat in genetically predisposed animals. For vitamin A, 1 IU is the biological equivalent of 0.3 μg retinol, or of 0.6 μg beta-carotene.

Although it is hard to keep control of the exact concentration, most farmers breeding beef cattle try to control the vitamin A according to some generic records as reported in the figure (Fig. 14).

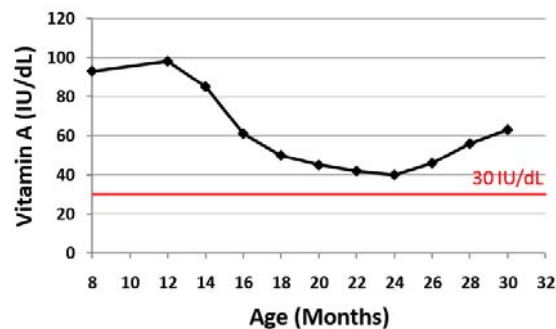


Fig. 14: Desired serum vitamin A level in cattle at different age of growth during fattening stage. The red line indicates the critical level (30 IU/dL) of vitamin A in Japanese black cattle (60).

If vitamin A deficiency happened, cattle would be vulnerable to catch diseases such as night blindness, xerophthalmia, or diarrhea, even death. It is important to monitor the vitamin A level to keep the cattle healthy and prevent economic loss for the breeders during vitamin A controlled period. Blood assay is the typical way to measure the serum vitamin A level. However, it is invasive and stressful to the cattle. Furthermore, it is complicated and needs expensive devices, high-performance liquid chromatography (HPLC) system which cannot be afforded by most breeders. Thus, an alternative that can estimate vitamin A level easily is desired. The relationship between serum vitamin A level of Japanese black cattle and light reflection on the pupil has been investigated as a new non invasive method and pupillary light reflex analysis can be used as indicators for cattle management during vitamin A controlled stage (Tanigawa, et al. 2011).

4.3.2) Colour and brightness of the meat

Meat color is assessed using the Beef Color Standard (BCS) made of silicone samples. The standard is scored in 7 grades (1 to 7) with the color becoming progressively darker from pale red n.1 to dark red n.7. The most preferred grades are from 3 to 4. Brightness of the meat is evaluated by visual appraisal.

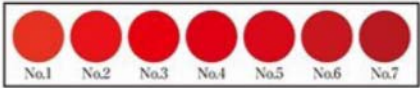
Beef Color Standard in Japan			
			
Grade		Color B.C.S. No.	Brightness
5	Very Good	No.3~No.5	Very Good
4	Good	No.2~ No.6	Good
3	Average	No.1 ~ No.6	Average
2	Below Average	No.1 ~ No.7	Below Average
1	Inferior	A Grade Except 5~2	

Fig.15: BCS (Beef Color Standard) by the Japan Meat Grading Association and below the classification of color and brightness grade

4.3.3) Meat firmness and texture

Meat firmness and texture are determined by visual assessment of the amount of exudate on the cut muscle surface. Water contains proteins released from the muscle. The degree of depression caused by the incision on the surface of the beef is considered, too (Fig.16) (JMGA website, beef carcass grading standards).

Grade	Firmness	Texture
5	Very Good	Very Fine
4	Good	Fine
3	Average	Average
2	Below Average	Below Average
1	Inferior	Course

Fig. 16: Classification of meat firmness and texture by JMGA

4.3.4) Fat colour, luster, and quality

These parameters are evaluated by using the Beef Fat Standard (BFS) made of silicone resin under the responsibility of JMGA official graders. The whiter the color of fat the higher the score: white is n.1 and the transition colors up to yellow are higher numbers until 7. Luster and quality are evaluated by visual appraisal together (Fig.17).

Beef Fat Standard in Japan



Grade	Fat Color	B.F.S. No.	Luster and Quality
5	Excellent	No.1 ~No.4	Excellent
4	Good	No.1 ~No.5	Good
3	Average	No.1 ~No.6	Average
2	Below Average	No.1 ~No.7	Below Average
1	Inferior	A Grade Except 5~2	

Fig. 17: Beef fat standard in Japan, below the classification of the fat color, luster and quality by JMGA.

Overall meat quality grade is determined considering the previous four items independently considered: marbling, color and brightness, meat firmness and texture, fat color, luster and quality. Meat quality grade is assigned according to the lowest grade of these four items, and then the carcass graded into one of 15 categories. For example, even if three criteria out of four are graded as the fifth, if the last one is graded as the second, the final judgement of the carcass results in the second grade (Fig.18) (JMGA website, beef carcass grading standards).

Yield Score	Meat Quality Score				
	5	4	3	2	1
A	A5	A4	A3	A2	A1
B	B5	B4	B3	B2	B1
C	C5	C4	C3	C2	C1

Fig.18: Carcass grading system by JMGA

The results of grading are valuable information for producers to know the quality of their production. Producers are able to learn the points of improvement from these grading results. The better cows and bulls are selected for the better breeding, and the management is also improved, for example by choosing the better blend of feed. Furthermore, for Wagyu breed improvement institutions, the national grading data offer valuable information for selecting the most qualified cows and bulls to enhance the whole Wagyu quality (JMGA website, beef carcass grading standards).

5) Fatty acids composition

5.1) Introduction

The perception of healthiness, tenderness, juiciness and aroma or flavour are important quality criteria that influence the decision of a consumer to purchase beef. (61)

All these factors are linked to the fatty acid composition of the beef, which is an important factor in its quality assessment, influencing not only consumers' attitude toward the product but also the quality of the carcasses, the visual appeal, the preservation and acceptability of the meat.

Beef production systems represent the combined and interacting effects of genotype, gender, age at slaughter, and nutrition. The fatty acid composition of meat has been widely researched, and all these factors mentioned above have important influence on it. Therefore, the fatty acid composition of beef has recently become an important trait in the beef industry, especially in Japanese Black cattle.

Improvements in Japanese Black cattle have been accomplished by changing from high marbling to better fat quality by focusing on the taste of beef, its texture and the possible health benefits coming from eating the beef (Piaoa, et al. 2018).

5.2) Factors determining fatty acid composition

5.2.1) Fatty acid composition

Fat composition of beef can be manipulated by time on feed, diet, and breed type. Diet and time on feed are considered much more important determinants of beef fat content and fatty acid composition than breed type.

It has been reported that fatty acid composition in highly marbled Wagyu is considerably different from those in other cattle breeds. The fatty acid composition of 833 Wagyu carcasses shows that the minimum value of monounsaturated fatty acid composition was 49.2%, the maximum value was 72.6%, and the majority of the values were between 56% and 55%. Most of the monounsaturated fatty acid composition was found to be dominated by oleic acid (C18:1). High level of monounsaturated fatty acids,

including the oleic acid composition, is a special feature of Japanese Black cattle (the main Wagyu breed) (Oka, et al. 2002).

Regarding the oleic acid composition, the minimum value was 42.9%, the maximum value was 65.2%, and the majority of the values were between 50% and 60%. Regarding the saturated fatty acid composition, the minimum value was 24.7% and the maximum value was 49.2%, but most values were between 32% and 42%. Regarding the polyunsaturated fatty acid composition, the minimum value of was 1.0%, the maximum value was 4.8%, and the differences between individual samples were small.

These values are regarded as being representative of Wagyu beef in Japan because the samples were collected over a wide area of the country (Oka, et al. 2002).

5.2.2) Breed type

As previously described, current beef produced by Japanese Black cattle contains more than 30% intramuscular fat. Zembayashi et al. (1995) investigated the effect of breed type, including Japanese Black, and sex on the fatty acid composition of subcutaneous and intramuscular lipids in finishing steers and heifers of pure Japanese Black and Holstein, as well as crossbred Japanese Black, Holstein, Japanese Brown, and Charolais. They reported that the Japanese Black is genetically predisposed to produce carcass lipids containing greater concentrations of monounsaturated fatty acids than Holstein, Japanese Brown, or Charolais steers (Zembayashi, et al. 1995).

Smith et al. (2006) have investigated oleic acid concentrations in the subcutaneous adipose tissues of Wagyu, Australian crossbred, Angus (corn-fed), Angus (hay-fed), and Angus (weaned) and found that they are 52.9%, 39.8%, 39.8%, 34.6%, and 32.9%, respectively (Smith, et al. 2006).

Also Gotoh et al. (2011) compared intramuscular fatty acid composition of Longissimus muscle in 26-month-old Japanese Black steers and Holstein steers reared and fattened using a standard fattening system with concentrate feed bases in a conventional Japanese fattening system even if normally a fattening period of Holstein cattle is shorter (20 to 22 months). In the Longissimus muscle of Japanese Black steers, there was a higher percentage of unsaturated fatty acid than in Holstein steers (Gotoh, et al. 2011).

Moreover, the intramuscular fat content and intramuscular fatty acid composition of 21 major skeletal muscles using the same animals showed that muscles from the Japanese Black cattle contained a greater proportion of numerous fatty acids, particularly MUFA such as C16:1, C18:1, C20:1, and monounsaturated fatty acids, compared with fatty acids in the Holstein cattle. In Japanese Black cattle, the proportion of C18:0 and saturated fatty acids was much lower compared to that in Holstein cattle (Gotoh, et al. 2014).

The fatty acid composition of Japanese Black cattle is a heritable trait. Heritability generally ranges between 0.31 and 0.73, with the heritability of C18:1 being 0.54, indicating a strong genetic basis for these traits in Japanese Black cattle. Several genes affecting fatty acid composition were reported in Japanese Black cattle (Uemoto, et al. 2010).

There are three fatty desaturases in animal tissues: $\Delta 5$, $\Delta 6$, and $\Delta 9$ desaturase. Of these, only the $\Delta 9$ desaturase acts upon saturated fatty acids (SFA) to convert them to their respective monounsaturated fatty acids (MUFA). The most abundant fatty acid in beef is oleic acid, produced by the $\Delta 9$ desaturation of stearic acid. The $\Delta 9$ desaturase, which is encoded by the stearoyl-CoA desaturase (SCD) gene, also converts trans-vaccenic acid to its corresponding conjugated linoleic acid (CLA) isomer, cis-9,trans-11 CLA.

Approximately 5% of the total fatty acids in beef are comprised of polyunsaturated fatty acids (PUFA), by far the most abundant of which is linoleic acid. As is the case for MUFA and cis-9, trans-11 CLA, PUFA contain a double bond at the $\Delta 9$ position; however, this is introduced into the fatty acid structure by the plant from which the linoleic acid was derived, and is not produced by $\Delta 9$ desaturation in animal tissues (Smith, et al. 2009).

Recently, the genes responsible for fatty acid composition have been identified in Japanese Black cattle.

Stearoyl-CoA desaturase (SCD) was first identified and reported as one of the genes associated with beef fatty acid composition. This enzyme converts saturated fatty acids

into MUFA in mammalian adipocytes. The composition of fatty acids stored in fat depots reflects the earlier action of SCD on substrates such as stearic acid or palmitic acid.

Since the report describing SCD, several candidate genes affecting fatty acid composition have been identified (Gotoh, et al. 2014).

Sterol regulatory element binding protein-1 (SREBP-1) regulates gene transcription activation by binding to the sterol regulatory element sequences contained in the promoters of downstream genes, including the SCD gene.

In general, economic traits in cattle such as the fatty acid composition have been considered polygenic. Although the adipogenic mechanism is extremely complicated, several genes have been identified and confirmed as either associated with or responsible for fatty acid composition in Japanese Black cattle. Representative genes such as SCD and FASN have already been used as DNA markers to select elite sires in Japanese breeding programs. These genetic markers may also contribute to the beef industry and human nutrition worldwide (Gotoh, et al. 2014).

5.2.3) Time on feed

Both the amount of marbling and the concentration of MUFA increase with time on feed in grain-fed and pasture-fed cattle, but much more dramatically in grain-fed cattle. High-concentrate diets stimulate the activity of adipose tissue stearoyl-CoA desaturase (SCD), which is responsible for the conversion of saturated fatty acids (SFA) to their $\Delta 9$ desaturated counterparts. Also, grain feeding causes a depression in ruminal pH, which decreases those populations of ruminal microorganisms responsible for the isomerization and hydrogenation of polyunsaturated fatty acids (PUFA) (Joo, et al. 2016).

The net result of elevated SCD activity in marbling adipose tissue and depressed ruminal isomerization/hydrogenation of dietary PUFA is a large increase in MUFA in beef over time. Conversely, pasture depresses both the accumulation of marbling and SCD activity, so that even though pasture feeding increases the relative concentration of PUFA in beef, it also increases SFA at the expense of MUFA.

Now is well established that, in neutral lipids of muscle and total adipose tissue lipids in beef cattle, there is a general elevation in MUFA and concomitant depression in SFA with increasing time on a grain-based, feedlot diet (Joo, et al. 2016).

5.2.4) Diet

The difference in fatty acid composition might be also attributed to the influence of different diets, forage, and grain feeding, although fatty acid profile in ruminants is not a direct reflection of the dietary fatty acid composition due to hydrogenation by rumen microorganism (Joo, et al. 2016).

The fatty acid composition in cattle is much less dependent on diet because microorganisms within the rumen hydrogenate the majority of dietary unsaturated fatty acids, which are mostly absorbed as saturated fatty acids. However, diet does influence the bovine fatty acid composition (Gotoh, et al. 2014).

Changes in the ruminal environment in response to grain feeding also may contribute to the increase in MUFA in cattle fed high-grain diets (Smith, et al. 2009).

5.3) Effects of the fatty acid composition on the beef

5.3.1) Oleic acid

The composition of fat in Wagyu is considerably different from that in other bovine breeds. Oleic acid concentration in the subcutaneous adipose tissue of Japanese Black, Hanwoo (Korean), Australian crossbred, Angus (corn-fed), Angus (hay-fed) and Angus (weaned) are 52.9%, 47.3%, 39.8%, 39.8%, 34.6% and 32.9%, respectively.

