



Evaluation of marbling bonuses
- Have it resulted in more marbled animals and what are the farmers perception?

Utvärdering av marmoreringsutbetalningar
- Har det resulterat i fler marmorerade djur och vad är lantbrukarnas inställning?

Filippa Blomander

Skara 2017

Agronomprogrammet- inriktning Husdjur

Studentarbete
Sveriges lantbruksuniversitet
Institutionen för husdjurens miljö och hälsa

Nr. 724

Student report
Swedish University of Agricultural Sciences
Department of Animal Environment and Health

No. 724

ISSN 1652-280X



Evaluation of marbling bonuses
- Have it resulted in more marbled animals and what are the farmers perception

Utvärdering av marmoreringsutbetalningar
- Har det resulterat i fler marmorerade djur och vad är lantbrukarnas inställning

Filippa Blomander

Studentarbete, Skara 2017

Avancerad D, 30 hp, agronomprogrammet – inriktning husdjur, Examensarbete i Husdjursvetenskap EX0567, SLU

Handledare: Katarina Arvidsson Segerkvist, institutionen för husdjurens miljö och hälsa, box 234, Skara

Examinator: Anders Karlsson, institutionen för husdjurens miljö och hälsa, box 234, Skara

Nyckelord: marbling, beef, qualitative interviews, farmers perception

Serie: Studentarbete/Sveriges lantbruksuniversitet, Institutionen för husdjurens miljö och hälsa, nr. 724, ISSN 1652-280X

Sveriges lantbruksuniversitet

Fakulteten för veterinärmedicin och husdjursvetenskap

Institutionen för husdjurens miljö och hälsa

Box 234, 532 23 SKARA

E-post: hmh@slu.se, **Hemsida:** www.slu.se/husdjurmiljohalsa

I denna serie publiceras olika typer av studentarbeten, bl.a. examensarbeten, vanligtvis omfattande 7,5-30 hp. Studentarbeten ingår som en obligatorisk del i olika program och syftar till att under handledning ge den studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Arbetenas innehåll, resultat och slutsatser bör således bedömas mot denna bakgrund.

Table of content

Abstract	3
Sammanfattning	3
1. Introduction	4
1.1 Purpose	4
1.2 Background	4
1.2.1 About KLS Ugglarps	4
1.2.2 Marbling	4
1.2.3 Customer demand and perception	6
1.2.4 Current situation Sweden	7
1.2.5 international outlook	10
1.2.6 Decision-making	13
2. Method	14
2.1 Selection	14
2.2 Qualitative interviews	14
3. Results	14
3.1 Farmer interview summaries	14
3.2 Advisor interview summaries	17
3.3 Statistics from KLS Ugglarps	19
4. Discussion	21
4.1 Marbling	21
4.2 Current situation Sweden	22
4.3 International outlook	23
4.4 Farmer interviews	24
4.5 Advisor inteviews	26
4.6 Statistical analysis	28
4.7 Final thoughts	29
5. Conclusion	30
6. References	30

Abstract

Marbling is visible intramuscular fat that directly or indirectly contributes to sensory attributes in meat, for example tenderness, juiciness and taste. Because of this marbling is an interesting trait when discussing meat quality. The purpose of this study were to investigate if the number of marbled animals delivered to KLS Ugglarps has increased since the introduction of bonus paying system for marbled animals. KLS Ugglarps provided data from 31 000 animals collected between August 2013 and October 2016. The dataset contained information on breed, sex, age, weight, marbling class, fat and carcass classification etc. The dataset were categorised and analysed. Result from the statistical analysis implies that the percentage of marbled animals has increased during the studied time. The aim was also to get an opinion of the farmers view on marbling and the new bonus-system. Eight farmers, selected by KLS Ugglarps, and two cattle-advisors were interviewed. The interest and knowledge in marbling varied among the farmers but all of them had an opinion on the subject. Many of the farmers thought that the marbling bonus system was a step in the right directions for higher quality Swedish beef. And

Sammanfattning

Marmorering är synligt intramuskulärt fett som bidrar till sensoriska egenskaper hos kött som mörhet, saftighet och smak. På grund av detta är marmorering en intressant egenskap när man talar om kött kvalitet. Syftet med denna studie var att reda på om antalet marmorerad djur levererade till KLS Ugglarps ökat sedan införandet av ett bonus betalningssystem för marmorerade djur. KLS Ugglarps tillhandahöll data från 31 000 insamlat mellan augusti 2013 och oktober 2016. Datasetet innehöll information om ras, kön, ålder, vikt marmorerings klass och klassning på slaktkropp och fettansättning med mera. Datasetet kategoriserades och analyserades. Resultaten från den statistiska analysen antyder att andelen marmorerade djur har ökat under den undersökta tidsperioden. Målet var också att få en uppfattning om lantbrukarnas syn på marmorering och det ny införda bonussystemet. KLS Ugglarps valde ut åtta bönder som intervjuades. Intresset och kunskapen rörande marmorering varierade mellan bönderna, men alla hade en åsikt i ämnet. Många av lantbrukarna tyckte att marmorering bonus systemet var ett steg i rätt riktning mot högre kvalitet på svenskt nötkött.

1. Introduction

1.1. Purpose

This study aims to find out if changes have been made on farm level in order to deliver more marbled animals to receive a higher payment. The study is conducted in association with KLS Ugglarps. The purpose is also to find out if the number of marbled animals, delivered to KLS Ugglarps, has increased since the introduction of the national standard for marbling, 2014.

1.2. Background

1.2.1. About KLS Ugglarps

KLS Ugglarps is a slaughter company situated in the south of Sweden. The operation is conducted in four plants: Hörby, Kalmar, Dalsjöfors and Ugglarp (Trelleborg). KLS Ugglarps was formed in 2008 when Danish crown bought Ugglarps kött (Trelleborg) and KLS abattoir (Kalmar) and fused them into one company, KLS Ugglarps. In conjunction with this affair, Danish crown acquired 51 % of Team Ugglarp abattoir in Hörby. Later Danish Crown invested in the remaining 49 % and thereby, Team Ugglarp became a part of KLS Ugglarps AB. During 2015 KLS Ugglarps invested in Dalsjöfors kött AB and became majority holder of the company. KLS Ugglarps slaughter and butcher Swedish meat from cattle, lamb and pig. Processing meat products is also a part of the operation. The company has about 1100 employees, 6 700 suppliers and the annual turnover is five billion Swedish crowns (SEK) (KLS Ugglarps, 2016).

Team Ugglarps founder, Tommy Nilsson, was interested in meat quality and finding ways to improve it. The marketing manager of the company, Jenny-Ann Sundelöf experienced the need to assess the quality of beef, and not only the carcass formation and fat content, from costumers and suppliers. KLS Ugglarps recognized the need of a system where the quality parameters could be assessed. The process of developing a system to estimate marbling began at KLS Ugglarps facility in Hörby in 2011. Between 15 000 and 18 000 carcasses were assessed. Approximately 6000 of the carcasses came from young bulls and it was recognized that only around 1 % of them were marbled. Therefore it was considered unnecessary to involve young bulls in the classification. A four-point scale was developed from the American USDA-scale: 1; no marbling, 2; traces of marbling, 3; marbling, 4; well marbled. It was not considered to be a need for more points on the scale because so few of the animals were expected to classify higher than 4. The marbling assessing system was put to use in 2011 at KLS Ugglarps facilities (Personal communication Jenny-Ann). KLS is one of few abattoirs that provide extra payment for marbled animals. The extra payment for marbled meat is 1 SEK/kg for grade 3, 1.5 SEK/kg for grade 4 and 2 SEK/kg for grade 5. The categories of animals that are assessed are young cows, steers and heifers.

1.2.2. Marbling

Marbling is visible intramuscular fat (IMF) that can form a net shape in the muscle. Intramuscular fat can have positive affect on sensory characteristics of meat. Tenderness, flavour and juiciness is directly or indirectly associated with marbling. Intramuscular fat and the composition of fatty acids directly affect flavour of the meat and the oxidation of lipids (Bernard et al., 2007). Tenderness is indirectly affected by marbling since fat deposits between the collagen fibres weakens the connective tissue (Venkata Reddy et al., 2015). The

correlation between marbling and juiciness of meat varies considerably between studies. Some studies showing a weak correlation between juiciness and marbling while some are showing an important relationship between marbling and sensory traits as juiciness (Wood et al., 2008). Venkata Reddy *et al* (2015) suggested that an increased IMF content increased the water-holding capacity of the muscle, which leads to a juicier meat.

Marbling in beef is influenced by breed, rearing method, age and gender of the animal (Bures et al., 2006). Generally heifers have more marbling than steers and bulls. The hormonal statuses of the cattle have influence on the fat deposition and female cattle have more favourable genes for hormones contributing to marbling (Venkata Reddy et al., 2015). Steers generally have higher fat deposition than bulls, even though castration lowers the growth rate, the meat quality is higher due to the higher fat content (Heaton et al., 2006).

Breeding

Marbling is attribute with high heritability. In order to improve marbling among Swedish beef cattle breeding efforts are required (Stenberg, 2013).

The breed of the cattle has great influence on marbling. A German study compared four different breeds potential for marbling; Angus, Galloway, Holstein-Friesian and Belgian blue. Five to fifteen bulls were slaughtered at the age of 2, 4, 6, 12 and 24 months. Differences in quantity, distribution and structure of the marbling appeared. Holstein-Friesian showed a great number and slightly finer structure of marbling flecks compared to the other breeds, while Angus had the largest marbling flecks. The largest marbling flecks are the easiest to detect and can therefore generate a higher marbling score. The greatest number and most regular marbling flecks were shown in Galloway. The distribution of fat was inferior in the double muscled Belgian blue compared to the other breeds in all ages of slaughter (Albrecht et al., 2006). The influence of breed on marbling was also studied by Marshall (1994). A large number of different breeds were compared, all slaughtered between 380 – 460 days of age. When assessing marbling Jersey, Red Angus, Angus, Short-horn and South Devon had highest rank while Chianina, Charolais, Brahman, Limousin and Sahiwal were ranked the lowest. Multiple quality traits were investigated in this study, for example shear force and sensory tenderness. The results suggested that breeds with higher marbling scores had a lower value for shear force higher scores on sensory tenderness (Marshall, 1994).

Diet and body size

Body size and age also have influence on marbling. Camfield *et al.* (1997) studied the effect of days on finishing diet and frame size on steers, on characteristics and sensory attributes. The results were that large framed steers had a higher carcass weight but medium framed steers were fatter and had higher marbling score and quality grades. All steers ate grass for 150 days, and were then finished on a high energy concentrate, for either 0, 30, 60 or 90 days. It was observed that the thickness of the fat increase as finishing time increases. Steers finished for 90 days had a higher percentage of heart-, kidney-, and pelvic fat. Marbling score increased as well, steers finished for 60 or 90 days had higher marbling grades than steers finished for 0 or 30 days (Camfield et al., 1997). This agrees with Van Koevering *et al.* (1995) who also studied the effects of time on diet on steers. The steers of British x Continental breed were divided into four groups and were slaughtered at 105, 119, 133 or 147 days on finishing diet. The marbling score and percentage of the steers graded U. S Choice (see Figure. 2) increased as days on feed increased. Williams *et al.* (1989) also studied the effect of time on finishing diet on medium framed steers. This study divided the

steers in to two groups, one group with higher daily muscle gain, and one group with slightly lower muscle gain. The results were that there were no difference in marbling score between the two groups but the marbling score increased with time on feed up to 112 days. After 112 days the marbling score remained the same (Williams et al., 1987).