Fat tissue containing monounsaturated fatty acids possesses a lower melting point, which contributes positively to enjoyable beef taste and tenderness. Oleic acid (C18:1) is one of the major MUFAs in beef fat. C18:1 is well known to convey a favourable tenderness and flavour to the beef. Therefore, it is recognized to be important to improve the fatty acid composition, especially the proportion of C18:1 (Uemoto, et al. 2010).

A high concentration of oleic acid is also associated with a low melting point of fat, and may be related to the overall palatability of the meat (Smith, et al. 2009)

A low melting point allows the fat to melt at mouth temperature. Efforts are currently being carried out in several brands of Wagyu to guarantee an oleic acid concentration of, for example, 55%, to add further value (Motoyama, et al, 2016).

5.3.2) Tenderness

Marbling (intramuscular fat) is one of the most important factors in determining meat quality, especially with reference to texture and flavor. Japanese Black cattle is characterized by the ability to deposit very large amounts of intramuscular fat.

The fatty acid primarily responsible for soft fat in Japanese Wagyu cattle is oleic acid (18:1n-9). The concentration of oleic acid also is positively correlated to overall palatability of beef, which may be related to fat softness. Stearic acid (18:0) is a primary determinant of fat hardness, so any dietary or production factor that enhances the conversion of stearic acid to oleic acid will increase fat softness (Uemoto, et al. 2010).

As the animal matures, fat is deposited first in subcutaneous and intermuscular sites. Fat subsequently accumulates within the muscle giving birth to marbling fat in the perimysial connective tissue. At high intramuscular fat concentration, when the intramuscular fat concentration can exceed 200g/kg muscle, the dilution of fibrous protein by soft fat may decrease the resistance to shearing or chewing. Also, fat cell expansion in the perimysial connective tissue can open up the muscle structure (Moloney, et al. 2001).

The shear force value of the Longissimus muscle in Japanese Black steers decreases after 20 months of age, concomitant with the rapid increase in the fat content. There is a high and inverse correlation coefficient between the crude fat content and shear force value of raw Longissimus muscle in Japanese Black cattle after 20 months of age. A greater level of marbling is most likely to be closely related to meat tenderness.

In addition, there are structural changes in the intramuscular connective tissues during fattening of Japanese Black steers. During the early fattening period from 9 to 20 months of age, collagen fibrils within the endomysium in the Longissimus muscle associate more closely with each other, the collagen fibers in the perimysium become increasingly thick, and their pattern grows more regular. These changes are closely related to the increased mechanical hardness of the intramuscular connective tissue, resulting in toughening of the beef during this period.

The shear force value of the Longissimus muscle decreases after 20 months of age, concomitant with the rapid increase in the fat content. Scanning electron micrographs of the Longissimus muscle dissected from 32-month-old steers clearly showed that the adipose tissues formed between the muscle fiber bundles, that the honeycomb structure of the endomysium was partially broken, and that the perimysium separated into thinner

collagen fibers. By contrast, in the semitendinosus muscle, which has a comparatively lesser crude fat content, the structure within the intramuscular connective tissue remained rigid at 32 months of age. Thus, the development of adipose tissues in the Longissimus muscle appears to disrupt the structure of intramuscular connective tissues and contributes to the tenderness of highly marbled beef from Japanese Black cattle (Nishimura, et al. 2010).

5.3.3) Aroma

The chemistry underlying beef flavour is complex, with in excess of 140 components identified in cooked beef volatiles. Flavour of beef is influenced by cattle diet, but assessment of flavor by a taste panel is subject to the previous experiences and preferences of the panelists (Moloney, et al. 2001).

Japanese Black beef has a sweet and fatty aroma known as "Wagyu beef aroma", which is preferred by Japanese people. The optimum cooking temperature to generate this aroma is 80°C. This is consistent with the optimum temperature of sukiyaki and shabu-shabu, which are typical Wagyu dishes.

One of the possible compounds contributing for this aroma is γ -nonalactone. Lactones in beef play a role in the desirable deep fat-fried flavor and the high levels of lactones may mask the grassy flavor.

In addition, alcohols and aldehydes with fatty aroma and diacetyl and acetoin with butter-like aroma would also contribute to the part of the fatty sensation of Wagyu beef aroma (Matsuishi, et al. 2014).

Wagyu beef aroma is therefore certainly attributed to the high fat content, and some extent, to the lipid oxidation during storage. It has been reported that the differences in fatty acid composition, adipose tissue location and beef production area have effects on beef aroma (Migita, et al. 2012).

5.3.4) Health

In the past, fat was not given a good image in its role towards human health, although fat is an important energy resource for human. Recently, fat has been reported to have fewer adverse effects on health than carbohydrates, especially simple

carbohydrates. In fact, meat has played a crucial role in human evolution of a healthy and well balanced diet. High quality marbled beef not only has excellent eating quality, but also contains a lot of beneficial fatty acids (Damian, et al. 2016).

Interest in beef fat and fatty acids has been increasing, especially in highly marbled beef such as Wagyu because fatty acids composition in the diet have impact on human health. Consumption of fat and cholesterol has been reported to be linked to cardiovascular disease, obesity, and cancer. Consequently, reduction of total fatty acid intake and replacement of SFA with PUFA have been recommended. However, not all SFA are linked to hyper-cholesterol or obesity. Duckett et al. (2013) have suggested that a higher proportion of oleic acid in beef is desirable because the consumption of high-oleic acid ground beef can increase HDL-cholesterol concentration (Duckett, et al. 2013).

According to Smith et al. (2016), the amount of fat consumed in a typical portion of beef will not increase risk factors for cardiovascular disease. Clinical trials have demonstrated that ground beef containing elevated oleic acid can increase the concentration of HDL-cholesterol or at least has no negative effect on the concentration of HDL-cholesterol (Lahey, et al. 2014).

Recently, Lahey et al. (2014) have reported that MUFA can normalize or improve lipid metabolism and maintain the balance in cardiac muscle. These have implied that MUFA have little effect on total cholesterol and that they are heart-healthy dietary fat that can lower LDL cholesterol and increase HDL-cholesterol.

Smith (2016) have concluded that beef cattle should be raised under production conditions to increase the concentration of oleic acid in their edible tissue, for example by grain feeding over extended periods of time.

Many research studies have shown that the IMF of Wagyu beef contains a lot of MUFA and demonstrated that high-oleic acid ground beef may reduce risk factors for cardiovascular disease (Gilmore, et al. 2011), (Adams, et al. 2010), (Gilmorea, et al. 2013).

Thus, although some consumers consider highly marbled Wagyu beef as being unhealthy, there is no scientific evidence to indicate that beef that is high in oleic acid will increase risk factors for diseases (Smith, et al. 2009). Consequently, the role of animal fats in the diet should be re-evaluated.

Recent functional medicine research studies have suggested that the intake of fat has positive effect on human health. It is essential to consume fats containing good quality fatty acids while reducing the consumption of food high in simple carbohydrates. The inclusion of high fat foods with superior sensory properties in a balanced diet such as highly marbled Wagyu beef is likely to gain wider acceptance as a well-being food in the near future (Piaoa, et al. 2018).

To ensure meat eating quality at the point of purchase by the consumer, all points of the beef production chain should be optimized. The industry is moving in this direction by developing a systems approach that is analogous to the 'hazard analysis at critical control points' approach used in food-safety assurance. This palatability assurance facilitates the incorporation at every stage of the production chain, from genetic selection to final meat preparation and cooking, of new technologies that can help to optimize eating quality and reduce variability in beef (Moloney, et al. 2001).

5.4) Wagyu in other countries

In June 2014, European Union allowed to import Japanese Wagyu for the first time. Wagyu has been imported from other countries such as Australia and the USA into European Union before but never from Japan. Australia has proven to be very successful in breeding and selling of Wagyu beef, embryos and cattles. Sales revenue of 2013 was 503,113 dollars and that of 2014 increased to 708,148 dollars for the beef selling (Kimura, 2015).

Wagyu's popularity is exponentially increasing. Owners of high standard restaurants, hotels and retail niche butcher shops are struggling to secure supplies of Wagyu not only in Japan but also in western countries.

Foreign tourists are so aware of the melt-in-your-mouth tenderness of Japanese beef that once in Japan they look for a taste of the most famous beef brands in the world. Prices are pushed to near record levels and the much improved safety standards, after years of negotiation, are leading to the rising of Japan's agricultural export.

Wagyu represents the core strength of superior quality agricultural products made in Japan (International Wagyu Association website).

Today, Wagyu is popular among other countries from Asian countries such as Macau and Hong Kong to European countries such as Germany. Apparently the marketing activities of Japanese Wagyu was not successful because each Wagyu kind competes over prices one another in European market. Not only Europeans doesn't know the differences among Wagyu types but also Japanese consumers. In beef market in Japan, consumers are not educated and some even do not understand differences between Wagyu and "domestically grown cattle". The later refers to any kinds of cattle which stayed longest in Japan. For example, if cattle is raised in abroad for 300 days and then brought to Japan where it stayed for 301 days, it can be labeled as "domestically grown cattle" (Kimura 2015).

Even if the current pace of the Wagyu expansion is keep going and Japan's beef exports this year will surpass 20 billion yen, nearly doubled compared to those in 2015, Japan's Wagyu industry is in crisis. Even though current prices allow farmers to earn a decent living, the younger generation has turned its back on a life that requires them to be grounded in the countryside. While Japan's Wagyu industry struggles with an aging population, cattle producers in other countries are beginning to step into this business.

To prevent competition with foreign producers, Japan has never exported live Wagyu, semen or embryos to overseas markets. The genetics of only 221 Wagyu animals were sent to the U.S.A. for research purposes between 1976 and 1997. This includes 167 Black Wagyu live animals exported from Japan to the U.S.A. along with 21 calves sired by Japanese bulls born after the arrival of the females, and 16 Brown Wagyu live animals exported from Japan to the U.S.A. along with 6 calves sired by Japanese bulls (International Wagyu Association website).

Only after this small amount of Wagyu cattle had been exported, Japanese government officially banned all further exports to foreign countries, having declared Wagyu a national treasure. The value of the unique genetics had been underestimated and it was too late to prevent its spreading around the world.

After the initial exportation of the original 183 live animals from Japan to the U.S.A., Wagyu genetics were exported from the U.S.A. to Australia, Canada and Europe. All the registered Wagyu animals outside of Japan have been originating from the genetics of the first 221 original animals exported to the U.S.A

The non-Japanese Wagyu cattle is a cattle which is produced outside of Japan. What is called “Wagyu” are usually Wagyu breeds that are crossbred with non-Wagyu breeds meaning they are not fullblood (International Wagyu Association website).

There are almost two million fullblood (100% content) Wagyu globally, 96% of which are in Japan and the second highest population is in Australia, followed by U.S.A. that has three time less amount of cattle.

In Japan, beef is also produced from Wagyu crossed with Holstein dairy females, and F1 beef cross production in Japan is also the largest globally, accounting for almost 50% of the total. The Americas, which include USA, Canada, Central and South America, comprise nearly 30% of all crossbreds. Australia contains the next highest crossbred Wagyu population.

Most Japanese Wagyu producers dismiss foreign Wagyu ones as copycats, but also the overseas farmers admit that Japanese Wagyu is superior in quality. While Japanese Wagyu beef is becoming a luxury good that only certain customers can afford, foreign Wagyu breeders are trying to obtain top quality Wagyu reducing the costs thus reaching a wider customer selection (International Wagyu Association website).

This particular Japanese beef style has attracted lots of attention from all over the world. Many producers now are focusing on achieving similar quality for their beef imitating Japanese farmers and trying to close the quality gap.

Given the differing standards and definitions for Wagyu outside of Japan, the genetic make up of Wagyu is vast resulting in a wide range of marbling, flavor and tenderness. Due to a shorter history in handling Wagyu breeds, producers outside of Japan are still developing the optimal breeding and feeding programs for Wagyu production in their respective countries.

Gains have been most significant in Europe over the past 10 years with several Wagyu associations being formed to assist developing the breed. Nowadays there are accredited breeders of pure Wagyu genetics who provide Wagyu semen and embryos around the globe in order to spread Wagyu breed (International Wagyu Association website).



Fig. 19: all the countries in which breeding and production of Wagyu take place

6) Geographical Indications on Beef products in Japan

In front of the globalization of world economy, and the higher competition on international markets, a growing interest in product differentiation can be observed both by producers and consumers. Indeed, competition based only on price and undifferentiated commodity products (standardized good of homogeneous quality) risks to seriously affect weaker participants to market exchange.

With the aim of escaping from price competition and mass markets, and taking advantage of consumers' needs to buy quality food and concerns about economic, social, and environmental impact of production processes, producers are increasingly trying to differentiate their products in order to reduce substitutability with other suppliers and, by so doing, to improve the share of the value added they can capture.

Typical food products, the quality and identity of which are the expression of the specificities of both human and natural resources of a region, offer interesting opportunities in this regard. Indeed, as highlighted in the Guide "Linking people, places and products" developed in the frame of the FAO Program on quality and Origin, typical products can become the pivotal point of a virtuous quality circle within a territorial approach (Vandecandelaere, et al. 2012).

6.1) Definitions

Typical products (sometimes named as regional products or origin products) are identified on the market by Geographical Indications, names and/or identifiers which offer a potential for differentiating these products and communicating their specific quality on the market and to final consumers.

Although there is no common definition of GIs, the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS, signed by 128 countries) defines GIs as "Indications which identify a good as originating in the territory of a Member, or a region or locality in that territory, where a given quality, reputation or other characteristic of the good is essentially attributable to its geographical origin".

Geographical Indications are geographical signs that express a direct link with the territory the food products come from that cannot be found in any other kind of product. The origin is not exclusively linked to the climatic and environmental conditions of a

certain territory, but also to the specific knowledge and work of those who care about maintaining the specificities of the product unaltered during time: the producers. The know-how of these producers is as much important as the physical characteristics of the geographical area, and it leads to give an added value to the product, preserving its originality and cultural baggage. This phenomenon took the name of "terroir", a word that indicates a limited geographical area in which the natural, physical, chemical and human conditions give unique characteristics to the product.

At the end, the use of the Geographical Indications should be reserved only to producers located in that particular territory, which produce that product in line with local traditions, production recipes, and using the specific resources that are at the basis of product specificities and reputation. Therefore, the definition and implementation of clear production rules for using Geographical Indications are among the most important actions to defend and support the reputation of the origin-linked products, and benefit producers, consumers, and society as a whole (TRIPS Agreement, 1994)

6.2) The evolution of the Geographical Indications system in Japan

Since 1982 the European Union has developed a specific *sui generis* legislation to protect Geographical Indications for agricultural and food products introducing two distinct quality seals (PDO and PGI).

The PDO sign indicates that a specific product originates in a specific place, region or, in exceptional cases, a country. The quality or characteristic the product has are essentially or exclusively due to a particular geographical environment with its inherent natural and human factors and the production steps of its production all take place in the defined geographical area.

On the other hand, the PGI sign is used for products that originates in a specific place, region or country, the product given quality, reputation or other characteristic are essentially attributable to its geographical origin and at least one of the production steps takes place in the defined geographical area (Regulation EU n.1151/2012).

In 1994, the TRIPs Agreement (Agreement on Trade Related Aspects of Intellectual Property Rights) was signed in Marrakech, dealing with the commercial relations of intellectual property rights. The TRIPS Agreement obliges all WTO member States to

provide their own domestic legislation for protection to Geographical Indications, recognizing them as a special type of intellectual property right. It was the first time that Geographical Indication was debated as an intellectual property right on an international level and, as a result, the interest towards GIs and their protection has grown and spread all over the world, stimulating the interest of many emerging countries that also adopted new systems of protection for food products (TRIPS Agreement, 1994).

Headed by EU countries, a number of nations support the application of the EU GI system and legitimize it under the claim that it is a tool for the revitalization of local rural economies and small and medium farms. In addition, it is considered an instrument for the safeguard of family farming, authentic taste and culinary cultures.

On the other hand, a group of countries headed by the US opposes these claims, contending that GI distorts the functioning of free trade competition being a sort of protectionism (Augustine-Jean, et al.)

In recent years, stimulated by the TRIPS, the debate has reached new countries, especially in Asia, which is playing an important role in the international agri-food business. Because many countries are still adapting their national regulations to the different international agreements, this event is likely to modify the unstable balance between the PGIs and the Trademark systems.

Japan, being under the influence of the US, introduced in 2006 the Regionally Based Collective Trademark System to protect GI products through a trademark system similar to that of the US. Additionally, Japan has recently complied with the TRIPS obligation, and in June 2015 enforced the Indication Law “The protection of the Names of Specific Agricultural, Forestry and Fisheries Products and Foodstuff Act”, also known as “The GI Act” (Law No. 84; June 25, 2015) on the protection of Geographical Indications. Thus, following the EU *sui generis* system, Japan established a second geographical indication system.

From June 2015 the GI Act (Law No. 84; June 25, 2015) has required the government protect these traditional products as Intellectual Property Right under a Collective Trademark System. The Act was issued to ‘protect producers’ interests and profits by contributing to sound rural development of the area of origin and to ensure the interests of domestic and international consumers’. To accomplish this, a ‘Registered Geographical Indication Mark’ for GI agricultural products and foodstuffs was

established. Under the December 2016 GI Act amendment (Law No.108; December 26, 2016), non-Japanese producers' groups may apply for GI registration in Japan (Kimura, 2015).

The long post-war history of political and diplomatic subjugation to the US led to the 2005 enactment and to a further improvement of the Trademark Law reform. Under the coordination of the Ministry of Economy, Trade and Industry (METI), this reform created the Japanese GI system, the Regionally Based Collective Trademark System, following the US model. This model though limits GI regulation to trademark legislation and excludes the creation of any other type of specific legislation. In addition GI products are not linked to a specific territory, its culture, know-how or production practices, but consists only in the recognition of trademarks (Augustine-Jean, et al.).

At the same time, the Japanese Ministry of Agriculture, Forestry and Fisheries (MAFF) drafted a GI document modeled after the EU system because convinced of the superiority of the European system as a solution to the issue faced by many small/medium sized farm's owners.

Differing from the US, the EU enacted legislation defines GI as a system based on location, history, culture and traditional production practices of a certain product and can never be transformed into a generic commodity (Augustine-Jean, et al.).

The METI sponsored legislation passed and MAFF halted its initiative. However, it encouraged the Japan Food Industry Association (JFIA), a major industrial association dominated by small and medium sized food processors, to establish an EU style private certification system that would not only identify the origins of traditional food items, but also guarantee their quality. The name of this voluntary system is called "Honba no Honmono" or "original authentic food". By 2016 there were 45 products included in this private scheme of certification, divided into two categories. Following the EU Protected Denomination of Origin (PDO) protocol, the first of these categories includes products made in specific geographical areas with locally grown ingredients that are processed with traditional techniques. The second includes products made in specific geographic areas with domestically grown ingredients that are processed with traditional techniques. This latter category is consistent with the EU Protected Geographical Indication (PGI) classification (Augustine-Jean, et al.).

The continuous crisis of Japanese agri-food, protests by farmers, food processor and consumer organizations, and the success of the EU's GI system in various parts of the world, prompted Japanese government to consider the introduction of new legislation. In this context of pro export and free market oriented policies and measures, Japan initiated negotiations for the EU-Japan Free Trade Agreement and the Government charged MAFF o drafting a new document based on the EU GI system that was eventually enacted on June 1st 2015. Under the new law, only the PGI typology was recognized, while the more stringent PDO typology was excluded (Augustine-Jean, et al.).

As a result, Japan remains with two legal frameworks concerning GI. There are three main differences between the two different types of protection. First, and contrary to the regionally based collective trademark, *honba no honmono* and the PGI system are designed to distinguish and protect quality, traditional food items from standardized and mass produced corporate-industrial agri-food products. Second, in the PGI system, the MAFF controls possible violation and issues sanctions. Under the other two systems, these tasks are expected to be carried out by private producer organizations. Accordingly, the PGI system is more advantageous to small and medium sized food processors that, while representing the vast majority of all processors, have also limited access to private certification. Third, under the PGI system, a registered GI is considered regional common property. Accordingly, its exclusive use by any single actor is impossible (Augustine-Jean, et al.).

6.3) The characteristics of the Geographical Indications system in Japan

In the late 20th century, internal migratory flows occurred from rural areas to metropolitan areas in Japan and as a result, agricultural activity lost importance. Foreign food products began to be imported especially from the US, and it has been difficult to control and guarantee high levels of quality, so that consumers began to express uncertainty and dissatisfaction. Thanks to a more focused policy on the restoration of rural areas, consumers regained confidence and to promote geographical areas became important again (Wolf, et al 2012).

By adopting the GI protection system, agricultural products are subjected to continuous controls on the entire production process to guarantee the originality of the

place of origin. The peculiar characteristics of the product, deriving from the particular surrounding territory and the technical know-how of the farmers handed down over the years, allow the qualitative differentiation of the products compared to other agricultural products of the same category. As a consequence, the registered product acquires a higher social and monetary value, which has an impact on the profits of rural enterprises. The social value is a real value added, able to enrich and enhance the recognition of some agricultural products both nationally and internationally. The enhancement of food products also generates positive effects on the tertiary sector: a recovery and enrichment of traditional Japanese culinary culture attracts many tourists and allows the growth of secondary companies of goods and/or services in the neighboring area (Kazuhito, et al. 2013).

According to the Japan Ministry of Agriculture, Forestry and Fisheries, the GI system is intended to protect typical products from unfair competition and from the risk of frauds and usurpation of geographical names, as well as to enhance the export potential of some terroir-based Japan agricultural products and foodstuffs (Fig.20).

The first major objective that this system has is protecting the producers' interests as protector of the intellectual property of the region. In this way the adequate evaluation of agricultural, forestry and fishery products and foodstuffs is preserved and the value of the product on the market would increase. The second objective this system wants to pursue is the protection of the consumer's interests and demands for high quality trustworthy products.

This kind of protection of authenticity of the highly value added agricultural, forestry and fishery products and foodstuffs will respond their needs (Kimura, et al. 2018).

More in particular, expected effects by the MAFF are (Japan Ministry of Agriculture, Forestry and Fisheries, 2015):

- Regional brand protection and utilization leading to revitalization of rural villages;
- Inheritance of traditional food culture;
- Protection of consumer's benefits; and
- Sharp increases in exports of agricultural, forestry and fishery products and foodstuffs (MAFF website, GI act).

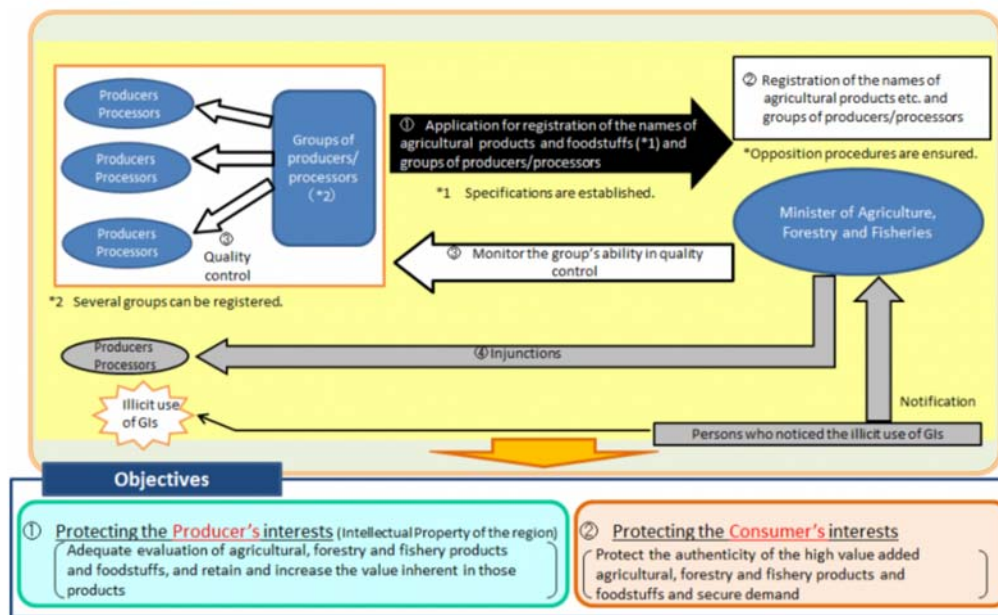


Fig.20: GI act outlines

6.3.1) Product characteristics

First of all the foods that can get the geographical name according to the GI Act must be specific agrifood products, including: edible agri-food products (fruit, vegetables, rice); food and drink (meat products, sweets, salt, tofu); some non-edible products (flowers, decorative food, pearls, ornamental plants); non-edible processed products using agri-food products (coal, oil, animal feed, lacquer) as raw materials. A separate protection system is established for GIs of alcohol products.

Secondly, the product needs to have some quality characteristics linked with territory of origin, which may be a place, a geographical area or a region. The peculiar characteristics of the product must derive from the production area: the climate, the environment and the typical temperatures of the place allow the creation of some uniqueness, impossible to find in the same product grown in different areas.

Additionally it must be certified not only that the production methods follow the tradition, but also that the production itself has been carried out for at least 25 years (MAFF website, Guidelines).

6.3.2) The GI logo



Fig.21: GI logo

The logo (Fig.21) represents the very emblem of Japan: it depicts the surface of the water from which Mount Fuji stands, to which a large red sun is attached. The colours used are also symbols of the Japanese cultural tradition: red, gold and white.

Only the agri-food products complying with the rules of the Ministry are allowed to use the identification logo (GI) of the geographical indication. The use of the reference logo is very important and must be used concurrently with the product name.

The identification logo (GI mark) is an additional symbol applied to the registered product, able to differentiate it visually from other substitute products on the market. It can be used only if it is a product registered with a certified indication. It can be omitted if you do not want to specify the designation of origin. In 2017, the GI mark is recognised as such in ten countries and territories in addition to Japan: Korea, Taiwan, Cambodia, Philippines, Malaysia, Laos, European Union, Australia and New Zealand (MAFF website, GI logo).

6.3.3) The procedure to obtain the GI protection for a food product

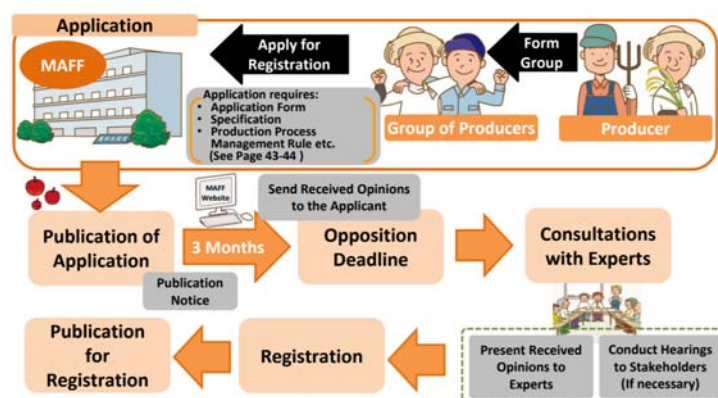


Fig.22: The application procedure

In the Japanese system, only producers registered to an association or to an agricultural/industrial cooperative can apply for registration (Fig.22).

When a group of producers want to submit a request, a certification is required for each product. The request must be submitted to the Ministry of Agriculture, Forestry and Fisheries (MAFF). The layouts of the documents required for the request must follow the models pre-established by the MAFF, available to download from the official website. The Ministry also provides a document with all the guidelines to follow for the presentation of documents in the appropriate manner. Along with the application form, some attachments must be filed such as the specification, a document in which production process management rules are displayed and other required documents such as a proof that the group is a “group of producers” as stipulated in the GI act, a proof that the applied product is a Specific Agricultural Forestry and Fishery Product and Foodstuff as defined in the same act, a photo of the product etc..(MAFF website, GI protection system).

Going more in detail, in the application form, the following items must be specified: the name(s) of the applied product, the place of production of the applied product, its characteristics, the method of production, the description of the link between the applied product to the place of production and others.