Rearing

Rearing system and feeding strategy also have influence on marbling. It has been shown that the energy concentration of the feed has influence on the intramuscular fat content (Aalhus et al., 1992). Duckett *et al.* (2014) investigated the effect of time on pasture on marbling. Crossbred Angus steers were kept on pasture 89, 146 or 201 days and then slaughtered. The marbling score increased as time on pasture did. Vestergaard *et al.* (2000) compared extensive and intensive rearing systems' effect on marbling. Friesian bulls born during the autumn were used in the study. All bulls were weaned after three months and then divided into two groups. The bulls reared in an extensive system were fed a forage-based diet with following grazing period. Some bulls were slaughtered when the grazing period ended (360 kg), while some were finished on grain-based finishing diet for additional ten weeks (460 kg). The intensive reared bulls were tied-up with free access of grain-based diet. Some of the intensively reared bulls were slaughter at the weight of 360 kg and some at 460 kg. Over all, the bulls reared intensively had generated higher quality meat than extensively reared bulls. The intramuscular fat content were 50 % higher for bulls reared intensively than bulls reared extensively at the weight of 360 kg. At he weight of 460 kg the difference in intramuscular fat content decreased.

1.2.3. Costumer demand and perception

According to Miller *et al.* (2001) tenderness is the most important quality trait for consumers. Consumers are willing to pay a higher price for steaks with higher tenderness.

The consumer's perception of beef quality often is affected by geographic differences and socio-demographic background. In Sweden and the rest of Europe, consumers prefer lean meat, with a fat content around 6 % as highest. In USA the consumers prefer somewhat higher intramuscular fat content, around 8-10 %, and in Japan a fat content of 20 % is requested (Hocquette et al., 2010).

The demand for Swedish meat is high, especially from restaurants and chefs that want to provide their costumers with high quality Swedish meat. The quality of Swedish beef has been inconsistent a

nd it has been a problem for the slaughtering companies to distinguish high quality beef in an effective way (Stenberg, 2012). Statistics from the Swedish Board of Agriculture showed that during the year of 2012 the production of Swedish beef decreased while the demand increased (Jordbruksverket, 2012).

Sweden has one of the most comprehensive animal protection regulations in the world. The production of Swedish beef contributes to an open landscape and a diverse flora and fauna, since the cattle in Sweden graze during the summer period. Choosing Swedish meat also provides more working opportunities and a vivid countryside. About 130 000 ton beef is yearly produced in Sweden, while the yearly consumption of beef is about 250 000 ton. This means the about half of the consumed beef in Sweden is imported (Svenskt kött, 2016). A survey made on behalf of Svenskt kött (an association organisation, owned by the Swedish meat industry, The Federation of Swedish Farmers (LRF) and Swedish animal farmers) showed that 62 % of the participants were prepared to pay more for Swedish meat than

imported. This could be explained by consumers' perception that the Swedish meat has higher production quality than imported meat. Many of the consumers connect the higher price to a higher standard of animal welfare (Svenskt kött, 2013).

An American study investigated the palatability of strip loins (*Musculus longissimus dorsi*) for different U. S. graded beef. The strip loins were selected from four different packing facilities in Texas, Kansas, Colorado and Nebraska and originated from 700 carcasses. All carcasses in the study were classified "A" on maturity and either "Slightly Abundant", "Moderate", "Modest", "Small", "upper half of Slight", "lower half of Slight" and "Traces" in marbling grade (see figure 2.). From each marbling grade, 100 strip loins were selected. The results showed that there were regional differences in the consumer acceptance for intramuscular fat in beef. It could also be concluded that steaks with lower degree of marbling had higher risk to be rated low by the consumers (Savell et al., 1987). These U. S. grades for marbling are the starting point for the Swedish marbling standard. The marbling grades in this study corresponds to the grades applied in the Swedish national standard.

Approximately 25 % of the carcass consists of bone, 25 % of the carcass becomes cuts like rib eye, sirloin, top side etc. and 50 % of the carcass becomes minced meat (Svenskt kött, 2016). The sirloin and the rib eye are often said to be the cuts most influenced by marbling. In order to prove that other cuts also are highly influenced, and increases in quality, when animals are more marbled KLS conducted a project in which applications for cuts that usually end up as minced meat were suggested. Among these cuts were Ribroast, Knuckle cap, top side and others (Jenny-Ann Sundelöf, 2016).

1.2.4. Current situation, Sweden

Rearing system

The majority of cattle in Sweden is raised outdoors on pasture during the warmer period of the year, and housed indoors during the winter. It is most common that the calves in suckler cowherds are born during the spring and reared on pasture with the cow. The calves are separated from the cows when the grazing season is over and reared intensively on silage and grain based concentrate. The average slaughtering-age for bulls are 17.3 months, the time before the next grazing season starts. Bulls from dairy-herds are born during the whole year and are fed silage and concentrate in varying amount. The dairy bulls are generally slaughtered at an age of 18.7 months. Heifers and steers are normally kept for a second grazing season to achieve a good weight at slaughter at the average age of 24.6 months. Dairy bulls usually are kept as intact males. The slaughter of young cows is usually the result of culled young cows from both dairy and beef production and are a minor part in the Swedish production scheme (Lundesjö, 2008).

Classification of beef

In Sweden the EUROP-system is used to assess carcasses. The classification involves category of animal, formation of the carcass and fat deposition. For beef the different categories of animals are bull, young bull, steer, cow, young cow or heifer. The conformation of the carcass is graded with letters, each letter can be supplemented with a + or -. This adds up to 15 assessment classes. The fat deposition is graded by numbers 1-5 which also can be supplemented with + or -, which is described in Table 1 (Svenskt kött, 2016).

Table 1. Classification of carcasses according to EUROP (Svenskt kött, 2016).

Conformation of carcass		Fat deposition	
<i>Grade</i>	<i>Explanation</i>	<i>Grade</i>	<i>Explanation</i>

E	Extremely swelling and well developed	1	Very lean
U	Very swelling and well developed	2	lean
R	Swelling and developed	3	average
O	Well developed	4	Abundant
P	Somewhat thin and sunken	5	Very abundant

Since 2014 there is a national standard for assessment and classification of Swedish beef marbling. The purpose of this national standard is to meet the demand of Swedish quality beef from consumers, restaurants and grocery stores (Svenskt kött, 2016). The project with introducing a national standard for marbling in beef started in 2013. Early in the process comments were made that the national scale should involve few grades and should be comparable to international standards, for example Canada and Australia. Both Canada and Australia have chosen to use the American USDA-scale as starting point for their national standards. The USDA-scale was therefore assessed to suit Swedish conditions as well. When the project to develop a national standard started, KLS Ugglarps had been assessing marbling in Swedish cattle for two years. KLS Ugglarps used a four-grade scale from the USDA-scale corresponding to the grades: no marbling, small, modest and moderate. Hardly 30 % of the slaughtered steers, heifers and young cows gained the two highest grades (3 and 4) of marbling. This implicates that there is no need for higher grades since the Swedish cattle are not marbled to a large extent. The report that led to the national marbling standard says that in order to increase the number of marbled animals breeding measures are required. To secure that at national standard would lead to a progress in breeding marbled animals, it must be possible to calculate a breeding value from the standard. To be able to genetically separate the animals it cannot be too few grades, hence five grades were identified as a minimum (Stenberg, 2013). The report resulted in a national marbling standard with five grades from 1-5 (see Table 2 and Figure 1). It is voluntary for the abattoirs to use the standard and to which extent.

Table 2. Swedish national standard for marbling (Stenberg, 2013).

Grade	Explanation	USDA-equivalent
1	No marbling	-
2	Incipient marbling	Small
3	Marbled	Modest
4	Well marbled	Moderate
5	Very marbled	Slightly abundant

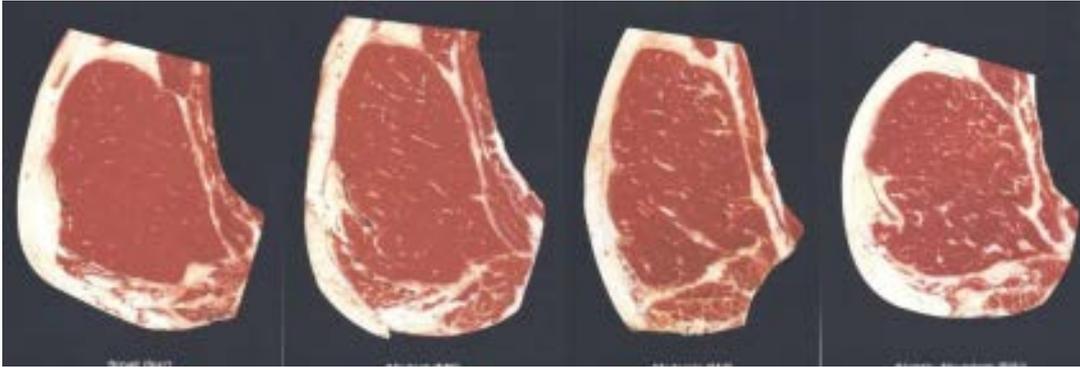


Figure 1. Class 2-5 in the Swedish standard for marbling (Stenberg, 2013).

After slaughter the carcasses are cooled using high airflow during the first cooling cycle. Usually the carcasses are stored one to two days before cutting. Most common is that the cuts are packed and aged in vacuum. Swedish meat industry association recommend that the meat should not be sold to customers until seven days after slaughter. Processing and preparations for consumer packages are often done centrally. The most common delivery system of consumer packages are modified atmosphere packaging (MAP). How the meat is age and packaged have influence on the meat quality (Lundesjö, 2008).

Animal material

Sweden traditional has used dairy breed bulls for meat production (Taurus, 2015). Dairy bulls have a high energy intake and a high daily gain, which leads to a shorter rearing time. Intact bulls have a higher energy requirement and a lower fat deposition than steers and heifers (Taurus, 2015). Because of this bulls have a lower intramuscular fat content and is very rarely marbled. Intramuscular fat is the last fat on the body to be deposit and the first to be synthesized as energy if the body goes in to starving mood. (Taurus, 2015). Beef breeds were introduced in Sweden during the early 1900's. Now beef breed cattle correspond to 35 % of all slaughtered cattle, the rest is crossbreeds or dairy breeds (Svenskt kött, 2015). As can be read above, the last decade the Swedish beef production has decreased. Mainly this is a consequence of the decreasing number of dairy farms in Sweden. When dairy farms liquidate, it results in less dairy bull calves available for raring to slaughter (Jamieson et al., 2010). This has also resulted in a higher number of suckler cow herds in Sweden (Lundesjö, 2008).

Breeding

Gård och Djurhälsan (Farm and Animal Health, an advisory company) in cooperation with different breed associations run the beef recording schemes on which genetic evaluation of Swedish beef cattle is based on. Gård- och djurhälsan runs the beef cow database that includes pedigree and performance recordings from test stations and abattoirs. That information is necessary for genetic evaluation. Pedigree recordings have been available since 1975. Imported animals are also documented in these pedigrees (Eriksson et al., 2007). Best linear unbiased prediction (BLUP) was introduced in Swedish beef breeding in 2000. In the BLUP-model information from all animals with recordings for different characteristics such as weight or calving process are linked in order to calculate the best estimate possible. In the model, kinship between animals is taken into consideration, which gives the opportunity to correct in order to avoid inbreeding. This system also provides the opportunity to correct for herd, sex, etc. By doing so, the model takes both environmental and hereditary factors into account. When BLUP was introduced in 2000 it included birth

weight and growth. During 2005 breeding values for carcass characteristics and calving properties were included. A breeding index (weight index) was introduced in 2009 (Gård- och djurhälsan, 2016). The breeding goal for Swedish beef production is “to produce animal material that makes it possible to produce beef of the highest possible quality to the lowest possible cost” Jamieson, 2010).