With regard to the place of production, it must indicate the geographical area in which production actually takes place. It is not necessary that the whole process be carried out in that indicated area: it is important that the precise moment of production from which the peculiar characteristics of the product are derived is consistent.

Speaking about the connection between the characteristics of the product and the terroir, it has to be clearly attributable to some scientific and quantitative evidences. The description has to be detailed and well explained, connecting the topography, soil, climate to the product.

In the specification form the following items must be detailed: name and address of the applicant; type of product, in which both the category to which it belongs and the type of product must be specified (for example: "fruit" category, "apple" product); the indication chosen for the product, the place of production, in which the geographical area, a description of the physical, chemical, micro organic and sensory characteristics, the production methods, which must follow the natural process and the tradition handed down for generations, again the reasons why the product is linked to the territory, the record of production of the applied product in the place of production and other documents.

In the production process management rule form there are the amendment of Specification, the confirmation of conformity to specification, the guidance for a producer who falls to comply with the Specification and other documents such as the annual report concerning the confirmation results (MAFF website, Explanation notes).

Once the request has been filed, the Minister of the MAFF performs some checks on the documents received. Subsequently, if there are no uncertainties, the documents and the geographical name are published on the MAFF official website, for a period of two months. From the day of publication, the Ministry of Agriculture, Forestry and Fisheries provides three months for the receipt of any complaint regarding the registered product. In the event that a producer wants to appeal, the content and layout of the document to be submitted is established by the MAFF and can be downloaded from the official website.

Once the available time has passed, any complaints received are examined and further checks are carried out by expert researchers, for a better and more in-depth control. Subsequently, the product is considered compliant or not: in the case of conformity, the geographical indication is definitively registered in the list of registered products.

The registration request is completely free; once registered, the association must pay a fee of about 80 euros within one month, to take advantage of the property rights, and it must send the payment receipt to the dedicated Ministry of Agriculture, Forestry and Fisheries. In the opposite case, a notification of inadequacy is sent to the association (MAFF website, Explanation notes).

6.3.4) Controls carried out on food products

The associations themselves carry out the activity of controlling production processes, linked to products that have the geographical indications. Controls are performed on the area, on the quality of the product, and on the production methods used. The contents of the controls carried out on the product are written in a document, and in the case in which the rules are not followed, it is not possible to use the registered GI.

Controls over registered products can be carried out, which, at least once a year, must send the results obtained to the specific office of the Ministry. The MAFF also regularly make some checks on registered products, which are mainly carried out on the standards in the descriptive document and are based on the appropriate use of the identification logo and the geographical indication, on the characteristics of the product and on the precautions in case of violation. The related documents are kept for five years. In the event that discrepancies are reported, a revision mode is performed on the entire production process and the MAFF is notified. Some third-party companies may also carry out checks, in order to provide a broad overview of the situation of the registered product (MAFF website, System Guidelines).

6.4) The protected Geographical Indication on beef products in Japan

2015 was a year of great change that saw the immediate registration of many agri-food products, thanks to the adoption of the system on Geographical Indications. Currently, 76 products have been registered, belonging to about 25 different Prefectures and many others are waiting to be controlled and accepted. In 2015 the denominations of seven alcoholic products were also recognized. Under the December 2016 GI Act amendment (Law No.108; December 26, 2016), non-Japanese producers' groups may apply for GI registration in Japan.

In the ministry website it is possible to find many kinds of GI products, from vegetables, fruit, to meat products, but also non food items such as the traditional tatami carpet or raw silk from domestic silkworm (MAFF website, Information on registered GI).

Regarding meat, the nine GI products are listed below in the approval order:

Tajima beef

Inside of Hyogo Prefecture

Is the beef produced from high grade Tajima cattle raised in Hyogo Prefecture, over the age of at least 28 months, and an average of about 32 months.

Kobe beef

Inside of Hyogo Prefecture

Is the beef produced from high grade Tajima cattle raised in Hyogo Prefecture, over the age of at least 28 months, and takes an average of about 32 months to create ideal meat quality.

Matsusaka beef

Cities: Matsuzaka, Tsu, Ise and Hisai

Towns: Karasucho, Ichishicho, Hakusancho, Ureshinocho, Misugimura, Migumocho, Inancho, Iitakacho, Takicho, Meiwacho, Ōdaichi, Seiwamura, Miyagawamura, Tamakicho, Obatacho, Ōmiyacho, Misonomura and Wataraicho

Matsusaka beef refers only to carefully select Hyogo Prefecture-born Japanese black-haired virgin female cattle with an age of at most 12 months, and are raised in the area of Matsusaka City and other designated municipalities in Mie Prefecture for more than 900 days.

Yonezawa beef

Cities: Yonezawa, Nanyou and Nagai

Towns: Takahatamachi, Kawanishimachi, Iidemachi, Shiratakamachi and Ogunimachi

Yonezawa gyū is beef from Japanese black-haired virgin female cattle produced in the Okitama area of Yamagata Prefecture, with an average age of more than 32 months at the time of shipment.

Maezawa beef

Maezawa, Oshu, Iwate Prefecture

Maesawa beef has a fine, marbled, and moist texture obtained from fattened cattle bred for the longest time in Maesawa Ward, Oshu City, Iwate Prefecture.

Miyazaki beef

Inside of Miyazaki Prefecture

Miyazaki Beef is the name granted to beef from Japanese Black cattle produced in Miyazaki Prefecture with a Japanese Meat Quality Grade of four and above.

Oumi beef

Inside of Shiga Prefecture

Omi Beef" is produced using Japanese Black. The Japanese Black can be called "Omi Beef" only when it has spent the longest part of their feeding period in Shiga Prefecture and Shiga is the final feeding place.

Kagoshima beef

Inside of Kagoshima Prefecture

Kagoshima Kuroushi is beef from the Japanese Black breed of cattle that spend the longest part of their feeding period in Kagoshima Prefecture and that are finished in Kagoshima Prefecture.

Kumamoto red beef

Kumamoto Prefecture

It is a Japanese brown cow with a calf registration certificate which was fattened for more than 12 months, and the longest and last breeding ground being in Kumamoto (MAFF website, Information on registered GI).

6.5) Tajima Beef GI

6.5.1) History of Tajima cattle

Tajima cattle (also Tajimaushi in Japanese) is defined as Japanese Black cattle born in Hyogo Prefecture in Japan, whose parents and ancestors were also born in the same area. The main and most interesting feature this cattle has is that it has never been crossbred with cattle that was not born within Hyogo Prefecture.

Tajima cattle is well known because of its high quality beef which is characterized by the beautiful marbling, the small amount of subcutaneous fat and the thin bones. The proportion of the meat in the carcass is high compared to other strains and the beef, including fat, has a good texture (Tajima Beef Specification, Jap).

The breeding area, Hyogo Prefecture, is an area characterized by different kind of environment and climate. It sits between two seas, the Sea of Japan and the Seto Inland Sea. Many islands also belong to Hyogo: Awaji Island, which borders the Pacific Ocean and Ieshima islands. Summertime weather throughout Hyogo is hot and humid. As for winter conditions in, the North of tends to receive abundant snow, whilst the South receives only the occasional flurry

In this area only and in these so diverse conditions, Tajima cattle has been bred for a long time. In 1310 in Kuniushijuzu, an historical document we found described Tajima cattle: “Tajima ushi, the crown of labour, nurtured by a rich land of nature and by the care and wishes of many loving people, refined day by day over a long history. Tajima ushi, renowned for their excellence, with a narrow-boned firm figure. Tajima ushi has soft skinned and round-shaped hard horns and hoofs, vigorous with large nose and mouth. Tajima ushi has a face with noble features and a tightly built body, their soft hair are as smooth as velvet, their beef of superb quality. Tajima ushi, a pride of our homeland and a cherished treasure of Hyogo” (Tajima Beef Specification, Jap).

As mentioned before, prior to the Meiji period, cattle had been used for agricultural purpose and transportation. The main objectives of the breeding were to enhance the reproduction and lactation abilities of the animals. During the Meiji period crossbreeding with imported foreign breeds then started to promote the abilities of hybrid cattle. The lactation performances increased but the quality of the meat and other unfavorable characteristic traits also developed. Cross breeding stopped and in Hyogo Prefecture cows

and bulls were raised and bred within each small area, located in valleys or along rivers. Excellent animals were required to be small and strong, follow the instruction of their owner and suitable for carrying a saddle. After the 1960s, with the spreading of mechanical cultivators, cattle was not required for draught purposes anymore and the breeding of beef cattle began. Due to the development of artificial insemination technology, emphasis in breed improvement was placed on stud bulls and a significant number of calves has been bred since then (Tajima Beef Specification, Jap).

6.5.2) Tajima characteristics

The characteristics of Tajima cattle are linked both to the heritability and genetics of the strain and the outstanding meat quality its beef has.

- First of all the exterior appearance is very important to consider in Japan and this cattle has exceptional qualifications. The fur is soft and dense, the bone structure is slender and thin so that it doesn't affect the body weight much, the figure is thin with moderately tight skin and the animal tend to be resilient and have a calm temperament.
- Secondly, Tajima genetics have a really strong heritability so that high quality characteristics of Tajima cattle are typically inherited as dominant traits. During the years there has been a wide use of Tajima genetics to make improvements in Japanese black cattle nationwide. Many of the most famous beef in Japan such as Matsusaka beef and Ohmi beef have Tajima genetics in their roots.
- Third, the carcass offers excellent yield and meat. The beef is famous for its perfectly diffused marbling and great palatability. Only from the best score Tajima carcasses, the prestigious Kobe Beef can be obtained after grading.

The official definition of Tajima beef we can find in the Specification is the following:

- “Moto-ushi” or purebred seed stock cattle must be Hyogo-produced Tajima animal. The breeding farm should be in Hyogo Prefecture and should be registered by the Kobe Beef Association.

- The cattle must be bred and fattened in Hyogo Prefecture.
- The cattle must be a steer or a cow and should be bred for above 28 months and under 60 months.
- The meat must be processed at slaughter houses in Hyogo Prefecture.
- The meat quality must be A or B above Rank 2.
- In case any damage is found in the carcass, the commission members have to check it and judge whether it could be Tajima Beef or not (Tajima Beef Specification, Jap).

6.5.3) Genetics

Tajima Region in Hyogo Prefecture is surrounded by steep mountains and valleys, so that it has been very difficult to move and cross Tajima cattle with other strains. This led the farmers to have been breeding their cattle within the region giving birth to this unique strain. This is the so-called “closed breeding” and it allowed for the efficient use of the genes of excellent cattle within a limited area resulting in an improvement in their quality. The remarkable characteristics of Tajima cattle have been further enhanced and established through decades of improvement using the closed breeding method but with more specific mating plans (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Hyogo Prefecture manages the genetic improvement system. The genetic research is carried out by the laboratories of the Research Institute of Kobe University, Veterinary Department. JA, National Wagyu Registration Association, and fattening farmers are interested in the improving so that they frequently meet and confront to research and make plans about genetics and objectives.

The field research is carried out in each facility that breeds and fattens Tajima cattle: not only the farmers but also Kobe University students help in the research and fatten their own cattle for genetic improvement purposes.

Based on the breeding value, the best superior breeding stock is selected to conduct and plan the optimum mating. To further increase volume and safety, the in vitro fertilization and embryo transfer are eventually performed (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Tajima cattle classification

Cattle is classified in groups according to many factors. The first classification is based on the line of the animal and there are three main lines:

- Nakadoi line
- Kumanami line
- Kinosaki line

These lines are organized into five groups from A to E, so in group A (G1-G2-G3-G4) we have Kinosaki line but also Nami and Doi, in group B or G5, C or G6 and D or G7 we have only Doi line cattle and in group E we only have Nami line.

Group A is further divided into subgroups G1, G2, G3 and G4. In each group we can find animals which are relatives and possess specific peculiar characteristics. For the purposes of the closed breeding each group must be kept separated to the others, so G1 females crosses only with G1 males (Table 1). Each group has distance from the others in terms of genetics and possesses specific characteristics. For example, group G1 cattle easily gets marbled and if Hyogo wants to breed cattle with that specific characteristic it will choose between animals belonging to group G1. If in the future should consumers need different kinds of beef, some other kind of genetics would be needed (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Table 1: Subgroups and Lines of Tajima cattle

SUBGROUPS		NAME OF THE BULLS
G1-G2-G3-G4	A Mixed	Miyakikushiro, Miyayoshi, Miyaikushiro, Miyahironami, Kitamiyanami, Taniishidoi, Okutani.
G5	B Doi	Tomikamedoi, Terumuradoi, Marutomidoi, Terunaridoi, Fukutoshidoi, Terunagadoi.
G6	C Doi	Yoshiyamadoi, Yoshihisadoi, Maruikedoi, Maruharudoi, Marumiyadoi, Fukuyoshidoi.
G7	D Doi	Terutadadoi, Chiyofujidoi, Terutatedoi, Nishisugidoi, Kikumasadoi, Kikunishidoi.
G8	E Nami	Shigekazuminami, Maruakinami, Shigehatsunami, Shigehironami.

Supermothers

In Hyogo Prefecture there are 16000 Tajima bovines per year, 13000 are female. Among these, 12000 are bound to be used to mate and produce calves for beef purposes in Hyogo Prefectures farms.

The other 1000 are selected to become potential supermothers and classified homogeneously into the five groups (A-E) we mentioned before. The selection of new members takes place every year, and it happens that only 300 female animals are chosen to join the 1000 cattle potential supermothers' group, while at the same time other 300 female animals have to leave the group to maintain the number steady. In this way, more or less every three years the entire group is replaced step by step by a new group.

These 1000 female animals have the permission to be crossed with the best sires of the country. The 1000 calves resulting from the mating are divided into the five groups and 300 of the female offspring are chosen to replace their mothers in the supermothers' group every 3 year, the male animals are raised for becoming potential superfathers or for beef purposes.