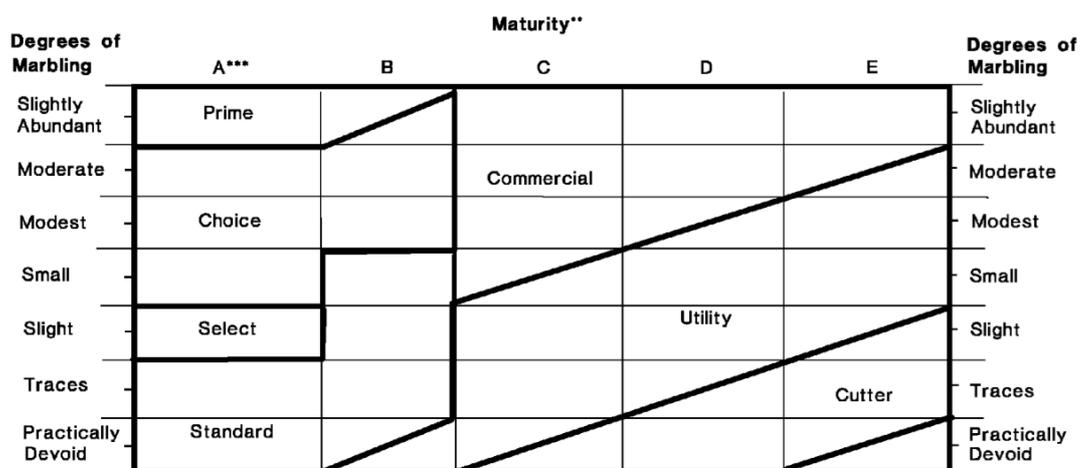
In the current situation genomic selection (GS) is not used in a large extent in Sweden on beef cattle. GS enable the calculations for an accurate breeding value, especially when traditional selections are difficult, for example traits displayed only in females. GS also provide the ability to reduce the generation intervals. By genotyping animals in young age, and not being as dependent on phenotypic traits the animals can be breed in an earlier age (Goddard and Hayes, 2007). In order to get a high reliability the reference populations need to be large. Also wider spread use of artificial insemination (AI) benefits GS. Since the use AI is low in, Sweden has high effective population size of the different beef breeds (Blomdahl, 2015).

1.2.5. International Outlook

USA

The first version of the U. S. grading system for dressed meat was formulated in 1916. Over the time the grading system has been developed and updated as the knowledge of dressed meat has grown. The system is developed by U. S. Department of Agriculture (USDA). When the system was developed, the main purpose was meat market reporting, but was later put to further practical use in numerous ways. In 1927 voluntary beef grading stamps began. As a follow up to this, the grades were changed from “medium”, “common” and “low cutter” to “commercial”, “utility” and “canner” for steer, heifer and cow beef. Later bull and stag beef were incorporated and led to the current terminology; Prime, Choice, Good, Commercial, Utility, Cutter and Canner. All references for colour of meat and fat were eliminated. The beef is graded on the maturity of the carcass and the marbling in the longissimus muscle at the 12th and 13th rib interface (see Figure 2). The aim of the grading is to produce meat with high eating quality based on tenderness, juiciness and taste (USDA, 2016).

Relationship Between Marbling, Maturity, and Carcass Quality Grade*



* Assumes that firmness of lean is comparably developed with the degree of marbling and that the carcass is not a 'dark cutter.'

** Maturity increases from left to right (A through E).

*** The A maturity portion of the Figure is the only portion applicable to bullock carcasses.

Figure 2. USDA grading based on maturity and marbling (USDA, 2016).

Canada

The marbling standard in Canada was changed in 1996, and they are currently using copyrighted standards developed in USA. Marbling is classified as Canada A, Canada AA, Canada AAA or Canada Prime. Canada A has no comparable USDA grade but AA, AAA and prime can be compared to USDA Select, Choice and Prime. Canada A is reserved for youthful quality carcasses with traces of marbling. Youthful quality often refers to carcasses from animals younger than 24 months, maximum 30 months. For Canada AA and USDA Select slight marbling is required. For Canada AAA and USDA Choice a minimum of small marbling is required and for Canada prime and USDA Prime, slightly abundant marbling. Maturity of the carcass, meat and fat colour, meat texture and muscling are also taken into consideration when grading carcasses in Canada. If the carcass has a devoid of marbling or less than 4 millimetres of external fat over the ribeye, the carcass can be graded as B1. The grades B2, B3 and B4 are given to youthful carcasses with yellow external fat, deficient muscling or dark colour meat. D-grades (D1, D2, D3 and D4) are referred to mature carcasses such as cows and refer to the same deviations as the B-grades. Youthful or mature carcasses from bulls or stags that exhibit pronounced masculinity can be graded E (Beef information centre, 2009).

Japan

The Japanese grading system is based on yield score and meat quality score. The meat quality score comprises beef marbling, colour and brightness of the meat, firmness and texture of the meat and colour, luster and quality of the fat. The yield score is calculated using an equation, which takes estimated meat percentage, rib eye area, rib thickness, cold left side weight and subcutaneous fat depth into consideration. The carcass is classified as A, B or C. A is the highest grade and C is the lowest, most carcasses are classified as B. Marbling scores range from 1 to 5, where 1 is no marbling and 5 is excellent marbling. These score can be supplemented with + or – on each grade (see Figure 3.). The colour can be graded from 1 to 7. Darker meat is more desirable. The colour of the fat is graded the same way as meat colour, on a seven-point scale, where darker fat is more preferable and classified higher. The texture and firmness of the meat are both graded on a five-point scale, where five is the highest possible score. These traits are added and a total quality grade is stamped on the carcass along with the yield score. The carcass can also be stamped for possible damage indications such as muscle bleeding or inflammation (Japan meat grading association, 2000).

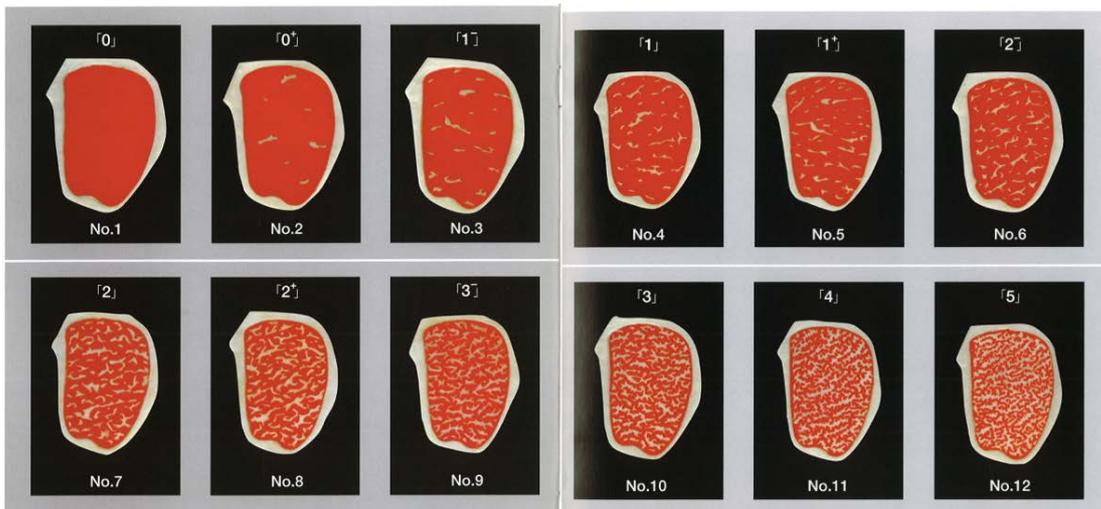


Figure 3. Marbling reference picture, Japan (Japan meat grading association, 2000).

Australia

When beef is graded in Australia a large number of factors are taken into account. To guarantee the best eating quality possible each cut is assigned an individual grade. All carcasses are graded and given a body number and lot number, carcass weight, sex, tropical breed content, hanging method, hormonal growth promotants, ossification, marbling, rib fat, pH and temperature and meat colour. Fat colour and eye muscle area are measures that don't affect the eating quality but is graded on consumer's request. If the carcass meets all the requirements from Meat standards Australia (MSA) and company specifications, selected parts from the carcass are packed and sold as MSA (Meat and livestock Australia, 2016). The marbling is assessed between the 5th and 13th rib. The MSA marbling score can range from 100 to 1900 in increments of 10 (Meat and Livestock Australia, 2015). Marbling is assessed and scored according to both MSA and Aus-Meat standards. The Aus-meat system indicates the amount of marbling while the MSA a system assesses an additional indication of distribution and size of the marbling flecks. Marbling is assessed on chilled carcasses (below 12° C) and scored on the amount of marbling fat in proportion of meat at the surface of the assessment site, which lies within the *M. longissimus* (see Figure 4.) (Aus-meat limited, 2010).

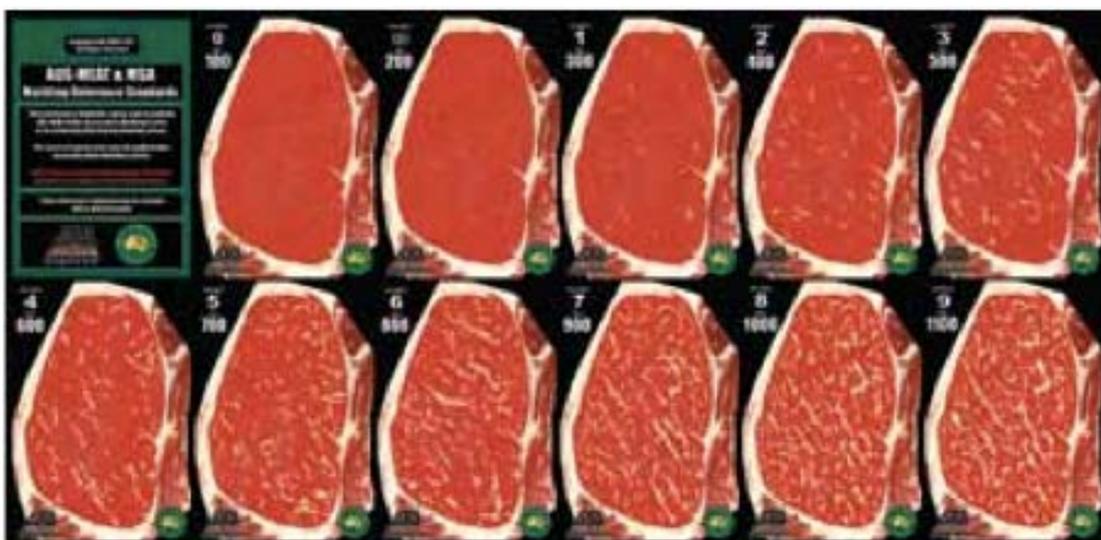


Figure 4. Marbling scale MSA (Meat and Livestock Australia, 2015).

1.2.6. Decision-making

In order to understand how the farmers can be influenced to produce more marbled meat, the path of decision-making should be taken into consideration.

There are four important steps in the decision making process for farmers: problem detection, problem definition, analysis and choice and implementation (Öhlmer et al., 1998). Since management seldom comprises one single decision, it is better to view the process as a matrix or a cycle than a linear process (Öhlmer et al., 1998, Gray et al., 2009). View it as an on going cycle of planning, implementation and control of decisions. Planning decisions tends to be less frequent than implementation and control (Gray et al., 2009).

Farmers decisions concerning their production is often complex and it is hard to distinguish linear causations. It is hard for the farmer to know the impact on the whole production when making a decision. There are many external forces such as weather and politics that have great impact on the production that the farmer is unable to control (Lindblom and Lundström, 2014). Farmers operate in a field with high risk and uncertainty. Weather and market affects for example, have great impact on the production and profit but these factors are out of the farmers' control. Farmers as a group are probably more willing to take risks than other professionals. If they were not willing to take risks, they would probably seek a job with a less variable income. Farming is inherently linked to nature and farmers are willing to let the whims of nature in large measure control their annual income (Debertin, 2012). Lindblom and Lundström (2014) write in their report about decision making that the farmers often tries to navigate and handle the "agricultural system" (national and on EU-level) rather than be controlled by the system. This report also concludes that the decision-making is not in order with predetermined or formal logic but on "rule of thumb" and proven work experience.

According to Öhlmer (2000) decisions are made either on intuition or analysis. Whether the decision is made on intuitive or analytic basis the decision maker always go through the four steps explained earlier, the difference is in how the steps are performed. If the decision maker is an analyst, detailed and large quantity of information will be gathered in order to be able to take the most advantageous decision. Intuitive decisions are based on general information and do not take for example price changes into consideration. This leads to a high uncertainty and intuitive decision-making is rarely used when the decision concerns changes that are large and irreversible, for example building investments. Farmers often make decision based on their intuition and handle the uncertainties by gradually change their production (Öhlmer, 2000).

A study conducted in Austria, studied decision making concerning investment in photovoltaics (PV) among farmers. By interviewing members of the photovoltaics society and forming hypotheses based on the interview answers the researchers found that economic aspects dominate the decision making. The results from the study also showed that socio-dynamic factors are important for decision making among farmers. If someone in the farmer's environment adopted PV, barriers for another farmer to adopt became weaker. It was also concluded that most farmers are driven by ethical consideration and have strong eco-attitudes (Brudermann et al., 2013).

2. Method

Statistics provided from KLS Ugglarps was analysed to find out if there is any change in the number of delivered marbled animals to KLS Ugglarps. The dataset provided from KLS Ugglarps were sorted in Excel and statistical analysis was ran in SAS.

Furthermore qualitative interviews with farmers who deliver animals to KLS Ugglarps were conducted. In order to profoundly understand the farmers view on certain questions/problems, a qualitative interviewing method were used. This in order to find out how much the farmers know about the national standard and whether the farmers have made any changes in their production system in order to take part of the extra payment for marbled animals.

Interviews with two advisors from two different advisory service companies wre conducted to further investigate farmers' interest and perception of marbling. The interviews with advisors also have the purpose to portrait advisors perception of the national marbling standard and their ability to answer any questions concerning marbling. The report will be supplemented with a literature study.

2.1 Selection

Eight interviews with suppliers from KLS Ugglarps were conducted in this study. The suppliers were selected by KLS Ugglarps and all the prospective farmers accepted the request to participate in the study. The farmers had varying prior knowledge about marbling and the national marbling standard. Some of the farmers have taken part of the marbling bonuses. The two advisers were chosen on their catchment area and availability.

2.2 Qualitative interviews

The qualitative interviewing method strives to understand the world by the interviewee's perspective, it can be described as a conversation with a purpose and structure (Kvale, 1997). A qualitative interview is often semi-structured and can be defined as "*an interview aiming to obtain descriptions of the interviewees life world in order to interpret the described phenomenon's meaning*" (Kvale, 1997). According to Kvale (1997) the strength of a qualitative interview is that it can comprise many different perceptions of one subject and reflect a diverse and controversial human world. Qualitative interviews are also characterized by that the interviewer asking seemingly simple questions but are often given long and complex answers (Trost, 1997). The interviewer constructs a question guide, which shouldn't include to many questions. The questions, and the order, can be changed during the interview. It is important that the interviewee, as much as possible, control the order of the conversation. By letting the interviewee decide the sequence of the conversation they can speak more freely and give the interviewer a better insight in their perceptions of the world (Trost, 1997).

The interviews in this study aimed to understand the way farmers think about marbling bonuses. In order to develop the bonuses and find ways to encourage more farmers to produce high quality meat and take part of the bonus system.

3. Results

3.1 Farmer interview summaries

Farmer A

Farm A is a breeding farm, located in the east of Blekinge. They have been breeding purebred Hereford cattle since 1974. Most of the cattle are sold as live animals but a few are slaughtered. The farmer has long experience in breeding and high interest in improving the quality and reputation of Swedish meat. Even before the Swedish standard for marbling was introduced in 2014 this farmer had marbling values in mind when choosing breeding bulls and semen. In order to get a faster breeding progress this farmer uses the breeding techniques available. He imports semen from USA and Canada, and use embryo technique. This farmer has never used or planed to use an advisory service, but he believes that KLS Ugglarps could increase their market shares by providing their own advisory service. He thinks it is a good thing that the marbling standard was developed, he also think it is good that KLS Ugglarps is ahead of many other abattoirs and that they negotiate with City Gross in order to increase the amount of easy access high quality meat to consumers. One measure this farmer suggested in order to get more farmers interested in delivering marbled meat could be negotiate a lowering of the fees for being a part of the project "Naturbeteskött" (meat from animals grazing on semi natural pastures, authors comment). This could lead to that the farmers with smaller farms could afford to be a part of the project and rear their cattle in a more extensive way and ultimately deliver more marbled animals.

Farmer B

Farmer B breeds crossbreed cattle (Hereford, Angus) in an extensive way. The farm is located in Blekinge and has a lot of semi natural pastures. Therefore all the bulls are castrated and reared as steers. All steers and heifers are kept until they reach slaughter-maturity at around 22 months of age. A few of the slaughtered steers and heifers have been classified as 3 on the marbling scale but the farmer doesn't do anything special in order to get marbling bonuses. This farmer thinks the bonuses are too small to change the rearing model or feeding he uses today. He has turned to advisory services to get advice on how to feed his animals in order to increase marbling but feels that the advisers are not qualified to give advice about rearing beef cattle. He believes that KLS Ugglarps would benefit from providing their own advisory service. He also experiences that the word about marbling bonuses are not that wide spread, he believes that KLS Ugglarps would benefit from spreading the information in a more effective way.

Farmer C

Farm C is located in the middle of Småland. It is a KRAV-certified breeding farm (Hereford) that delivers live animals to their customers. The production of the farm comes from the many semi natural pastures that belong to the farm. This farmer thinks that the Swedish marbling standard is a step in the right direction to improving the quality of Swedish beef. The animals sent to slaughter is mostly young bulls and young cows, and only the young cows are assessed and can be classified for marbling bonuses. Since the marbling standard was introduced this farmer has looked closer at marbling scores when choosing breeding bulls and semen. He thinks positive on the breeding techniques that exists, but is limited in using them because of the KRAV-certification. He thinks that KLS Ugglarps could improve the amount of marbling and number of marbled animals by providing feedback to the farmers that deliver animals and are interested in meat quality. That service would provide a wider insight in how the delivered carcasses look than just getting the slaughtering note.

Farmer D

Farmer D has a few suckler cows but mostly buy live animals and rear them on the farm, both dairy and meat breeds but mostly crossbreeds. Currently he doesn't take part of the marbling bonus system and doesn't know so much about it. He has a fixed price for all slaughtered animals and are not sure if he would profit from changing that and take part of the marbling bonus system. The farm has capacity to house 400 animals in five different stables. Because of this he consider himself having high potential to change his production and rear a group of animals in order to get them more marbled, as long as he benefits from it. Farmer D believes that KLS Ugglarps would benefit from spreading the word about marbling bonuses more in order to get more farmers interested. He also believes that he would benefit from a reliable advisory service. That would make a change in the production easier and more effective.

Farmer E

Farmers E has a suckler cow production, mostly with Simmental. The heifers are bred with Hereford or Angus bulls in order to promote easy calving's. This farmer has heard about the marbling bonuses and have attended a few courses about marbling but feels like the payment is to small relative to the cost for keeping the animals for that amount of extra time. They are also hesitant to if marbled meat is what the consumers actually want. If the slaughter companies wants to sell marbled meat, these farmers believe that they need to market the marbled meat in a more effective way, maybe getting a TV cook to be the spokes persona. In conclusion these farmers believe that the most important instrument to get more marbled animals is payment.

Farmer F

Farmer F both have a breeding herd, a suckler cow herd and buys bull calves for rearing. The breeding herd and the suckler cow herd consists of purebred and crossbred Angus, while the bull calves are of various breed. There is also a small number of Wagyu-cattle on the farm. However, it is only the bulls that are delivered to KLS Ugglarps. Farmer F has attended a meeting at the beginning of the project and knows about the system. According to this farmer advisory service and feedback from the slaughter company is the most important instruments. This farmer does not think that ordinary commercial herds know much about marbling and that they need more information. To benefit some breeds, that has better conditions to gain marbling, in the payment from the slaughter companies could be one way to improve marbling according to farmer F. Farmer F can se how this could harm the slaughter companies. By benefiting some producers, other producers, which are not benefited from this payment, could chose to turn to another company. Farmer F chose to sell his animals to a different company because the pay more. But he is curious how his animals would be classified if he delivered to KLS Ugglarps. If KLS Ugglarps would pay the difference he would loose if he delivered to them, he would consider selling his animals to KLS Ugglarps instead. Farmer F pointed out that the fixed price system might lower the interest in marbling-bonuses. The slaughtering prices are high at the moment and the farmers are content with the fixed prices, therefor they believe that they wouldn't profit from trying to produce marbled animals in order to receive the bonuses. He also believes that it would be profitable for KLS Ugglarps to provide feedback on the carcasses.

Farmer G

Farmer G buys both heifers and bull calves for rearing. At the moment he is in the process of creating a suckler cow herd in order not to be dependent on the decreasing number of calves to buy and their high prices. Since the meat prices has been high during the last few years, marbling bonuses is not one of his priorities. He believes that it is hard for him to control since he gets a lot of different animal material. This farmer thinks that marbling could be an efficient tool to assess quality of carcasses and believes that it is a high need for it. The farmer believes that it is important to make a clear labelling for marbled meat in the supermarkets, so the consumers easy can distinguish high quality meat from low quality meat. This farmer is currently not using any advisory service and doesn't think that it would be to any help. He believes that farmers can learn a lot from each other, by visiting other farmers and communicate with experienced farmers.

Farmer H

Farmer H has a Charolais herd and he breeds and rears all animals on the farm. With marbling in mind he acquired a few Wagyu-embryos two years ago, and let the Wagyu bulls mate with Charolais heifers. This farmer has experience from Australian beef farmer and believes that we have a lot to learn from them. For instance he asks for a tougher trial for bulls especially on feed conversion ability. This farmer had a lot of thoughts on marbling but not so much knowledge on the current marbling scale. After explaining the payment, he didn't believe that the payment were high enough to motivate farmers if they don't have a high interest in meat quality. He also believe that the fixed prices prevents the progress in beef quality. Another key to get progress in beef quality is the knowledge of the consumers according to this farmer. If the consumers are prepared to pay more, the slaughter companies will be able to pay the farmers that deliver marbled animals more, then it will be more desirable for the farmers to produce more marbled meat.