Only 50 female cattle from the supermothers' group every year are specifically selected to breed the potential best sires of the country or superfathers (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Superfathers

There are only 12 living superfathers, chosen for their outstanding characteristics expressed by their breeding value, and other 28 male animals which could become superfathers when they will come to a certain age, in total there are 40 male appointed bovines that are homogeneously distributed into the five groups. The selection of the superfathers is like passing through different steps of selection, built up like a pyramid. At the bottom we have the young potential superfathers, while at the top we find the proven sires or superfathers (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

The 50 female animals are chosen for the appointed breeding to be crossed with the 12 superfathers keeping the balance in the groups. The offspring results in 50 calves, average 25 males and 25 females. The 25 male animals are narrowed to 16 of which 12

male calves are purchased from farmers and they are from Nakadoi line. They come from designated breeding between proven sires and cows using artificial insemination (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

4 male calves are produced at Hokubu Agricultural Research Center (HARC) and they are of Kumanami and Kinoshita Line, produced by embryo transfer.

The first test these 16 cattle has to pass through is the growth test. In this test the selection is made by taking into account the growth rate, the feed efficiency, the semen quality etc... and within these only 7 still unproven sires pass to the next step.

Among these 7 unproven sires 5 are used to inseminate 200 Tajima cows in farms, we have 40 cows per sire x 5 sets, while the 2 others are used to inseminate 80 Tajima cows in HARC and we have 40 cows per sire x 2 sets (Hyogo PIAFF, pamphlet).

The progeny test begins and the offspring are selected basing on the growth of the calves and the age of the dams. In the end 16 calves per sire are grown and fattened for the progeny test, 8 of which are raised at Livestock Research Center (LRC) in Hyogo Prefectural Institute for Agriculture, Forestry and Fisheries (HIAFF) and 8 cattle at the farms (Hyogo PIAFF, pamphlet).

Under the supervision of HIAFF these cattle is raised:

- At Hokubu Agricultural Research Center 40 cattle (8 cattle x 5 sets)
- At the Livestock Research Center 8 cattle (8 cattle one set)
- At the Agricultural College 8 cattle (8 cattle one set)
- At the farms 56 cattle (8 cattle x 7 sets)

This cattle is fattened according to the fattening management manual of each farm and slaughtered at 31 months of age, which is the average slaughter age in Hyogo Prefecture (Hyogo PIAFF, pamphlet).

Basing on the performances and the carcass quality traits of these animals it is possible to assess the breeding value of their father and then eventually choose the proven sires or superfathers.

Among the 7 unproven sires, only few of them, often 2 or 3, are certified to become superfathers and join the group of 12. Since there must be 12 superfathers only, an equal number of cattle must leave the group to be replaced. The new superfathers often are at least 6 years old and they can stay within the group for 15 year maximum. Superfathers

though are quickly replaced to carry on the genetic improvement. Once the new group is established, a full supply of frozen semen is furnished to farms in Hyogo Prefecture (Hyogo PIAFF, pamphlet).

Summing up, there are only 12 alive possible fathers for producing Kobe beef and they are controlled by the Kobe Beef Promotion Association. There are also potential fathers waiting in line to replace these 12 after the end of their production career.

The 12 fathers have frozen sperm too but they do not keep it for long because the genetics of fathers keep improving during time.

When one possible father waiting in line joins the group of productive father, one of the twelve has to leave because they must be always twelve. The reason why is the budget constraint of Hyogo Prefecture and the physical space also.

There are only two places where fathers live: Kasai and Tajima region in Hyogo Prefecture. They keep them in only two places because of the risk of diseases, that increases if they are raised close to each other (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Gene dropping

In addition a special phylogenetic systematics is assessed by utilizing the gene dropping simulation method in order to avoid any problem due to close relative mating. To secure genetic diversity and supply the reservation of the breeding stock is very important that all the breeders follow these instructions. As we have already said before there are 16000 Tajima cattle. Among these, 1000 are maintained as pure lines and there are only 8 different pure lines. This pure lines are used just for reproduction of the Tajima strain because the genes has to be maintained, while the other 15000 are mixed lines and sold on the markets as beef (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

These 8 pure pedigrees (1000 cattles) are classified from G1 to G8 and it's very important that G1 female cattle and G1 male cattle cross in order to maintain the line. G1 mother only produce G1 calves with G1 father, G2 mother produces G2 calves with G2 male and so on... The other 15000 cattle, that can be consumed as beef, are mixed lines (G1 and G2, G3 and G2 etc..) made by pure lines crossings.

It is very important to maintain this 8 family genes because if they mix, the blood would be out of control and there will be many genetic diseases (physical abnormality and small bodies). This is also very important because Tajima breeders are not allowed to bring cattle from outside and so they have to maintain the number. Breeders outside Hyogo however, can purchase cattle from Hyogo and other Prefecture (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

6.5.4) Tajima breeding and fattening system

The definition of Tajima beef also comes from Kobe Beef Marketing and Distribution Promotion Association that complies with the breeding management: Tajima cattle is cattle aged between 28 and 60 months that were born by Hyogo origin sires and bred in the Prefecture, fed by registered members of the association and shipped to meat centers in Hyogo Prefecture (Tajima Beef Specification, Jap).

Tajima cattle is raised, slaughtered, and graded so that it's possible to determine whether they can become Kobe beef according to the quality parameters we have already mentioned. As a consequence, there is no Kobe cattle but only Tajima cattle, while there can be both Kobe beef and Tajima beef. In other words, among 16000 Tajima animals some become Kobe beef and the others remain Tajima (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Breeding farms

The number of breeding facilities is slightly declining, there were 1140 breedings in July, but the number of cattle is more or less the same so they are raising in dimensions. This is due to the aging of the breeders: younger people are trying to hold bigger farms but it is difficult to maintain them, mainly because of the great amount of time to grow the calves and the care they need (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Some farmers do both breeding and fattening but it is more common to have the two operations separated even if there are no contracts or agreement between fattening farms and breeding farms. The recent trend is doing both breeding and fattening, it is

called the “consistent management”. In the previous years breeding and fattening farms were separate. While now it is beginning to develop this system.

Sometime the fattening farms say that the breeding farms are not capable to produce the calves they want to raise so they raise them themselves.

Kobe University also has a breeding and fattening farm for studying, experiments and education. Also agricultural high school and Hyogo region have Tajima cattle and grow them. They make money from these breedings they later on invest in research (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Cows

Breeding affects the quality of beef especially the feed for mother cows. Depending on the characteristics of the mother, the environment (water, weather) and the know how of the breeder (quantity of feed, how long do they are kept in breedings) some calves easily gain weight. Hyogo is a big production area including islands, so the environment changes a lot and so do the specific characteristics of the calves.

The age of the pregnancy is also very important. The first pregnancy often occurs at the 13th months. Good producers can make the mother pregnant 10-11 times or 12-13 depending on the mother strength, how is it raised etc... (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Birth

Breeding farmers breed calves until more or less the 8th month. The calves for beef production can be both castrated male or female (in general in Japan). Male are castrated because it is thought that the lack of hormones makes the meat softer.

Some farmers raise only males, this because the male cattle grow faster and more efficiently. Female are different and more difficult to raise especially because of the rut, in this period they don't eat much and they're not stable. Even if they are difficult to grow, female cattles have better fat quality because it's softer and compared to male they have higher fatty acids score (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Auction

When the auction takes place, the calves are sold to the fattening farmers and they start to be fed with different feeds.

Auction are held once a month to sell the 8 months old calves to the fattening farms. Fattening farmers see the calves and decide which to buy according to their specific strengths. Interesting is that fattening farmers are specialized in fattening specific types of calves: for example some are very good in raising small, thin calves, others for well physically developed ones (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Fattening farms

The number of fattening farm in which Tajima cattle is raised was 315 in July and the fattening form pursuit is typical. The feeding process starts more or less at the age of 9 months at a body weight of 260 kg. The feeder calves are purchased at the auctions held in Hyogo at an average price of 4.500 \$ each and then fattened for at least 22 months reaching the age of 31 months and a bodyweight of 650 kg (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Calves stay at the breeding farms until the age of 8 month. Once at the fattening farm, there are three stages the cattle needs to pass through which are different in the type of feed given to them. The length of each stage varies according to the farmer's decision and know how:

- First stage: 9-14 months
- Second stage: 15-22 months
- Third stage: 23-30/31 months

This division of the stages is the same in all Japan but the length of the period differ from one breeding to another. Tajima cattle are the only one who stay so long in the fattening farm. At the end of the fattening they castrate both male at 21 months and female at 33 months (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

We also have to mention that Japanese black cattle get easily fat, especially they easily get intramuscular fat. The way of fattening calves is not natural though and at the

age of 13 months they are really big respect to the size they would have naturally. In biological aspects it is recognized that the way they are fattened is not natural (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

The main objective of the farmers in this stage is to fatten the cattle as much as possible. Indeed the weight and the ratio of fat are the two most important thing to consider to assess the quality of the beef.

To become Kobe beef, Tajima carcasses have a limitation in weight, that must be less than 470 kg, which is also the main difference between Kobe and Tajima beef and other black cattle (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Tajima can be any weight but at present Kobe must be under 470kg so the producers are making big efforts making Tajima cattle fat but weighting less than 470kg. This is the reason why one of the most important thing in Kobe beef producing is the know how to have cattle weighting less than 470kg but with a fine marbling.

Producers might not understand the best ration of protein for feeding but based on the experience and knowledge they know how to reach the Kobe standards and finish up the cattle. They just look at the cattle and judge them, not calculating anything and they decide the feed ratio. For other cattle this is not usual or mandatory because they can get as much fat as they want (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Slaughterhouses

After the slaughtering within the Prefecture facilities, the carcass is graded by JMGA and sold at the auctions at the Meat Centers. The basic price is 9.000 \$ for each half of the carcass and it varies according to the quality grade obtained by the previous analysis (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Parameters

- The average daily growth for Tajima cattle only is 600-660 g in 10 days. When in the early stages of fattening they gain 1 kg in 10 days, while in the final stages it's 300 g in 10 days. Other Prefectures' cattle often gain three times more, growing faster and bigger. They usually complete their growth in 29 months while Tajima cattle needs at least 6 months more.

- The feed conversion index (dry substance/1kg growth) is different for each month but for the wet feed (10% water), we have 7-8kg of feed for each gained kilos, while we have 10 in the later stages.

Regarding the late stage of fattening we need at least 15 kg of dried feed to make cattle gain 1 kg growth.

- The weight of the cattle in each growth stage is roughly:
 260 kg at the start of fattening early stage (9 months old).
 400 kg at the start of the middle fattening stage (at 15 months of age).
 550 kg at the start of the fattening stage of fattening (23 months old).
 690 kg at the shipping time (31 months old).
 Cattle should weight 470g without head, gut and bones (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

6.5.5) Feed

There is no specific rules about the feed Tajima beef should get to obtain the GI quality sign but there are some recommendations we can find on the GI specification papers given by Hyogo Prefecture.

There are anyway the Japanese feeding standard (MAFF), which gives indications for the best feeding to be used for each livestock type, and the Feeding safety law (Minister of Health, Labour and Welfare).

This last one gives some rules for safety purposes like that until the age of 3 months the calves can be fed with artificial milk or that feed must not contain animal parts (neither fish powder). Farmers are very careful now choosing feeding industries which do not produce feed according to those regulations (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

The national regulation from MAFF gives general indications for feeding the livestock like pigs, chicken and cows, so that the ration for every stage is already fixed.

Some breeders and farmers buys feeds from private company, but they are few. Most of them buys feed directly from JA. JA blend basing on the analysis made by Hyogo laboratory and gives these feed to both breeders and farmers.

Some years ago breeding farm and fattening farm blended themselves but now is JA who plans, purchase, blend and give it to the farmers (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

JA buys feeds from Japan and foreign countries, mainly soy, corn, grain and then they mix them making the perfect blend for each growth stage of the cattle. Breedings and fattening farms buy the blends for their cattle varying according to their growth stage.

So both the feeding manufactural industries and each producer decides the feed ratio (barley, corn, grain) in two steps basing on Japanese public or private suggestions and on the personal know how of the famers (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

10 years ago (2007-2010) region Hyogo decided to improve the feeding management.

They made lots of examinations (try and error) to choose a certain ratio of protein for each growth stage in the fattening period. The motivation for this examinations was that they wanted to raise the percentage of Kobe beef among Tajima (means obtain BMS over 6). Still region Hyogo is working on a “version up” feeding system to update the feeding manuals already made (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Feed ratio

Rumen and bones are normally completed in around 5 years but normally we can say that a calve is grown up at the age of 16 months and could give birth at the age of 2.

During the growth of the cattle we first see the development of the bones' structure and the rumen, then we see the muscular growth and at last we see the marbling. The feeding is given taking into account these aspects and the growth stage: at the beginning of the growth calves need more proteins, at the last stage they need more energy and calories. The stages are divides by months, age, not weight and each stage is more or less 7 month (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

The feeding is mainly composed by mais and bran, than soy, remainings of soy oil, bran, barley's straw, imported grass and rice straw. The ratio of feeding changes depending on the stages and each feed element has a specific role in the cattle growth.

When the calves are really young they let them graze or give them rye, especially imported from Italy;

When they grow up the feed varies according to many factors. There is a special feed for calves from the birth to the 8th month, it's the farmer's know how that determine the exact month and week to stop feeding the calves with that blend because of the individual characteristics and the area in which they live (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

In the first stage of fattening then, cattle eat mostly fibers in order to grow rumen and internal organs, in the second stage feed ratio gradually changes, while in the third stage fibers are reduced and they are fed with lots of corn.

Corn and barley have more carbohydrates and energy, bran doesn't have much protein, while soybean has more protein. Farmers change the ratio of those ingredients during the calves' growth: bran decreases while corn increases.

The feed for mother cattle has a great importance too because it affects the pregnancy and the calves inside their mother's womb.

Each producer tries to produce the highest quality of the beef (in terms of price, A5 is the best) so in terms of feed there is no producer wanting to produce A3 and they all try their best to reach top quality beef (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Grazing

The farmers have to choose if their own cattle need to graze or not but usually small calves graze. Oyama professor at Kobe University let the university owned cattle graze because Kobe university is fine with lean cattle.