More

All of the interviewed farmers believed that it is possible to spread the supply of slaughter mature animals. The abattoirs could provide a higher payment for animals slaughtered at different times of the year. By offering higher payment at times when the demand for Swedish beef is high, the abattoirs could control the flow of animals.

3.2 Advisor interviews summaries

Advisor A

An advisor at the advisory service company VÄXA doesn't experience any interest from farmers in her working area. So far she hasn't got any questions concerning marbling. She feels like she is unprepared to answer questions on marbling and thinks that the research results are too few and too straggly to provide good recommendations for the farmers. When the interview started, the advisor didn't know how the marbling bonus system works. After explaining, the advisor thinks that the payment is insufficient to motivate farmers to change their production in order to deliver more marbled meat. She also believes that the possibility for farmers to negotiate fixed prices slows down the process of increase the number of marbled animals.

Depending on how the marketing and the interest among consumers go, the future for marbled meat can be bright. The advisor believes that it will take a lot of hard work to market marbled meat and make sure that the consumers understand the difference between higher-quality meat and regular meat and why there is a price difference. She believes that the major problem is the anonymity that characterizes meat counters in supermarkets. Today there is very little price-range in the meat counters and consumers have no way to know which category of animals they are buying beef from. There's very limited range of quality and price. The only information available on the package is often land of origin and fat content. In order to market marbled meat as higher quality meat, the quality and price range have to get wider and the knowledge among the consumers need to get better.

The advisor says that she and her colleagues has noticed higher interest in meat production among farmers, the main reason for this is the low milk price. She believes that a change in the Swedish meat production is coming, the usage of dairy bulls will get lower as many dairy farms shuts down.

The advisor has not have any dialog with the slaughterhouses but believes that both the slaughter houses and the advisory companies would benefit from a better collaboration. She thinks that both the slaughterhouses and the advisory companies are in responsibility to provide the farmers with information and advises concerning marbling when they ask for it. She believes that the food retail sector and the slaughter houses responsibility to educate the consumers on the difference in high quality and low quality meat. At last, the advisor questions why no other slaughterhouses has tag along on this project. She believes that the answer to that could be laziness and old habit.

Advisor B

This advisor works solely with beef production at Gård och Djurhälsan. The office is situated in the south of Sweden within KLS Ugglarps catchment area. She has experienced interest from beef producers and feels like she has a good idea about how the payment system for marbling works. She also feels quite comfortable answering questions about marbling based on the current available facts. This advisor believes that it would be easier to motivate the farmers to producer more marbled animals if it was linked to a clear concept. The marbling-bonuses are good because it raises questions regarding what the individual farmer could do in order to affect quality of Swedish beef. She also thinks that the payment is high enough and that farmers could profit from producing marbled beef. According to the advisor the low bonus-payments shows that it is not desirable to get at fat carcass due to getting higher marbling grades.

The advisor also expresses a need for opportunity to develop a clear advisory model for marbling. Someone has to take the responsibility to develop such an advisory model. It is important to take all aspects (breeding, rearing, slaughter, maturation of carcasses) of production into consideration to be able to see the long term effects. She also believes that a tighter cooperation between the advisory companies and the slaughter industry would benefit them both, and the farmers.

According to the advisor the future for marbled beef is bright. She believes that we can make use of the trend of eating Swedish meat and elaborate it further by market more benefits with Swedish beef, and quality should be one of them. Marbling is one of few

tools available for assessing quality of beef and therefore it is of great importance. Before the advisory companies have elaborated a “how to”-type of advisory model, this advisor believes in intensive rearing models in order to get more marbled animals.

The advisor believes that the fixed-price system harms the interest in marbling-bonuses. It is convenient for the farmers to always get the same price for the animals, even when they deliver a animal with lower quality. The farmers are hesitant if they would profit from having a variable in order to get marbling bonuses. They are satisfied with their fixed prices and know that they won't lose money if one delivered animal is not up to standard, therefore they refrain from negotiating the price.

Finally she states that it is both the slaughtering industries and the advisory companies responsibility to make sure that the farmers have access to the advisory service they need. She also says that she is glad to see projects as this and that research is conducted on the area, because there is a need for it.

3.3 Statistics from KLS Ugglarps

KLS ugglarps provided data on 31 684 animals. The dataset contained information on animal category, date of slaughter, age in months, breed, weight, classification on fat, carcass and marbling. Almost 40 % of the animals in the dataset were missing information on classification on marbling or age when slaughtered, these animals have been taken out of the analysis. The dataset were categorized in excel and statistical analysis ran in SAS. As explained earlier in the text marbling classes 3-5 generate an extra payment for the farmers that deliver animals to KLS Ugglarps. In this analysis classes were converted into economic value and calculations were made on value for the different classes: class 3 = 1 SEK, class 4 = 1,50 SEK and class 5 = 2 SEK. The result of these calculations can be seen in *Table 4*, *Table 5* and *Table 6*.

Table 3. Number of animals slaughter during each year.

Animal Cat. \ Year	Heifer	Young cow	Steers	Bulls
2013 (Aug. →)	1003	171	265	927
2014	3 937	455	895	39 499
2015	8 756	1 973	4 168	40 610
2016 (→ Oct.)	5 773	1 458	3 228	26 499

The percentage of steers relative to the percentage of bulls decreased between the year of 2013 till 2014, but increased between the years of 2014 and 2015, and between 2015 and 2016 as can be calculated from the numbers in Table 3.

Table 4. Mean value for each category of animals during August 2013 until October 2016.

Animal category	Heifers	Young cows	Steers
Total value (SEK)	0.29	0.36	0.42

Table 5. Mean value including all categories of animals during August 2013 until October 2016.

Year	2013	2014	2015	2016
------	------	------	------	------

Mean value (SEK)	0.25	0.22	0.35	0.37
-------------------------	------	------	------	------

Table 6. Mean value for Heifers during August 2013 until October 2016.

Heifers, year	2013	2014	2015	2016
Mean value (SEK)	0.22	0.20	0.31	0.32

Table 7. Mean value for young cows during August 2013 until October 2016.

Young cows, year	2013	2014	2015	2016
Mean value (SEK)	0.21	0.16	0.36	0.40

Table 8. Mean value for steers during August 2013 until October 2016.

Steers, year	2013	2014	2015	2016
Mean value (SEK)	0.39	0.32	0.41	0.43

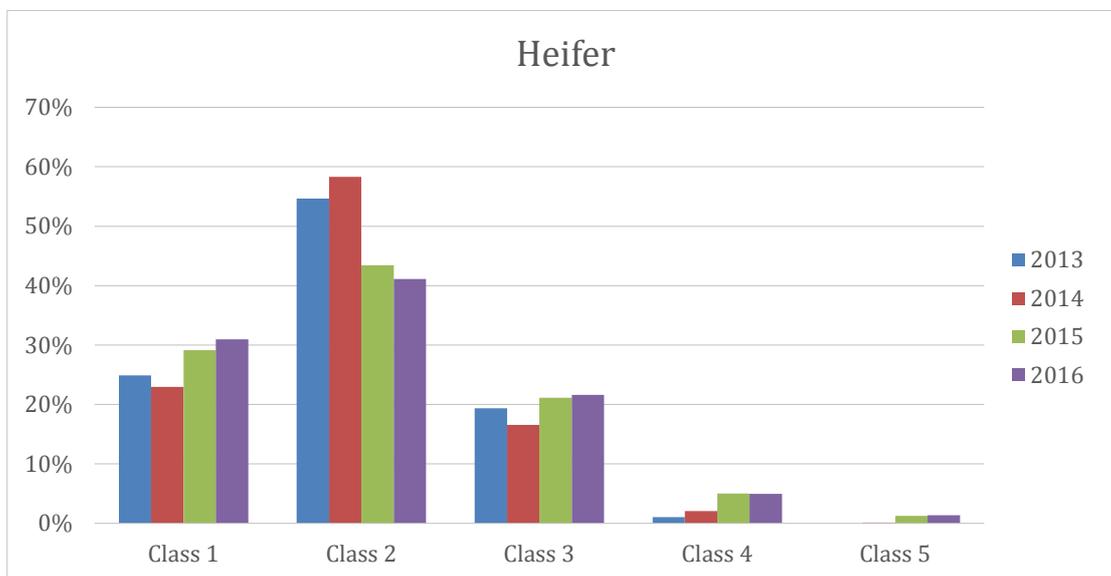


Figure 5. Distribution in marbling classes among heifers slaughtered between August 2013 and October 2016.

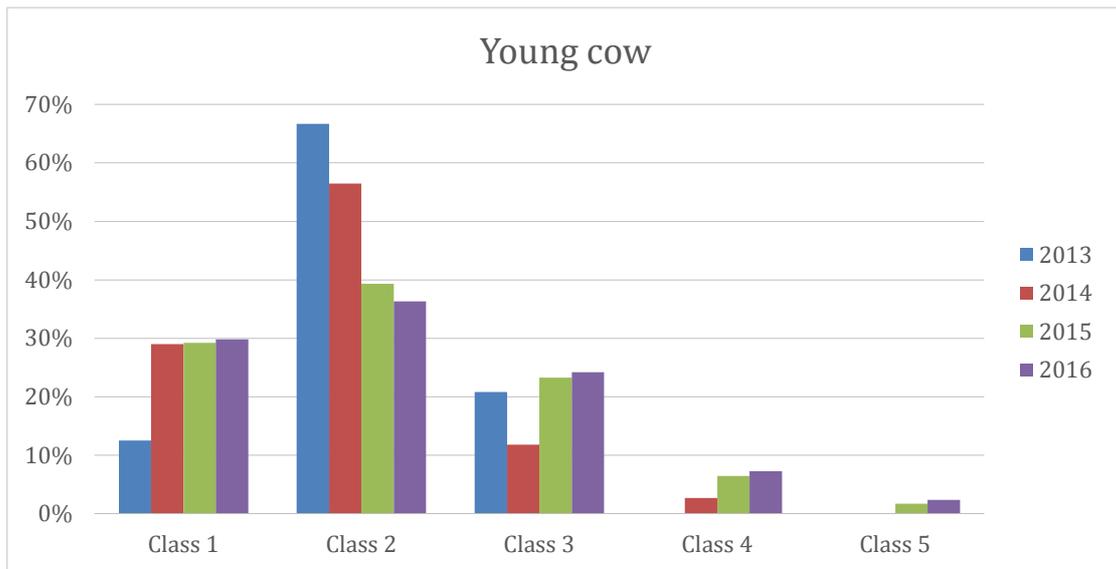


Figure 6. Distribution in marbling classes among young cows slaughtered between August 2013 and October 2016.



Figure 7. Distribution in marbling classes among steers slaughtered between August 2013 and October 2016.

Figure 5, Figure 6 and Figure 7 show the distribution of marbling classes between August 2013 and October 2016 for each category of animal.

4. Discussion

4.1 Marbling

The influence marbling has on other eating quality traits have been studied with varying results (Bernard et al., 2007, Venkata Reddy et al., 2015, Woody et al., 2008).

According to Miller *et al.* (2001) tenderness is the most important quality trait for costumers. The relationship between marbling and tenderness has been investigated with varying results. While Venkata Reddy *et al.* (2015) suggested that tenderness is indirectly affected by marbling. Marshall *et al.* (1994) compared quality characteristics in different breeds and found that breeds with higher marbling score also had higher scores on sensory tenderness

and lower shear force value. One might wonder why quality of meat is not assessed by tenderness instead of amount of marbling. This probably depends on the techniques available for assessing tenderness. While marbling can be assessed ocularly, tenderness cannot and therefore requires technical instruments. That would probably extend and complicate the assessment.

Rearing method, age and diet is also influencing marbling. Number of days on finishing diet and frame size have an effect on marbling (Camfield et al., 1997, Van Koeveering et al., 1995, Williams et al., 1987). All studies on number of days on finishing diet showed that marbling increased as number of days on feed did. Duckett *et al.* (1992) studied the effect of keeping steers on pasture at different amounts of days on marbling. The results were that marbling increased as days on pasture did. The common factor of these studies is that as the age of the animal increased, so did marbling, independent of diet. When Duckett *et al.* (1992) presented the results of the study, the increase in marbling was thought to be because of the increased number of days on pasture, not the fact that the steers with more marbling were older at the time of slaughter. The effect of the frame size and muscle growth were also investigated (Camfield et al., 1997, Van Koeveering et al., 1995, Williams et al., 1987). Camfield *et al.* (1997) showed that medium framed steers had higher ability to gain fat, both intermuscular and intramuscular, than large framed steers. This result agrees with the results from Marshall *et al.* (1994) that studied different breeds' ability to gain marbling. The breeds ranked highest in marbling scores were all medium framed breeds. This also agrees with the perception among the interviewed farmers in the current study. The farmers thought that medium framed breeds such as Angus and Hereford have higher ability to gain marbling.

About 50 % of the carcass becomes mince, remaining 50 % consists of 25 % bone and 25 % fine cuts. If it could be proven that cuts, not usually associated with marbling, can increase in value when marbled, it would increase the value of the whole carcass and a lower percentage of the carcass would be minced. KLS Ugglarps did a report, in which different marbled cuts were cooked in order to demonstrate different applications. It would have been interesting to cook the same cuts from at least two different carcasses, one marbled and one without marbling. In that way the cuts can be compared to each other to confirm if there are any eating quality differences. If there are no differences in quality, then the percentage of carcass that gets minced could be decreased by communicating and marketing the possible applications for the cuts.

4.2 Current situation Sweden

As mentioned before Sweden has a high usage of dairy bull calves in beef production. Only 35 % of the produced meat comes from meat breeds, the rest comes from dairy breeds and crossbreeds (Svenskt kött, 2015). As also mentioned earlier, dairy breed bulls have a low ability to gain marbling. This is because of the high energy demand and high daily gain (Taurus, 2015). The tradition of using dairy breeds for meat production can probably somewhat explain the inconsistency in quality and the lack of marbling in Swedish beef.

The decreasing number of dairy farms in Sweden have resulted in a decrease in Swedish beef production. This leads to a reduction of dairy bull calves for rearing to slaughter (Jamieson et al., 2010). Could the possibility to use sex-sorted semen in dairy production have something to do with this reduction as well? The interviewed advisor A experienced that a lot of the former dairy farmers convert to suckler cow production. She states that the prices for live-calves are currently high because of the decreasing number of dairy herds and

therefor a decreasing number of dairy bull calves. Because of that there will be a decrease before the suckler cowherds fill the void for the decrease in dairy bulls calves. This could be an opportunity to increase the number of beef cattle with good marbling traits. In order to get the upcoming suckler cow herds to choose a breed with high ability to get marbled, marketing and information would be crucial.

Since it is voluntary for the slaughterhouses to apply the national marbling standard (Stenberg, 2013) it is hard to regulate how many carcasses that will be assessed. It would be desirable that as many carcasses as possible would be assessed and registered in order to accelerate and simplify future development of meat quality. In order to gain knowledge about which animal categories that are more marbled the assessment, registration and documentation is crucial. Assessing carcasses provides an opportunity to identify which factors that are important for marbling. It is also important to give feedback on the carcasses to the producers. A solution to this problem could be to make the assessment and registration mandatory, but keep the extra payment from the abattoirs to the suppliers on a voluntary basis.

The majority of Swedish beef is vacuum packed, and only a small proportion of the beef is dry aged. How the beef is aged has influence on the quality. Dry aging is usually connected with high quality meat. Using dry aging and pelvic suspension could even out the differences in quality within and between animal categories (Lundesjö, 2008). This theory from Lundesjö (2008) is very interesting for Sweden because of the high diversity in meat quality as a consequence of using dairy and beef breeds and different categories of animals. If it is possible to even out the differences in quality without needing to change breed of animals, rearing system, feeding system it should be interesting for Swedish meat industry. Even though dry aging probably is more costly and more space and time consuming than vacuum aging it might be worth it if it could lead to an increased trust in, and higher payment for Swedish beef.

Breeding predictions in Sweden is based on BLUP. And it is crucial to have good recordings of as many individuals as possible to get a good prediction. New breeding techniques as genomic selection are used in dairy-breeding which offers the possibility to speed up the breeding process because of the shorter generation intervals and reach genetic progress at a faster rate (Blomdahl, 2015). As this techniques develops and gets cheaper it could be of interest to apply this techniques in Swedish beef production. The challenge probably lays in the tradition to use bulls in each herd during pasture season and therefor large effective population sizes in Sweden.

4.3 International outlook

Other countries such as Japan, Canada, Australia and USA have well-developed quality-grading standards (Beef Information Center, 2009; Japan Meat Grading Association, 2000; USDA, 2016; Meat and Livestock Australia, 2016).

USA has a long tradition of grading beef on marbling. The USDA beef grading system has been elaborated and developed since 1916 (USDA, 2016). The Canadian standard and the Swedish standard are both copyrighted from the U. S. marbling standard. But the Canadian system has been used for a longer period of time than the Swedish standard. The Canadian standard also have more steps on their scale than the Swedish standard. This probably has to do with the Swedish tradition of using dairy cattle in beef production. Dairy cows are, as described earlier in the text, less prone to gain marbling (Taurus, 2015). When developing

the Swedish marbling standard, it was agreed on that more than five steps were unnecessary since so few animals would qualify for a high grade than five (Stenberg, 2013).

Japan and Australia have chosen to take other factors such as meat colour and texture into consideration when grading meat quality. This might be possible for Sweden in the future depending on how the consumer interest for high quality beef develops. If the consumers are willing to pay more for a high quality meat, it will mean higher payment for the slaughter companies and farmers. Higher payment could in turn provide the opportunity to develop more tools for assessment of beef quality.

I believe that Sweden have a lot to learn from countries with well elaborated marbling and quality standards, both in the process of grading and assessing beef in an effective way and marketing and labelling beef in supermarkets.

As mentioned earlier in the text, geographic differences and socio-demographic background have influence on consumers' perceptions of beef quality. While Swedes and other Europeans prefer lean meat, Americans desire high fat content and Japanese even higher fat content (Hocquette et al, 2010). This is evident when reviewing the marbling standards for different countries. The Japanese scale has the highest demand on large amounts of intramuscular fat, which matches the demand of the Japanese consumers. Traditionally

4.4 Farmer interviews

The interviewed farmers had varying prior knowledge about marbling and of the national standard. There are uncertainties about which factors that have the most impact on marbling. It is known that breeding has a large impact; marbling is a trait with high heritability (Stenberg, 2013). In this study two farmers of breeding herds were interviewed. Both of them bred Hereford. It is my perception that farmers that ran the breeding herds had most knowledge of marbling. Both of them took marbling into consideration when choosing breeding bulls. Both of these farmers were positive towards the marbling standard and thought it was important to have a tool to assess beef quality. The farmers perceived to have the least knowledge of marbling, both of the standard and what the influences are, were those farmers who buy calves and rear them. This could probably be explained by the fact that these farmers don't have any type of breeding at their farms. Farmers that buy their calves were hesitant on which factors that have influence on marbling and how much they can affect the marbling of the animals when all their calves comes from different herds and have different genes.

Half of the interviewed farmers stated they had fixed prices and all of them pointed out that this system probably prevents progress in number of marbled animals. Hence, the farmers had the same concerns as the advisors regarding fixed prices. The farmers that had fixed prices were very content with this system and didn't think of marbling when rearing animals. If this system with fixed prices will continue KLS Ugglarps should offer marbling bonus beyond the fixed prices. If the farmers always has the same price, they are unlikely to strive for a progress in there production. As mentioned before economics is the most important factor of decisionmaking (Brudermann et al., 2013).

If KLS Ugglarps wants the farmers to deliver animals with more marbling they need to pay for it. Many farmers pointed out that they didn't think that the payment would be enough to make a change. But if KLS Ugglarps is to be able to pay more, the consumers need to be prepared to pay more for marbled beef. It will probably be of great importance how the

marbled beef is marketed. Many of the farmers pointed out the importance of marketing and getting well known TV- and restaurant chefs to propagate the benefits of marbled beef.

Two of the interviewed farmers were in the process of changing their production from just buying and rearing calves to establishing their own suckler cow herd. Since many of the farmers that buys and rears calves for slaughter don't feel like they can influence the marbling they are not interested in marbling bonuses, but when they change their production to a suckler cow herd it could be more relevant for the farmers to gain information and knowledge on marbling. It could be of importance for KLS Ugglarps to intercept these farmers in change and provide information on the marbling standard in order to spread the interest.

All of the interviewed farmers said that it would be helpful with feedback from the abattoirs, beyond the slaughter listings. The slaughter listings contains information on marbling grade, but the grade 2 could be a "good" 2 or a "bad" 2, the farmers would like to know how close the animals are to be classified as grade 3. Feedback would make it possible to let the farmers know if one batch of animals performed higher or lower than normal. This would make it possible for the farmer, together with their purchaser, to identify if he or she had done something different in that batch, maybe a change in diet or shorter or longer rearing time than normal. By providing feedback the farmer could get a greater insight in the influence of changes made in the production on the carcass.

One of the interviewed farmers had taken part of advisory services concerning marbling. He got advice from two different services, which gave totally different advice on how to improve marbling. Since he didn't know who to trust he decided to not trust any of the advisors and go his own way. The rest of the farmers didn't believe there was any advising to get concerning marbling, even though half of the farmers believed it would be helpful. One of the farmers even stated that advisory service and feedback from the slaughter companies would be the most important tool in order to get more marbled animals. Feedback from the slaughter houses was requested from a majority of the farmers. By providing feedback when a batch of animals stands out, either good or bad, it would be easier for the farmer to get a progress since it would be easier to identify possible changes in the production. Maybe it would be possible for the farmers to receive the feedback from their purchaser at the slaughterhouse.

One of the interviewed farmers had three different productions. At one farm he reared bull calves he bought from dairy farms, at another farm he had a breeding herd where he bred Angus cattle and at the third farm he bred and reared crossbreeds. This farmer also had some Wagyu cattle and some crossbreeds (Angus x Wagyu). He only delivered the bulls from the first farm to KLS Ugglarps, the rest of the animals are delivered to another slaughterhouse and a distributor. This farmer is one of the top breeders of Angus in the country. Angus is one of the breeds known to have high ability to gain marbling, and Wagyu is also known for their high ability to gain marbling. This farmer has a high interest in producing animals with high quality meat. He has all the right conditions for producing marbled animals. Since he has multiple sites where he conducts his production he has good conditions for having different production goals at different sites. The slaughterhouse he currently delivers animals to have no marbling assessment by the distributor pays more per kilo beef than KLS Ugglarps, up to 10 SEK more. He is curious to know if his animals would be classified as marbled but as long as the distributor he uses currently pays more than KLS Ugglarps, he will always turn to that distributor. It seems unfortunate that KLS Ugglarps is not able to

intercept this kind of farmer. Since he strives to always improve his meat quality, he can probably be expected to keep a consistent high standard and possibly keep getting better.