Grazing is good for developing a good bones structure which they want to reach and not letting the cattle graze lead them not to gain much weight, for this reason farmers usually keep cattles inside and directly feed them with their special blends (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Supplements

Vitamin: A, D, E but not C are often given to the cattle along with some mineral salt such as zinc. Regarding vitamins, Region Hyogo is conducting studies about rumen's

fermentations and about vitamin A intake to assess how to maintain its level steady during the fattening stages. Speaking about minerals, some manufactured mineral stones from the ground are also given frequently to cattle. The most common item used to supplement in minerals is the so called “Koen” which is a manufactured like brick rich in various salt.

Many years ago cattle only ate grass outside but when they ate grass they also ate some ground so they could intake some salt too. Today this is impossible so they have to be fed as supplement (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

They started feeding salt supplement only when farmers saw some salt deficiencies like cobalt deficiency and eating disorder caused by lacking of vitamins.

When Japanese started eating cattle 130 years ago, before it was just for labour, the cattle was kept next to the agriculture storage and they liked the walls of the houses. Since they were made by mountain soil, consisting in vitamin and salt, cattles were supplemented naturally. The manufacturing companies then took the koen idea from this (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Feed recommendations on the GI specification papers

The version of the fattening manual of Tajima beef cattle I am referring to is that of the 2012 at it is version 4.1. Since the quality management tend to improve, new versions of the manual could be edicted.

The manual is divided in two sections according to the gender of the animal so that male and female cattle have to be fattened differently.

The first section is about the classification of the size of the castrated male animal to be fattened and the fattening index (Tajima Beef Specification, Jap).

There are three categories based on the whiter height:

- Large (over 117 cm)
- Medium (112-116 cm)
- Small (below 111 cm)

There are other two categories based on the fattening index:

- Normal (the animal weights 210-250kg)
- Obese (the animal weights 250 kg or more)

The second section is about the feed ratio in general to be given to the cattle and we can find the amount of concentrate and roughage recommended (Tajima Beef Specification, Jap).

The ratio of concentrate is divided into the three stages of fattening: early, middle, late and the various sources of nutrients listed as showed in the Table 2 below:

Table 2:Concentrate feed ratio divided into three stages

FEED	EARLY STAGE 9-14 months	MIDDLE STAGE 15-22 months	LATE STAGE 23-31 months
Barley	0	15	25
Mais	50	50	50
Bran	27	23	18
Corn	10	5	0
Soy	10	5	5
Clay	2	1	1
Salt	1	1	1
Protein	72.8	73.8	74.3
TDN	14.5	12.0	11.1

The ratio of roughage is given only after 3 months of age and there are only some basic indications about the type of fiber used, such as wheat straw, ryegrass straw Bermuda, sudan with less beta-carotene. Before reaching 3 months of age it's recommended to give beta-carotene supplements in the amount of 10mg/kg or more, timothy, oatshey and Sudan. After the age of 20 months it's better to give cattle rice straw and watch the beta-carotene content that should be less than 2mg/kg or less (Tajima Beef Specification, Jap).

In the third section is deeper analyzed the amount in kg of roughage and concentrate feed to be given to the cattle according to the fattening index (normal or obese), size (small, medium or large) and the age of the animals month by month.

At the end of this section is highlighted the target weight for each category (small, medium and large) at three different point of the growth, like is displayed in the table below:

Table 3: weight of different size animals related to their age stage.

Age (months)	Small size	Medium size	Large size
9	240kg	260 kg	280 kg
20	462 kg	487 kg	510 kg
30	615 kg	640 kg	665 kg

The fourth and last section of the manual is about general management techniques of the cattle in different stages of its growth (Tajima Beef Specification, Jap).

First of all when new animals arrives to the breeding, farmers should give them some vitamin A supplement, provide them vaccines and anti-worms drugs and the horns should be removed. In the early fattening period then (9-14 months) it's important to give the animals at least 3kg of good quality hay for 3 months. In the middle fattening period blood tests are conducted to assess the vitamin A level that should be less than 30 IU/dl. In the late fattening period it is recommended to give cattle 500.000 IU vitamin A monthly after 27 months of age.

The other part of the manual is specific for female cattle and some parts differs in terms of quantity of feed and body dimension, weight and vitamin A supplement content (Tajima Beef Specification, Jap).

Feeding strategies

The breeding farmer's main objective is to earn as much money as possible so they try to breed fat, beautiful calves. This is not the ideal way to raise calves because it will highly increase the fat quantity when they become adults, so that it's better for them not to have much fat when young. Since now the trend is changing and breeding and fattening are together, when the calves are in the early stages they tend not to be so fat. Farmers increase fattening only at the latest stage of growth before shipment (Tajima Beef Specification, Jap).

All depending on the producer's vision, finished cattle is raised and fed according two types of criteria:

- Weight oriented farmers want to sell cattle which weight 470kg or more
- Quality oriented farmers want to sell cattle which weight less than 430kg but having the best marbling

At the auction and shipment the price is determined by the weight so that some of the farmers, the quality oriented ones, try to raise the ratio of fat maintaining a small body but high marbled, some others instead try to have middle quality marbled beef but cattle with a big fat quantity that weight more (Tajima Beef Specification, Jap).

The price varies according to the weight of the carcasses and to the marbling of the beef: well grown and fattened cattle which weight much more than 470 kg worths a lot, but also cattle which weight less than 470 kg, having a fine beautiful marbling could worth the same. It depends on the fattening farmers how to manage weight and fat quality according to his vision. Some of the farmer prefer bigger cattle with less marbling, others prefer quality and they sell less weight cattle but with a fine marbling. It's quality vs quantity (Tajima Beef Specification, Jap).

6.6) Kobe Beef

In 1868 the first international trading port was established in Kobe, the capital city of Hyogo Prefecture. As there were a number of foreigners who ate beef in Kobe, the custom of eating beef was gradually adopted by the Japanese as well.

Since then, "Kobe beef" has been known for its deliciousness and taste internationally. It was said that the treat of going to Japan was to "view the fine sights and eat Kobe Beef" (Kobe Beef Specification, Jap).

Having been selected as one of the world's most expensive nine dishes in 2009, along with caviar, foie gras and white truffle by the U.S.A. media, Kobe beef is very famous as "the highest grade beef in the world" in many countries including Japan and Western countries.

“Kobe Beef” is produced by selecting carefully fattened Tajima cattle bred with all the possible attention in Hyogo Prefecture. The beef contains lots of fat mixed into its cherry red muscle creating a beautiful and well distributed net of marbling.

When you heats these kind of cuts, the fat within the beef melts and releases its flavor in the surrounding muscle. This is felt in the mouth as a soft and creamy texture that along with the taste of the beef itself is perceived as an intricate combination of sensations (Kobe Beef Marketing & Distribution Promotion Association website)

The authentic flavor of “Kobe Beef” is determined by the quality the original cattle has, which is Tajima. Kobe beef refers to Tajima beef that is produced from heifers or steers and satisfy the following conditions (Fig.24):

- Grade of meat quality: BMS (beef marbling standard) grade 6 or above
- Yield grade: grade A or B
- Weight carcass: between 230 and 499 kg for heifers or between 260 and 499 kg for steers (Kobe Beef Specification, Jap).

There are only seven facilities in which it is determined whether Tajima beef could become Kobe beef. Once the carcass is validated, a seal is printed with a stamp by the JMGA on 6 area of the carcass and the certificate of authenticity is issued (Kobe Beef Specification, Jap).

In specific, from 1983, distributors are strictly limited and selected under the conditions of selling at least 12 cattle a year for the retail stores, while restaurants have to purchase at least 720 kilo a year. Furthermore every distributor needs to file documents, pass the examination and complete contracts with Association. When the distributor passes the exam, Association gives statue of cattle and certification which will be shown at the store or at the restaurant. Association keeps monitoring and auditing each distributor and conducts interviews periodically. In 2001, Kobe beef is registered for ordinal trademark, and in 2007, Regional Collective Trademark is registered. In 1983, numbers of the registered distributors were 119 and in 2007 the numbers increased to 192, which results in sales increase of Kobe beef (Kimura, 2015).

Kobe Beef GI suffers unfair competition from other countries which imitate the product. Kobe Beef GI was previously sold in the market under a Regional Collective Trademark, which contributed to increase the positive product image among consumers, but played a limited role in contrasting the risk of imitation of the geographical name (Kimura, et al. 2018).

The producers' organizations involve a large number of agents: 305 fattening farms and 1,340 breeding farms for Kobe Beef and Tajima Beef.

The governance system of Kobe Beef and Tajima Beef supply chain is long-existing (1983). It is particularly well organized and concentrates on the farming, processing and distribution stages in a single producers' organization. The producers' organization also directly manages the sales in export markets (Kimura, et al. 2018).

(1) Yield score :Score of A or B Meat quality score: Score of 4 or above.												
	No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12
Marbling	0	0 ⁺	1 ⁻	1	1 ⁺	2 ⁻	2	2 ⁺	3 ⁻	3	4	5
Grade	1	2	3	4	5	6	7	8	9	10	11	12
Kobe Beef	Kobe Beef											
Tajima-gyu	Hyogo-produce Tajima Beef (*include local brand in Hyogo)											
(2) Beef Marbling Standard (BMS)	·Marbling ratio, called BMS, of level 6 and above.											
(3) Weight of carcass	·270kg—499.9kg for cow ·300kg—499.9kg for steer											
(4) Other	·In case that the any damage was founded in the carcass, the commissioned meat delivering company or commission member of the Association, shall check it and judge that it should be "Kobe Beef" or not.											

Fig.24: Classification criteria for Tajima and Kobe beef

Kobe Beef is the beef produced from high grade Tajima cattle raised in Hyogo Prefecture, over the age of at least 28 months, and takes an average of about 32 months to create ideal meat quality (Kobe Beef Specification, Jap).

Tajima cattle from which "Kobe beef" is sourced has thin and elastic skin, soft downy hair and tight muscle as a result of repeated improvements. Also, aside from the good taste of the meat, there are many edible parts due to the thin bones and less subcutaneous fat, and it can be said that the cattle is blessed with the highest qualities for consumption (Kobe Beef Specification, Jap).

The meat is fine and soft, fat finely ingrained in the muscle, and has the finest quality "marbled meat" with the fresh red color of the muscle and white color of the fat

crisscrossing each other. When you eat it, it feels soft and pleasant on the tongue, and it melts in the mouth with its mellowness and unique flavor.

Tajima cattle which is the source of the meat was raised as cattle for agriculture in the mountains of the Tajima region in the northern part of Hyogo Prefecture since about 1200 years ago, in a blessed natural environment with clear air, pure streams and plentiful mountain grass. In the Meiji Era (1868-1912), its pedigree became known for the superiority as cattle, and for a long time thereafter, it was bred as edible beef with good quality meat (Kobe Beef Specification, Jap).

As meat, Tajima cattle began to be consumed when the port of Kobe opened in 1886. It is said that foreigners who came to Japan at that time ate Tajima cattle and were captured by its taste. Since then, "beef hotpot shops" opened in cities, "sukiyaki" came to the table at home, and Kobe Beef became synonymous with feasting.

Kobe Beef Distribution Promotion Association strives for managing the whole quality and safety management from the breeders to the customers in order that everyone can taste the authentic product. The association was born in September 1979 with the co-sponsorship of Hyogo Prefecture. This association registers Kobe Beef producers, meat sales channels, restaurants and other facilities in order to supply the beef and promote further advancement of Tajima cattle breeding basing on consumers' choices (Kobe Beef Marketing & Distribution Promotion Association website).

6.6.1) Kobe Beef product specification

Kobe beef has been the third GI product registered on the MAFF website having the date of protection on December 22nd 2015. The exact name of the GI product is Kobe Beef and it is one of eight product belonging to the Fresh Meat (Beef) class 6. The producing area is specifically Hyogo Prefecture and the applicant for the protection was Kobe Beef Marketing and Distribution Promotion Association based in Kobe city (MAFF website, Information on Registered GI).

The specification is not available in English yet and it is composed by different parts.

The first part opens with article 1 indicating who subscribed the application form. It is pointed out that just one single organization asked for the protection. Article 2 instead classifies the product into its specific category: Fresh meat product. Article 3 explicitly

identifies the protected names. Article 4 defines the geographical area in which the product can be obtained (Kobe Beef Specification, Jap).

Article 5 gives a clear and brief insight into the history of Tajima beef, a description of the physical characteristics of the cattle and how the classification system to assess beef quality works. The main features of the beef are explained, too, together with the unique taste experience we can have eating it by linking the taste to specific molecules.

Article 6 is about the general breeding methods used to raise Tajima cattle and the parameters to determine whether Tajima cattle can become or not Kobe Beef.

Article 7 is about the reasons why the characteristics of Kobe Beef are attributable to the specific geographical area of production and about some of the major features of Tajima cattle. It sums up the historical background of the closed breeding that occurred for Tajima cattle during the last 1200 years. In addition, it says that the environment, such as the mountains in which most of the breeding activities took place, has affected the outcome by allowing the cattle to be exposed to fresh and clean air and water. Furthermore, the abilities and efforts of local people in taking care of the cattle and improving the product are highlighted, which made it possible to achieve the high quality level of the product today. A description of the strong genetic of Tajima cattle follows, and how it is used all over Japan to improve other strains quality score (Kobe Beef Specification, Jap).

Article 8 illustrates the history of the fame of Tajima cattle, from the exploitation for draught purposes to the use for transportation. Furthermore, it tells about the fame it gained after the opening of the Kobe port in 1886 among the foreigners who ate Sukiyaki (traditional Japanese beef dish) for the first time. It also establishes the year of the definition of Kobe Beef name in 1958, when producers and caring people first started to produce authentic Kobe Beef. The owning of the bronze trophy, granted by the Kobe Beef Association to the retailers, is an assurance: it is the only proof along with a certificate that authentic Kobe Beef is sold in that store. Kobe Beef Marketing and Distribution Promotion Association promotes and upholds the stringent standards for Kobe beef. Wholesalers, importers/exporters, retailers and restaurants, must be authorized by the Association to marketing Kobe Beef. Bronze statue of Tajima gyū placed at their shop front is the symbol of the authorized Kobe agent (Fig.25) (Kobe Beef Specification, Jap).



Fig.25: Tajima gyū bronze statue

Article 9 sets some definitions about the owning of the trademark, the names that can be used and the Kobe Beef GI registration data. Article 10 is about the institutions to be contacted for the registration procedures (Kobe Beef Specification, Jap).

The second part of the specification is about the rules for the production management and the most important article of this section is number 5. Article 5 focuses on the criteria on which it is determined whether Tajima beef can become Kobe Beef. The first needed thing is the calf certificate the registered producers have to submit at the time of the cattle shipment, when the animals are from 6 to 12 months old. The second is the confirmation of the fattening method, which must last from 28 to 60 months and the animal must be bullock or uncalved cow. In addition, the identification number and the identification of the cattle as Tajima is required. In the end the confirmation of carcass standard has to be displayed: to become Kobe Beef, Tajima Beef carcass needs to score Meat Quality score of A or B, Yield Score of 4 or 5 and Beef Marbling Score (BMS) of 6 or higher. Furthermore, gross carcass weight must be 470 KG or less (from 260 to 470 for bullocks and from 230 to 470 for uncalved cows).

If all the requirements set by Kobe Beef Marketing and Distribution Promotion Association are met, the Japanese Meat Grading Association would stamp the Trade mark of Kobe Beef on carcasses. The Trademark is designed by a Chrysanthemum, a floral emblem for Hyogo Prefecture (Fig.26) (Kobe Beef Specification, Jap).



Fig.26: Kobe beef trademark

Article 6 and 7 are about the Role of Kobe Beef Promotion Association has. First, if producers do not comply with the specification rules, the Association has to warn and ask for corrections. If producers do not follow the given indications, the Association may prohibit the producers from shipping cattle for a certain period. The Association then has to check on the meeting of the beef quality standards mentioned before and on the correct utilization of the Kobe Beef GI mark. It is further indicated that the Association will not let utilize the Kobe Beef quality mark on beefs that do not meet the standards they set (Kobe Beef Specification, Jap).

The other articles 8, 9, 10, 11 are about the instructions on the utilization of the Geographical Indication name and other less important matters.

Other documents are attached such as:

- An example of a calf registration paper showing its pedigree and its muzzle pattern.
- An example of the fattening system certification papers with some data about the breeding period, the type of diet and the owner's name and location.
- An example of carcass rating statement in which we can clearly see the yield and quality score of the carcass and also if some defects are visible.
- The Kobe Beef certificate, issued only to the carcasses that met the standards.
- Some of the papers that accompany the carcass to be identified.
- An analysis on the MUFA content differences among different Japanese beef, showing that Tajima Beef has the highest percentage of them.
- The feeding indications by Hyogo Region (Kobe Beef Specification, Jap).

Among the documents attached there is also the only opposition that has been given against the registration of the Kobe Beef name.

The objections were:

1. Considering that Tajima beef and Kobe beef come from the same strain of Tajima cattle, it is impossible to distinguish them and to attribute a different value.
2. The fact that Tajima cattle lives in a mountainous area with fresh clean air and water and it has soft hair and thin bones don't affect the growth and the

characteristics of the beef, so it's not an evidence of the link between the geographical area and the product.

3. Since the name of the Geographical Indication is "Kobe Beef" the production area should be Kobe city area and not all Hyogo Prefecture (Kobe Beef Specification, Jap).

Responses to these objections were:

1. It is proven that Tajima beef is the fattest beef within Wagyu beef so it can be easily distinguished. The difference between Tajima beef and Kobe is mainly the marbling, which is less intense in Tajima compared to that we have in Kobe and also more scattered.
2. The link between the product and the geographical area is highlighted by attaching important documents about the history of the breeding of Tajima cattle. It starts in Kamakura age in 1192 where we can find the specific and peculiar description of Tajima cattle: the animal has delicate thin bones and good muscles, thin skin and hard horns and hoofs, big nose etc... The good quality is due to the skin, hair, horns, hoofs, bones and the tight body and well recognized as typical of Tajima. Tajima female furthermore has lot of skin wrinkles, this means that the skin is thin and flexible. On the other hand males have curly and soft hair. Eighteen years ago then, a new Tajima history and characteristics was described and the appearance of the cattle is still the same and differs from that of other strains. The peculiar quality of Tajima cattle is eventually due to the soft grass growing in this region as night dew forms on the grass because of a large temperature difference between night and day and to mineral rich water.
3. When consumers hear "Kobe Beef" they automatically link the name to the whole Hyogo Prefecture because of its already well established fame. The production area is Hyogo Prefecture since 1983 and its borders have never changed so that it is an historical name and must not be changed (Kobe Beef Specification, Jap).

Kobe beef production system has remained the same from the beginning of its creation. They had a specific regulation before applying for GI. They did not change the rules so there was no confusion at the GI application and registration because Kobe beef association have been existed for over 35 years and they have already developed all the production procedures. While the ministry of agriculture was writing this GI law, they came to visit them asking what they should do. The system was already developed in terms of manuals (rules of production and feedings) so there was not confusion among the farmers. For producers it did not change anything (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

6.6.2) Growth in the quality grades

The average of national marbling score for Japanese Black cattle is 6.9 and slightly increasing year by year. The Kobe beef marbling score is increasing too: not only the bottom line becomes higher and higher every year, so there are less bad quality grades, but also the number of cattle reaching good quality score is booming.

For example, 5 years ago the percentage of Tajima cattle which reached to score to become Kobe beef was 53%, now is 80% (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

The most important thing is the selection of sires and superfathers which really have outstanding merits or “ikushuka”. The standards for superfathers selection are many but mainly marble score, weight and others like oleic acid quantity since few years. Based on this evaluation criterion and doing selection, the improvement was slowly made.

During this time, which lasted 10 years, beef had been slightly improved, and its quality had been still low. The bad thing about this kind of improvement is that you only can tell if it worked 10 years from the day you started making it. Because it takes at least 6 years to evaluate the quality and to gather data to assess any improvement, the process is still on going (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

6.6.3) Differences between Kobe beef and other GI beefs

The main and unique characteristic of Kobe beef is that it has to come from Tajima cattle, which originates from a close breeding system. Other main differences are the weight, and the size of the cattle, which is smaller. Isolation and accurate careful selection of mating plans make Tajima cattle have merits that other strains in Japan do not have. In addition, this system supports economically the breeders and the farmers of Hyogo Prefecture. Other strains of Japanese black cattle such as Shimane or Kagoshima are mixed lines and they are called hybrids. Hybrids generally have a great meat quality but the progeny of the hybrids does not maintain it. Since Tajima cattle is famous to get easily marbled and it also has a good quality of meat in general, many breeders from other Prefectures use to buy Tajima cattle and cross them with their own cattle in order to make hybrids. The cattle originating from this crossing has many merit because of the so called “hybrid strength”. This results in having a good beef marbling and making the price raise for them. These hybrids have been assessed to be higher quality than Tajima itself so Hyogo Prefecture had a huge economic loss in these years where this kind of crossing was permitted (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Some breeders from Hyogo Prefecture asked to be allowed to cross Tajima with Kagoshima, another kind of Japanese black, because Kagoshima cattle is very big. Kobe Beef Promotion Association prohibited it because the brand was already established and they didn’t want to break the rules.

Unfortunately for this reason the Tajima beef and Kobe beef price went down 10 year ago and the Kobe Association was to make a choice: to continue with the isolation and breed only Tajima cattle or to breed hybrids to raise the price. In the end they decided to stick to the rules already established for many reasons:

Firstly, the first generation of hybrids is stable and they possess really good qualities but the second generation gets worse, secondly the cattle wouldn’t be Tajima anymore so the blood would be mixed and they would never control it like before, last when the breeders would get older they could not be protected economically anymore by the Association because it only deals with Tajima producers (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

The other most important characteristic that differentiates Kobe Beef from other kinds of Wagyu beef is the taste it has. Tajima and Kobe beef already have a good reputation for their taste, many consumer tests have already been carried out.

The thing to know now is why this beef has its particular appeal to consumers and to which molecules the tastiness and the typical perfumes are linked (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

6.6.4) Markets

The main markets for Kobe Beef are the U.S.A. that imports premium cuts and Taiwan that imports not so popular cuts. There are seven suppliers in Italy where to buy Kobe beef, the main is in Venezia.

The demands are wider than the supply so Kobe Beef Distribution Promotion Association need to respond to everyone in balance but it is difficult to expand the production even if they are trying hard.

The 99,5% of Kobe beef in weight stays in Japan because the demand is sirloin or tender loin, the rest, 0.5% of Kobe beef is due to foreign markets. Speaking about numbers the 15% of the cattle is slaughtered for export. Indeed, only some cuts are exported, the remaining 85% is slaughtered for Japan (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

6.6.5) New trends for Kobe Beef

Farmers have always focused on improving the marbling and BMS score of the beef. Since the higher degree of fat meant a higher price, producers wanted to go on focusing only on marbling to raise cattle, as they had always done (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

At the beginning of the quality improvement programs, the tendency had been to put more fat in muscles until the quantity of fat, few years ago, was considered enough.

In few years however in all Japan started a movement, which made things change and the Kobe Association wanted to improve the quality of the beef fat. The new indicator to focus on to reach the objective is the quantity of oleic acid. It is proven that oleic acid

makes the fat melt at lower temperature, and makes the texture and flavor more complex too (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

This way of thinking started 15 years ago, and since then the Kobe Beef Promotion Association worked on improvement of accuracy, devices, selection and methods to improve the oleic acid content. There has been opposition from producers because they feared a reduction of the beef price due to a lower assessed percentage of oleic acid. Kobe Beef Promotion Association has not raised or lowered the price according to oleic acid percentage yet but it worked really hard to raise the standard for fatty acid quality and now it reached its objective (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

The tests first started in 2016 when the Association conducted the analysis on each cattle in Kobe market. Each Tajima cattle since then got a number, representing the quantity of oleic acid. Basing on this number, the Association chooses the sires and the dams for further improvements. The chosen farmers have brought their own Tajima cattle to a Tajima beef study group, where oleic acid is better assessed.

Some years ago the Association only used “mekiki”, “having good eyes” in Japanese, to make accurate judgement about the oleic acid content. Some experts therefore assessed beef content of oleic acid only through visual assessment, experience and knowledge, so that the professional judges only could tell the value of the carcasses. Scientifically “mekiki” worked very good but now gas chromatography is used to measure oleic acid content (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

In some areas in Japan the oleic acid content already gives an added value to the beef: in Tottori, Nagano, Oita and Fukui the price raises if the beef has higher oleic acid.

This change has been easier for this group because the number of cattle they have is smaller than that in Hyogo, so they can easily make agreement and check each sold cattle.

Since Tajima cattle on average has always higher oleic content as compared to other Japanese black strains, it could have been easier for them to raise the price.

At first Kobe Beef Promotion Association thought to invent a new kind of Kobe standard “Premium Kobe Beef”, but since the brand was already established, they decided not to make it. This also because it could have lead consumers’ confusion.

The Association is anyway improving the quality through the raising of oleic acid in beef, but also palmitoleic acid and monounsaturated fatty acids in general are tested.

The other direction of improvement of Tajima cattle is now “Oishii” which means “delicious”. The objective, few years ago was to make the cattle bigger, which means quantity and improving the quality of marbling (Iwamoto E., Oyama K. and T. Tetsunori Interview, Dec 2018).

Now Kobe Beef Association is thinking about consumers’ demand. Since the dimension of the Tajima cattle resulting in Kobe Beef or the high marble ratio are not necessarily linked to deliciousness, it’s now mandatory to improve quality to satisfy consumers when they eat Kobe Beef with the improvement of the composition of the beef itself. In order to do that, the Association needs to accumulate further data about the quality of fat and use those data for superfathers’ selection.

Kobe Beef Association wants to differentiate from the other Wagyu brands starting with perfumes and taste of the beef that come from the cooking methods. Once they would find the perfect perfume they would need to describe it in specific numbers and data to make some improvements

7) Analysis of an Italian Wagyu beef sample

7.1) Methods and materials

7.1.1) Samples

The analysis was conducted on muscle samples of animals bred and fattened at “Ca’ Negra” breeding (RO), Italy. Samples were collected by the sectioner “Carlo’s Beef” (MN) and sent vacuumed to the laboratory.

The average age of the animals when slaughtered is 31 months weighting 610 kg with a daily gain about of 0.6 kg/day.

The genetic lines to be crossed, the no-stress environment and the feed blends are managed by a Japanese consultant who helps the breeding. Almost all the feed is produced in Italy and made by a feed industry according to the request made by the breeding itself.

The animals are raised with the mother until the age of 3 months, brought to the stall and weaned. They are kept in the same stall for at least one year and they are fed with long hay and corn flour, barley, grain and beetroots mixed in a specific feed ratio blended according to the consultant. In addition, soy, flaxseed and sunflower seeds are used as supplement. The steers are castrated at the age of 6 months and the horns removed.

The fattening is the most important phase of the rearing system, where the feed truly influences the outcomes of the product itself. The cattle are moved to a different stall in which they are kept until the slaughtering. The space in which they live is progressively reduced. The ration of fattening period is built up almost every week and the fattening followed step by step as it requires much time.

7.1.2) Analysis

pH

The pH measurement was carried out by means of a pH meter for solid foods which had been calibrated with three different solutions. The device was repeatedly put in different spots of the whole steak to measure pH.

Color

The color was assessed using a colorimeter Minolta which had been calibrated with blank sample and then put on different spots of the whole steak to make the measurement representative.

Mb content

The myoglobin was determined spectrophotometrically. Briefly; 2g of the sample were carefully weighted and put in a 50 mL test tube. 20mL of phosphate buffer solution 0,04M (pH6.8) was added. The mixture was homogenized by using ultra-turrax for 20 seconds and left in the refrigerator for 1 hour at 4°C. The sample was centrifuged at 1500rpm for 1hour and then filtered by filter paper in a 25ml volumetric flask and made up to the mark with phosphate buffer solution.