Brudermann *et al.* (2013) stated that decision making ultimately depended on economic factors. Socio-demographic factors were also important in decision making. This corresponds to the answers from the interviewed farmers, all respondents said that a higher payment would be required for them to make a change in their production in order to rear more marbled animals. Beef production and farming overall is dependent on many factors not controlled by the farmer. Among these factors are politics, payment, depending on demand and weather. These factors make it harder for farmers to know how one decision would impact on their production (Lindblom and Lundström, 2014). All of the interviewed farmers talked about how the current meat price is high but it is hard to anticipate for how long it will be. Maybe they will be more interested in marbling bonuses when the meat price is low. The farmers hesitate to make the decision to negotiate their fixed prices in order to receive marbling bonuses because it is hard to know if the production will profit in it.

The qualitative interview method was chosen because it can give a higher insight in the interviewed worldview (Kvale, 1997). For this project it was important to fully understand the farmers' knowledge and attitude towards marbling. The qualitative interview method should be a structured conversation with a purpose (Kvale, 1997). In this study the qualitative interviewing method was a good match. By having a conversation instead of letting the interview-object answer predetermined questions, a lot more information and thoughts from the farmers came up. The downside of working with this model is that the interviews differ from time to time. The predetermined base of the interview was adapted to the interview. All conversations are different which means that the interviews can take different directions depending on the knowledge and interests of the objects. This is important to remember when compiling the interviews.

4.5 Advisor interviews

One advisor has not experienced any interest for marbling among her costumers. She operates mostly in the south east of Sweden and most of her costumers deliver to abattoirs that do not provide extra payment for marbled meat. That could be an explanation to why she has not experienced any questions or interest from the farmers in that area. This theory matches with the fact that the advisor operating in the same location as KLS Ugglarps experienced questions concerning marbling. This advisor couldn't separate if the questions came from curiosity or because the farmers wanted to produce more marbled animals in order to take part of the extra payment. She stated that she feels comfortable answering general questions regarding marbling but that it would be desirable to have an advisory-concept based on science that could guarantee increased marbling. But at the moment, both scientific support and time is lacking to do this. There are some scientific studies available but not enough to prepare a good model according to the advisor. A problem with the scientific reports are that Sweden is relatively unique to rear dairy bull calves for slaughtering and there's not much research done on meat quality in this system.

Production advisor B also raised an issue of the anonymity of beef in the meat counters in supermarkets. She experienced that the pricing of the meat depended mostly on whether it was Swedish or not, rather than the quality of the meat. She also pointed out that the quality of Swedish meat can vary quite a lot. Even when purchasing the same product from same brand, there is no guarantee that the quality is the same from time to time. Marbling is a quality trait that could make it easier to distinguish higher quality meat from lower quality

meat. Maybe the consumers would be prepared to pay more if they could be certain that the quality of the meat wouldn't vary as much. To make this possible it is necessary to be able to differentiate beef of different quality. In order to do that more tools for assessing quality than marbling probably would be acquired. It would be interesting to find a way to effectively assess tenderness in beef at a low cost, since tenderness according to Miller *et al.* (2001) is the most important quality trait for consumers. Developing other instruments of assessing beef quality might not be acute right now since the marbling scale recently have been developed. Before moving to that next step of the development towards a better beef quality the marbling scale should be fully implemented.

Producing marbled meat is more costly and it is therefore priced higher in the supermarkets. It is crucial to communicate why the marbled meat has a higher price than other, leaner, meat. If that is not done properly, the marbled meat probably won't sell.

The two advisors had different opinions on whether the marbling payment was sufficient. Advisor A was determined that the payment was too low for any farmers to gain from delivering marbled animals, while advisor B thought that the payment was sufficient for farmers to benefit from it. She also pointed out that by keeping the payment at the current level, the abattoirs show that it is not desirable to deliver a fat animal in order to gain marbling. In Sweden it is often costly to deliver fat animals. If the animal is too fat, the carcass needs a lot of trimming. If the payment were so high that it would be profitable to have some fat deduction in advantage for marbling it would probably lead to a lot of fat carcasses, which would require a lot of trimmings. That would imply that slaughterhouses would pay for not only intramuscular fat, marbling, but also intermuscular fat that probably would be trimmed from the carcass. It is crucial to find a proper payment, which catches farmers' interest in marbling without meaning that KLS Ugglarps pays for too fat animals.

Both advisors interviewed criticized the system with fixed prices. If the farmers are offered a high fixed price they are unlikely to strive to produce more marbled meat, or change their production. The farmers have nothing to gain on changing the production. As long as their animals perform on a consistent level, the farmers will always get the same price, marbled or not. If KLS Ugglarps were to offer fixed price plus additional marbling bonus they might see a higher interest in marbling and possibly a faster progress in number of marbled animals.

The advisors agreed that both the advisory companies and the slaughter companies have responsibility for providing reliable and science based consulting. Both of them implied that more research is required to do this. In order for slaughter companies and advisory companies to together provide consulting it would be beneficial to have a dialog between the two. One of the advisors said that she and her colleagues had no communication with the slaughter companies while the other advisor said she had good communication with the adjacent slaughter houses. It was clear that the advisor that had communication with the slaughter companies had a greater insight in the slaughtering business and how the marbling bonus system worked. That shows how important it is with communication. Having a good communication between the advisory services and the slaughter companies should be in both parties interest. Both parties have to gain on a good collaboration.

4.6 Statistic analysis

When the processing of the dataset delivered from KLS Ugglarps started, some faults were discovered. Many of the animals registered in the dataset were missing registration on marbling class. All animals should be classified and if the animals are not marbled they

should be classified as class 1 (no marbling). KLS Ugglarps thought this fault was due to problems with the old registration program, which was replaced during September 2015, but some animals lacked data on marbling classes in the new program as well. The animals that lacked marbling class were taken out of the statistical analysis. There were also some animals missing registration in age. These animals were also taken out of the statistical analysis. Almost 40 % of the animals were taken out of the statistical analysis. There is no way to know how these animals would have been classified, but the representation of the animal categories are the same between the animals with classification and the animals without. This suggests that the distribution between marbling classes is similar between the two groups.

It also has to be noticed that the year of 2013 only contains data from August, and the year of 2016 only contains data until October. But the distribution of animal categories is approximately the same for all years. Because of the similar distribution it can assume that a part of the year is a good representation of the whole year.

Table 3 shows that the number of animals increased between 2014 and 2015. Unlike 2013 and 2016, the entire years of 2014 and 2015 is represented in the data. One explanation could be that KLS Ugglarps became major holder of Dalsjöfors kött in 2014. The animals slaughtered in the plants belonging to Dalsjöfors kött became a part of the statistics after the fuse.

Figure 5, 6 and 7 shows that no animals classified as class 5 on the marbling scale. This is explained by the fact that the national five-graded scale was introduced in January 2014. Before January 2014 KLS Ugglarps used their own marbling scale which only had four steps. These four steps were equivalent to the first four steps in the national scale. This means that the animals classified as class 5 on the national scale would have been classified as a class four on the scale used prior to January 2014. In this study, marbling is present with value. Class 3 is converted to 1,00 SEK, class 4 to 1,50 SEK and class 5 to 2,00 SEK. Prior January 2014 animals were not classified as class 5, which means that the mean value would decrease for animals classified prior January 2014. This suggests that the mean value of 2013 presented in table 5 would have been higher if it was possible for animals to be classified as class 5. With this in mind the values presented in table 5, 6, 7, and 8 and in Figure 5, 6 and 7 shows an increase of marbled animals. The increase is most evident between 2014 and 2015. This might be explained by the time it takes to rear cattle for slaughter. The marbling standard used by KLS Ugglarps was introduced in 2012, and it would take at least a year and a half to rear cattle to slaughter maturity. This means that if farmers started to rear animals with the purpose of getting more marbled animals when the standard were presented, the animals would be ready for slaughter around the year of 2014.

The distribution between animal categories has changed over the time of the dataset. The percentage of bulls has decreased in favour for steers during the later years of the dataset, as can be seen in Table 3. Steers generally have higher fat deposition than bulls (Heaton et al., 2006). The fact that the percentage of steers have increased in favour of bulls might be a part of the explanation to the increase of marbled animals during the same period of time.

As can be seen in *Figures 5-7*, the majority of animals are classified as class 2 on the marbling scale during the whole time included in the dataset. This might be of interest in further breeding. Since the majority of animals are classified as having incipient marbling

there might be possibilities that these animals have predisposition to develop more marbling and get classified as a class 3, 4 or 5, if breed and reared in optimal conditions.

In future research it would be interesting to investigate which parameters influence marbling the most and how these parameters could be influenced by the farmer. Possible parameters could be; breed, carcass and fat classification, age, sex and rearing-model. By investigating and determining which parameters is most favourable for marbling a model for marbled animals could be developed. Advisors can later use this model when farmers have questions concerning rearing and breeding animals with good conditions for marbling. It could also be of interest to investigate how the marbled animals are distributed over the year. One can imagine that the marbled meat would be more sought-after during summer, barbeque season.

The dataset received from KLS Ugglarps were very extensive and contained information on breed, age, sex, classification on carcass and fat, time of slaughter, place of origin and sex. This dataset can be used in further research since it contains a lot of information on a lot of animals. This dataset may be used to developed a “marbling-model”.

4.7 Final thoughts

In the future KLS Ugglarps have some questions to work with. Many of the interviewed farmers mentioned that fixed price and the opportunity to obtain marbling bonuses contradicts one another. If KLS Ugglarps reach to have more marbled animals delivered the fixed prices are standing in the way for farmers to aim for more marbled animals since they already have a high price for their meat and are uncertain they would gain from choosing a varying price but have the possibility to gain marbling bonuses. One way to go could be lowering the fixed prices and in addition to that provide the opportunity to earn marbling bonuses. Later on it might be possible to gradually eliminate the possibility to get fixed prices, if it gets more accepted that the money lost on fixed prices can be earned by delivering more marbled animals. It could also be a step in the right direction to stop negotiate fixed prices with new suppliers. It is my perception that the farmers how are offered fixed prices often are those that deliver animals of high and consistent quality.

One of the interviewed farmers had three different production systems, one breeding herd (Angus), one suckler cow herd (Angus) and a third herd where he bought live bulls from dairy farms. He only delivered the bulls from the third herd to KLS Ugglarps. This farmer had a lot of knowledge on beef production and breeding and is one of the top breeders of Angus in Sweden. He strives to always deliver high quality animals from his suckler cow herd. He chose deliver his high quality animals to another distributor because of the higher payment. This made me think about what KLS Ugglarps could do to reach this farmer and get him to deliver animals to them instead of the other distributor. I believe that this farmer would be a good asset for KLS Ugglarps because of his passion and knowledge on beef production. It is my observation that framers tend to listen to other farmers and but higher trust in senior farmers advice and experiences then they do to advisers. Instead of offering this farmer a higher payment for his animals, KLS Ugglarps could recruit him as an advisor for part time. By doing this KLS Ugglarps and other farmers that deliver to KLS Ugglarps can take part of his knowledge, experiences and inspiration.

5. Conclution

The aim of this study was to investigate if the amount of marbled animals has increased since the introduction of marbling bonuses at KLS Ugglarp. According to the statistics presented

in this project marbling seems to have increased over the investigated time period. The aim was also to understand farmers' views, knowledge and attitude towards marbled meat. The conclusion drawn from the interviews is that the knowledge and interest of marbled meat is varying, but the subject seems to engage all farmers when brought to their attention. Both farmers and advisors agreed on that marketing is the key factor in order to succeed with marbled meat. If the consumers are not interested in buying marbled meat, there is no point for farmers to produce it, or abattoirs to pay extra for it.

6. References

Aalhus, J. L., Jones, S. D. M., Tong, A. K. W., Jeremiah, L. E., Robertson, W. M. and Gibson, L. L. (1992). The combined effect of time on feed, electrical stimulation and aging on beef quality. *Canadian Journal of Animal Science*. vol. 72, ss. 525-535.

Albrecht, E., Teuscher, F., Ender, K. and Wegner, J. (2006). Growth- and breed-related changes of marbling characteristics in cattle. *Journal of Animal Science*. vol. 84(5), ss. 1067-1075.

Aus-meat. (2010). *Australian beef carcass evaluation – Beef and veal chiller assessment language*. Available: <https://www.ausmeat.com.au/WebDocuments/Beef & Veal Chiller Assessment Language.pdf> 2016-10-31

Beef information center. (2009). *The Canadian beef grading system*. Calgary: Beef information centre. Available: http://bic3dev.boldinternet.com/OrderCentre_files/public/151748-en.pdf (2016-10-31)

Bernard, C., Cassar-Malek, I., Le Cunff, M., Dubroeuq, H., Renand, G. and Hocquette, J-F. (2007). New indicators of beef sensory quality revealed by expression of specific genes. *Journal of Agricultural and Food Chemistry*. vol. 55, ss. 5229-5237.

Blomdahl, S. (2015). *Genomisk selektion inom köttraser*. Sveriges lantbruksuniversitet. Institutionen för husdjursgenetik/Agronomprogrammet-husdjur (Examensarbete / SLU, institutionen för husdjurgenetik, 460)

Brudermann, T., Reinsberger, K., Orthofer, A., Kislinger, M. and Posch, A. (2013). Photovoltaics in agriculture: A case study on decision making of farmers. *Energy Policy*. vol. 61, ss. 96-103.

Bures, D., Barton, L., Zahradkova, R., Teslik, V. and Krejcova, M. (2006). Chemical composition, sensory characteristics, and fatty acid profile of muscle from Aberdeen Angus, Charolais, Simmental and Hereford bulls. *Czech Journal of Animal Science*. vol. 51, ss. 279-284.

Camfield, P. K., Brown, Jr, A. H., Lewis, P. K., Rakes, L. Y. and Johnson, Z. B. (1997). Effects of frame size and time-on-feed on carcass characteristics, sensory attributes, and fatty acid profiles of steers. *Journal of Animal Science*. vol. 75, ss. 1837-1844.

Debertin, D. (2012). *Agricultural production economics*. 2. ed. University of Kentucky: Department of agricultural economics.

Duckett, S. K., Fernandez Rosso, C., Volpi Lagreca, G., Miller, M. C., Neel, J. P. S., Lewis, R. M., Swecker, W. S. and Fontenot, J. P. (2014). Effect of frame size and time-on-pasture on steer performance, longissimus muscle, fatty acid composition, and tenderness in a forage-finishing system. *Journal of Animal Science*. vol. 92, ss. 4767-4774.

Eriksson, J-Å., Eriksson, S., Näsholm, A. and Roth, A. (2007). *Genetic evaluation of beef cattle in Sweden*. Stockholm: Swedish dairy association.

Goddard, M. E. and Hayes, B. J. (2007). Genomic selection. *Journal of Animal Breeding and Genetics*. vol. 124, ss. 323-330.

Gray, D. I., Parker, W. J. and Kemp, E. (2009). Farm management research: A discussion of some of the important issues. *Journal of International Farm Management*. vol. 5 (1), ss. 1-24.

Gård- och djurhälsan. (2016). *Frågor och svar om BLUP*. Available: <http://www.gardochdjurhalsan.se/sv/not/kunskapsbank/avel/fragor-och-svar-om-blup/> (2016-11-08).

Heaton, K., Zobell, D. R. and Cornforth, D. (2006). A successful collaboration research project: Determining the effect of delayed castration on beef cattle production and carcass traits and consumer acceptability. *The Journal of Extension*. vol. 44.

Hocquette, J. F., Gondret, F., Baeza, E., Medale, F., Jurie, C. and Pethick, D. W. (2010). Intramuscular fat content in meat-producing animals: development, genetic and nutritional controls, and identification of putative markers. *Animal*. vol. 4:2, ss. 303-319.

Jamiesson, A., Hessle, A., Salevid, P. and Stenberg, H. (2010). *Nötkött*. Natur Kultur läromedel.

Japan meat grading association. (2000). *Beef carcass grading standard*. Tokyo: Japan meat grading association.

Jordbruksverket. (2012). *Årsrapport – klassificeringsverksamheten 2012*. Jönköping: Jordbruksverket.

KLS Ugglarps. (2016). *KLS Ugglarps AB*. Hörby: KLS Ugglarps.

Kvale, S. (1997). *Den kvalitativa forskningsintervjun*. 1. uppl. Lund: Studentlitteratur. (Dnr 19-10925/12).

Lindblom, J. and Lundström, C. (2014). *Lantbrukarens beslutsfattande och lantbruksrådgivning- en förstudie (DEMIPROF)*. Uppsala: Sveriges Lantbruks Universitet (ISBN: 978-91-576-9263-4).

Lundesjö, M. (2008). *Influence of Pelvic Suspension on Beef Meat Quality*. Diss. Uppsala: Swedish University of Agriculture.

Marshall, D. M. (1994). Breed differences and genetic parameters for body composition traits in beef cattle. *Journal of Animal Science*. vol. 72, ss. 2745-2755.

Meat and livestock Australia. (2016). *Grading Beef*. Available: <http://www.mla.com.au/marketing-beef-and-lamb/meat-standards-australia/msa-beef/grading/> (2016-10-28).

Meat and livestock Australia. (2015). *The effect of marbling on beef eating quality*. Available: http://www.mla.com.au/globalassets/mla-corporate/marketing-beef-and-lamb/documents/meat-standards-australia/tf7_marbling.pdf (2016-10-31).

Miller, M. F., Carr, M. A., Ramsey, C. B., Crockett, K. L. and Hoover, L. C. (2001). Consumer thresholds for establishing the value of beef tenderness. *Journal of Animal Science*. vol. 79, ss. 3062-3068.

Savell, J. W., Brandson, R. E., Cross, H. R., Stiffler, D. M., Wise, J. W., Griffin, D. B. and Smith, G. C. (1978). National consumer retail beef study: Palatability evaluations of beef loin steaks that differed in marbling. *Journal of Food Science*. vol. 3, ss. 517-519.

Stenberg, H. (2013). *Ett svenskt system för klassificering av nötkött*. Matlandet Sverige.

Svenskt kött. (2013). *Fakta om svenskt kött*. Solna: Branchorganisationen Svenskt kött. Available: https://static-svensktkott.s3.amazonaws.com/uploads/attachments/SVK_RAPPORT_2013.pdf (2016-09-29).

Svenskt kött. (2016). *Nöt*. Available: <http://www.svensktkott.se/om-kott/styckdetaljer/not/> (2016-11-15).

Svenskt kött. (2016). *Om kött*. Available: <http://www.svensktkott.se/om-kott/> (2016-09-28).

Taurus. (2014-04-15). *Om den svenska nötköttsproduktionen*. <http://www.taurus.mu/sitebase/default.aspx?idnr=TXadbeAlKrvH59zFCFIMPSWZcahou5NBIPVcdjq17EKYfs9GTa6PkFtbFF26>
2015-04-21

Trost, J. (1997). *Kvalitativa intervjuer*. 2. uppl. Lund: Studentlitteratur.

USDA. (2016). *United States Standards for Grades of Carcass Beef*. United States Department of Agriculture. Washington DC: Agricultural marketing service. Available: <https://www.ams.usda.gov/grades-standards/carcass-beef-grades-and-standards> (2016-09-26).

Van Koeving, M. T., Gill, D. R., Owens, F. N., Dolezal, H. G. and Strasia, C. A. (1995). Time on feed on performance of feedlot steers, carcass characteristics, and tenderness and composition of longissimus muscle. *Journal of Animal Science*. vol. 73, ss. 21-28.

Venkata Reddy, B., Sivakumar, A., Jeong, D. W., Woo, Y. B., Park, S. J., Lee, S. Y., Byun, J. Y., Kim, C. H., Cho, S. H. and Hwang, I. (2015). Beef quality traits of heifer in comparison

with steer, bull and cow at various feeding environments. *Journal of Animal Science*. vol. 86, ss. 1-16.

Vestergaard, M., Therkildsen, M., Henckel, P., Jensen, L. R., Andersen, H. R. and Sejrsen, K. (2000). Influence of feeding intensity, grazing and finishing feeding on meat and eating quality of young bulls and the relationship between muscle fibre characteristics, fibre fragmentation and meat tenderness. *Meat Science*. vol. 54, ss. 178-195. OBS!! KOLLA UPP DENNA

Williams, S. E., Tatum, J. D. and Stanton, T. L. (1989). The effect of muscle thickness and time on feed on hot fat trim yield, carcass characteristics and boneless subprimal yields. *Journal of Animal Science*. vol. 67, ss. 2669-2676.

Wood, J. D., Enser, M., Fisher, A. V., Sheard, P. R., Richardson, R. I., Hughes, S. I. and Whittington, F. M. (2008). Fat deposition, fatty acid composition and meat quality: A review. *Meat Science*. vol. 78, ss. 343- 358.

Öhlmer, B., Olson, K. and Brehmer, B. (1998). Understanding farmers' decision making processes and improving managerial assistance. *Agricultural economics*. vol. 18, ss. 273-290.

Öhlmer, B. (2000). Beslutsprocesser i lantbruksföretaget. *Jordbruks konferensen, 2000. Uppsala 6-7 november*. ss. 190-191. (in Swedish).

Vid **Institutionen för husdjurens miljö och hälsa** finns tre publikationsserier:

- * **Avhandlingar:** Här publiceras masters- och licentiatavhandlingar
- * **Rapporter:** Här publiceras olika typer av vetenskapliga rapporter från institutionen.
- * **Studentarbeten:** Här publiceras olika typer av studentarbeten, bl.a. examensarbeten, vanligtvis omfattande 7,5-30 hp. Studentarbeten ingår som en

obligatorisk del i olika program och syftar till att under handledning ge den studerande träning i att självständigt och på ett vetenskapligt sätt lösa en uppgift. Arbetenas innehåll, resultat och slutsatser bör således bedömas mot denna bakgrund.

Vill du veta mer om institutionens publikationer kan du hitta det här:
www.slu.se/husdjurmiljohalsa

DISTRIBUTION:

Sveriges lantbruksuniversitet
Sciences

Fakulteten för veterinärmedicin och
Animal

husdjursvetenskap

Institutionen för husdjurens miljö och hälsa
and Health

Box 234

532 23 Skara

Tel 0511–67000

E-post: hmh@slu.se

Hemsida:

www.slu.se/husdjurmiljohalsa

Swedish University of Agricultural

Faculty of Veterinary Medicine and

Science

Department of Animal Environment

P.O.B. 234

SE-532 23 Skara, Sweden

Phone: +46 (0)511 67000

E-mail: hmh@slu.se

Homepage:

www.slu.se/animalenvironmenthealth

th