The absorbance at 4 different wavelengths was measured by using a spectrophotometer and results analyzed.

Water Holding Capacity WHC

Water holding capacity was determined according to Nakamura & Katoh (1985). Briefly; 1 g of the sample was weighted and put in a folded filter paper down into a 50 mL test tube. Sample was centrifuged for 4 minutes at 1500 rpm. After the centrifugation the sample was absorbed the surface moisture by filter paper and reweighted. Following the sample was put in the laboratory oven overnight at 70°C and weighted the day after. The aluminum dishes used to weight the beef had been scaled by resting at 70°C and then put in the dessicator for 10 minutes.

Total lipids extraction

Total lipids have been extracted according to Rodriguez et al. (1997) which modifies Folch et. al. (1975). 15g of the sample were grinded and homogenized with a mixer and put in a 200 mL bottle with 120 ml of a solution chloroform:methanol 1:1 (v/v). The mixture then was homogenized by using ultra-turrax for 3 minutes. After resting 20 minutes 60mL of chloroform were added so that the chloroform:methanol became 2:1. The solution was homogenized again with ultra-turrax and left to rest for 10 minutes. The bottle content was filtered with filter paper in another bottle and 60ml of KCl 1M were added to that solution. The bottle rested overnight at 4°C. The following day using a separation funnel, the organic phase was collected in a bottle and two spoons of anhydrous sodium sulphate added to remove the water left. After shaking the bottle, it was put in the refrigerator at 4°C for 2 hours.

The solution was filtered into a flask, previously tared and evaporated until dry by using rotavapor at 37°C. Before weighting the flask, it was left overnight in a vacuum essiccator. After having been weighted, the sample was re-suspended in a hexane:isopropanol solution 4:1 From this sample we analyzed cholesterol.

Saponification

100 mg of the total lipids already extracted were resuspended in 2 mL of hexane:isopropanole 4:1 and transferred in 20 ml flask. The internal standard was put in the same flask (140 µg of dehydrocholesterol).

Solvents were removed using stream of nitrogen and then 4,5 mL of KOH added (4,8% p/V in absolute ethanol). Again, the sample was put under stream of nitrogen, closed, protected by light using aluminum foil and then put over a tilter overnight.

The following day, 4,5 mL of water was added. 9 mL of hexane was then added twice for a double extraction, each time followed by centrifugation at 3000 rpm for 5 minutes.

The unsaponifiable fraction was collected and evaporated until dry by using rotavapor at 37.5°C and resuspended in 200 µl of methanol.

Silanization

150 µl of unsaponifiable fraction were transferred to an auto-samples vial and 1mL of silanizing solution added. The mixture was shaken by vortex and put in a thermoblock at 40°C for 20 minutes then evaporated until dry using nitrogen stream.

Vials were filled with 300 µl of hexane and shaken before centrifuging them at 3000 rpm for 4 minutes. The supernatant was moved to another auto-sampler with conic insert.

Methylation

15-25 mg of total lipids previously extracted were put into vials and 1 mL of internal standard added (1mg/ml of methylated derivatives of C9:0 – C:10 fatty acids in hexan solution). Vials were shaken by vortex and transferred to a 20 mL test tube where 2 mL of methanol methoxide were added.

After further shaking test tubes were incubated at 50°C for 5 minutes and cooled down to room temperature for 10 minutes.

Other 3 mL of methanolic HCl 10% were added and the sample tubes shaken, heated up and cooled down again. Before centrifuging at 1200 rpm for 5 minutes, 7.5 mL of 6% K₂CO₃ were added to the tubes. The supernatant was taken and moved to a auto-sampler vial.

7.2) Results and discussion

From the analysis of the nutritional characterization of the sample of Italian Wagyu beef, resulted a very high amount of lipids, 48% and quite low proteins content (about 13%) (table 4).

Table 4: chemical composition of Italian Wagyu beef for the Italian nutritional labeling (g/100g fresh meat)

Humidity	38,7
Total minerals	1,1
Total lipids	48,0
Saturated fatty acids	15,5
Total proteins	12,1
Total carbohydrates	0,1
Total cholesterol (g/100g total lipids)	0,2
Total cholesterol (mg/100g fresh meat)	78,4
Kcal/100g	480

Even if a total of 480 kcal per 100g of beef is found, which represents a high caloric content, the cholesterol represents only 0.2% of total lipids, very lower than lean beef (3-4%). Total cholesterol is less than 80 mg/100g of meat (table 4). This result confirms that cholesterol content in the meat is not directly linked to the total lipids but to the type of muscle fibers (Serra, et al. 2017).

In addition, we found a high percentage of unsaturated fatty acids, the major part of which are monounsaturated fatty acids, more than 56% (table 5). Among them oleic acid stands out, representing the 81.80% of the monounsaturated fatty acids and 50% of the total lipids, accounting for a total of 25 g each 100g of meat. There are a lot of evidences demonstrating that intake of beef rich in oleic acid is able to increase the concentration of HDL-cholesterol or, at least, has no negative effect on the concentration of HDL-cholesterol (Smith, et al. 2016).

Table 5: fatty acid composition of meat of Italian Wagyu beef (g /100g total lipids). (part one)

C10	0,01
C12	0,02
C14iso	0,02
C14	1,68
C15iso	0,08
C15ante	0,10
C14-1c9	0,63
C15	0,26
C16iso	0,12
C16 (palmitic)	19,96
C16-1t8	0,03
C16-1t9	0,01
C17iso	0,31
C16-1c7	0,19
C16-1c9 (palmitoleic)	2,67
C17ante	0,57
C17	0,79
C18iso	0,12
C18ante	0,02
C18	9,87
C18-1t6-8	0,23
C18-1t9	0,28
C18-1t10	1,12
C18-1t11 (vaccenic - VA)	0,92
C18-1c9 (oleic)	46,27
C18-1t12	0,20
C18-1c11	1,75
C18-1c12	0,22
C18-1c13	0,52
C18-1t16	0,22
C18-2t9t12	0,13
C18-2t11c15	0,07
C18-2cc (linoleic)	2,10
C20	0,10
C20-1c8	0,14
C20-1c11	0,52
C18-3n3	0,30

Table 5: fatty acid composition of meat of Italian Wagyu beef (g /100g total lipids). (part two)

CLA9-11ct (rumenic - RA)	0,62
CLA8-10tc	0,02
CLA8-10ct	0,03
CLA11-13cc	0,02
CLA11-13tt	0,02
CLA8-10tt	0,04
CALA	0,01
C22	0,01
C20-3n6	0,07
C20-3n3	0,02
C20-4n6 (arachidonic)	0,07
C23	0,01
C22-2	0,01
C22-4n6	0,03
C22-5n3 (DPA)	0,04

The amount of polyunsaturated fatty acids on the other hand is pretty low in absolute term. This is attributable to very high fat meat content. Is well note that high lipid deposition is due to triglycerides fraction mainly. The most part of polyunsaturated fatty acid are esterified in phospholipid fraction; thus, triglycerides determine a dilution effect of them. On the other hand, we relieved a good nutritional quality of polyunsaturated fatty acids, considering that the omega6/omega3 ratio is 5.2, slightly over the recommended value by nutritional guidelines (less than 4) (Table 6). This is a value very lower (thus better from the nutritional point of view) than other beef which reach a n6/n3 ration variable from 6 to 23.

The ratio PUFA-SFA is 0.10, half of what it is desirable to be (Serra, et al. 2009) (Table 6).

Table 6: Class of fatty acids and indexes of meat of Italian Wagyu beef (g /100g total lipids)

Saturated fatty acids	34,16
Unsaturated fatty acids	60,26
Poliunsaturated fatty acids	3,60
Monounsaturated fatty acids	56,66
Omega 6 fatty acids	2,40
Omega 3 fatty acids	0,44
Omega 6 / Omega 3	5,43
Trans fatty acids	2,99
Desaturation index C14	27%
Desaturation index C16	11%
Desaturatioin index C18	82%

The very high content of oleic acid could be due both to feed and genetic reasons. The oleic acid of meat comes from diet but also from the desaturation of stearic acid by the Delta 9 desaturase enzyme (named also stearoyl CoA desaturase, SCD). The main substrate of SCD is stearic acid (converted in oleic acid), but, this enzyme is able to insert a double cis bound also in myristic a palmitic acid (producing myristoleic and palmitoleic acid respectively). For this reason, the desaturation “intensity” of SCD can be conveniently esteemed by calculating the specific desaturation index. The most useful index is the desaturation index of myristic acid, as C14 is a fatty acid which comes from the diet only. This index can be calculated by the following formula:

$$[C14:1/(C14:1 + C14)] \times 100.$$

In the same way a desaturation of C16 and the C18 can be calculated.

The results of the C14:0 desaturation index is very high, almost the 27% while in other ruminants is 3-4%. Conversely, other two index, 11% for the 16:0 and 82% for the

18:0, are quite similar to those of other ruminants (Serra, et al. 2017). These results show that the most part of the oleic acid comes from the enzymatic desaturation activity, even if a minor amount of oleic acid is taken up from diet.

Table 7: physical characteristics and myoglobin of Wagyu beef

Water holding capacity (WHC)	g/100g fresh meat	33,41
Color parameters		
Lightness (L)		50,9
Yellow index (a)		16,6
Red index (b)		18,2
Hue (H)		47,8
Chroma (C)		24,7
Myoglobin	mg/g of fresh meat	8,81
Deoxymyoglobin	% on myoglobin	36,4
Met-myoglobin	% on myoglobin	40,8
Oxymyoglobin	% on myoglobin	6,5
Hardness	kg	2,959

Speaking about the physical characteristics of the beef, it results to be very tender given the high amount of fat found in the meat. The shear force value is 2 when the average value of the shear force calculated on samples of raw meat of European cattle breeds is 40.

The colour is very light, scoring 51 when the mean above the most famous European breed is 42. Chroma and Hue instead are slightly higher than the other kind of beef on average (Failla, et al. 2004).

8) Conclusions

The aim of this work is to analyze Wagyu Beef and Kobe Beef GI production systems, and to understand where the special quality at the origin of their outstanding reputation comes from.

Meat eating culture of Japan started quite recently, since the ban over meat consumption was removed only in 1872 after 1200 years of prohibition. In few years, a new breeding system was installed, and crossing plans established.

The native breeds of Japanese cattle were crossed with imported breeds to widen the genetic basis and to both improve the volume of milk production and the draught capacities. This practice stopped quite soon, and the modern Wagyu breeds fixed in the last century only.

Wagyu means literally “Japanese cattle” and only the bovines that fulfill the requirements can be labelled with such a name. Cattle must be authentic Japanese breeds, born and bred in Japan having Japanese breed ancestors.

The most famous Wagyu beef characteristic is the intense marbling that differ from most of Western beef. Marbling and other quality characteristics are assessed through a specific and strict control system built up by the Japan Meat Grading Association (JMGA). This nationwide grading system makes sure each carcass of Japan is evaluated objectively to be given a quality score which is linked to its price on the market.

The quality of this beef though depends not only on its appearance, but also on its unique production system.

Cattle is mainly raised at the breeding farms and only once it reaches a certain age it is sold at auctions. In this way the farmers from the fattening farms from all over Japan can choose the most suitable bovines which fit their fattening abilities, to be raised at their maximum potential.

Specific feed is then designed for each animal basing on recommendations given by the Ministry of Agriculture, Forestry and Fisheries (MAFF) the Prefecture in which the farm is located. In addition, each farmer adapts these recommendations to his breeding and his animals.

The Japanese breeding system includes also a strict genetic management, a beef traceability system which follows the animals from the breeding farm to the table and

unique organoleptic characteristics, recognized among different breeds through the unique “Wagyu beef aroma”.

In front of the growing competition on international markets, a strong interest in product differentiation can be observed. Typical food products, the quality and identity of which are the expression of both human and natural resources of a region, offer interesting opportunities in this regard. These products are identified on the market by Geographical Indications (GI) and are protected by any attempt of imitation and fraud in the countries which the goods are registered.

The protection granted can also have other purposes in case the GI product is not well known on the market yet. GI system is intended to spur rural development giving the product a price premium and to spur exports providing also new sales channels.

Japan established its own GI system in 2015, and 76 agri-food products have been registered by the MAFF until 2018.

Among all Japanese products Kobe Beef GI is the most famous in the world. Many attempts of imitations have been carried out selling non authentic product and deceiving consumers willing to taste the real Japanese beef.

Regarding Kobe beef GI production, the requirements are the strictest in Japan. Cattle from which Kobe beef comes from must be Tajima, a peculiar strain of Japanese Black cattle, born and raised in Hyogo Prefecture and never crossed with other strains in the so called “closed breeding”.

The knowledge and experience of farmers in Hyogo Prefecture is highly evaluated and respected. The skills of blending feed are considered art, used in order to achieve the best quality grade for every animal. Each bovine is treated like a member of the family in small farms counting a small number of animals each, feed is chosen each week following the specific needs of the animal.

The careful managing of genetic plans by Hyogo Prefecture, Kobe University and Kobe Beef Promotion Association, along with the feeding techniques, results in the highest quality score of all Japan and the world. Only Tajima carcasses (Tajima Beef GI) that reach the top-quality score can be given the name of Kobe Beef GI.

The objective of Kobe Beef Promotion Association now is to improve both beef taste and healthiness by increasing the oleic acid percentage and the molecules responsible for the melt-in-the-mouth texture and flavor. Our analysis on showed that, although high fat, Wagyu beef meat provided a very high amount of oleic acid, confirming the uniqueness of the product.

Wagyu beef and Kobe Beef fame and uniqueness have spread all over the world, and breeding have been established outside Japan trying to obtain the same beef quality level as Japan.

Wagyu beef and Kobe Beef in particular are kinds of beef consumed for special occasions. Given the high price for what is considered and proven to be a special and unique product, Kobe Beef stands out as the masterpiece of Japanese food tradition all over the world. Even if the offer of this product is less than the request, it could be possible to lead the consumers more information about the nutritional content of the beef. This in my opinion, given the low cholesterol content and the high oleic acid percentage among the lipids, could be an interesting marketing tool.

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