The effects of welfare-related management practices on carcass characteristics for beef cattle

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ABSTRACT

The improvement of farm animal welfare through management practices has become important despite the fact that there is a conflict between animal welfare and production efficiency. It may be possible to find associations between production and management practices related to animal welfare, such as management strategies to enhance both production and animal welfare. The objective of the present study was to investigate the effect of different fattening management practices with respect to animal welfare on the carcass characteristics in Japanese beef cattle fattening systems at the farm level. The face-to-face interview survey on welfare-related management practices was conducted with 30 beef fattening farmers who sold more than 5 animals from July 2014 to March 2015 in the carcass market in Shiga Prefecture. The best linear unbiased predictors of each farm (the so-called farm BLUP) for carcass traits (carcass weight, CWT; marbling score, BMS; *longissimus* muscle area, LMA; rib thickness, RT; and subcutaneous fat thickness, SFT) and carcass unit price (CUP) were estimated from the data collected at the carcass market. The effect of management practices on farm BLUPs for carcass traits and CUP were tested using one-way ANOVA. For management practices, there were significant effects of routine claw trimming on farm BLUP for SFT ($P < 0.05$), dehorning for CUP ($P < 0.05$), and nose ring for BMS ($P < 0.05$) and CUP ($P < 0.01$). In Japan, some farmers who purchased stock calves at the calf markets maintain them in isolated pens before grouping them at the start of fattening, and this management had a significant effect on farm BLUPs for RT ($P < 0.05$), CWT, and LMA ($P < 0.01$). Likewise, the equipment of additional identification tags had a significant effect on farm BLUP for CWT ($P < 0.05$). For housing management, the floor type significantly affected the farm BLUP for LMA ($P < 0.05$). These results suggest that the consideration of animal welfare at the farm level in beef fattening systems might improve the quantity and quality of the beef produced.

1. Introduction

In recent, there has been an increase in societal interest in the management and care of farm animals, and therefore the improvement of farm animal welfare through management practices is important. In this context, proposals for measuring animal welfare at the farm level have been established (e.g. Welfare Quality, 2009), and animal welfare certification systems have been developing in European countries (Main et al., 2014; Mench, 2008; Veissier et al., 2008).

The association between animal welfare and production is also of increasing interest to researchers as well as industry and the public, and its relationship determines the extent to which welfare improvement will be incentive on farm (FAWC, 2011). McInerney (2004) mentioned that there is a non-linear relationship between animal welfare and productivity; up to a point, increases in productivity

arising from better nutrition, health and housing should also enhance animal welfare, whereas greater production efficiency and profitability can lessen animal welfare. In this context, farmers have to consider not only animal welfare but also how to produce efficiently in their decision making because more production costs would be required by considering animal welfare in many cases (Sørensen et al., 2001). Nevertheless, if it is possible to find positive associations between production and management practices related with animal welfare, these management practices could be intriguing and thereby enhance both animal production and animal welfare. In fact, some findings represent associations between animal welfare related management practices and beef productivity (quantity and quality of beef). For example, Keane (1979) found that animals maintained on slatted floors have lower carcass gains than those on solid floors bedded with sawdust. Misumi et al. (2001) reported the positive effect of routine trimming

hooves on dressing percentage (ratio of carcass weight to slaughter weight) for fattening Japanese Black steers. Herva et al. (2011) reported a negative relationship between on-farm welfare and the incidence of higher fat scores in Finland. These studies suggested that management practices concerning animal welfare might influence the level of production at the farm level.

The objective of the present study was to investigate the effect of different fattening management practices with respect to animal welfare on the carcass characteristics in Japanese beef cattle fattening systems at farm level. For this purpose, the best linear unbiased predictor (BLUP) of each farm (the so-called farm BLUP) was estimated using carcass data to evaluate each farmer's ability of producing high quality beef. To our knowledge, the present study is the first to evaluate farmer's skill using the BLUP procedure developed in animal breeding systems and combine this information with the results of an interview survey for farmers to investigate the relationship between the productivity of each farmer and the management practices.

2. Material and methods

2.1. Overview of Japanese Black cattle production systems in Japan

In Japan, beef production systems for Japanese Black (Wagyu) cattle are generally divided into two operations, a cow-calf farm and fattening (feedlot) farm (Komatsu and Malau-Aduli, 2014). Reproductive cows are raised in cow-calf farms and their male and non-replacement female calves are sold at 8–10 months of age at calf markets and purchased by feedlot farmers there. In fattening farms, animals were fattened till age of 30 months with average slaughter weights of 725 kg (Komatsu and Malau-Aduli, 2014). The longer fattening period reflects the production of highly marbled beef (Hirooka et al., 1996). In the fattening farms, animals are given free access to concentrates and small amount of roughage (mainly hay and rice straw) throughout the whole feedlot period. Concentrates consist of barley, corn, wheat bran, soybean meal and so on. In general, beef cattle are housed in free barns, and the recommended space allowance is more than 5 m^2/head in Japan (Okano and Kitagawa, 2015). Now, Japanese Black cattle has become more internationally known and fed in other countries such as the United States and Australia (Gotoh et al., 2014).

2.2. Interview survey

Face-to-face interviews with farmers were conducted using a questionnaire to collect data on management practices of beef fattening farms in Shiga Prefecture, Japan. All farms raised beef steers and heifers (Japanese Black) and some of the farms also fed dairy (Holstein) and crossbred (Japanese Black×Holstein: F_1) steers for beef production. The questionnaire survey was conducted during October 2015. The questionnaire consisted of the items related to the (1) management practices and (2) housing management, which may affect the level of animal welfare on the farms. The management practices included the equipment of additional ear tags for identification within the farm along with the mandatory tag bearing individual identification numbers notified by the government (identification tag on each ear), routine hoof trimming, routine health check, dehorning, nose ring and individual feeding of calves before introducing them into the herd. The items related to the housing management included floor type, frequency of floor cleaning and cooling methods. Lists of the questionnaire to farm households in the present study are shown in Table 1. Among the farms surveyed in the questionnaire, 30 farms having more than 10 carcass records were chosen for analysis, which were approximately 30% of the number of all fattening farms in the region.

Table 1
Results of the questionnaire survey.

Variable	No.	Frequency, %
Farm's attributes		
Type of farm		
Fattening (steers and heifers)	15	50.0
Plus other types[a]	15	50.0
Breed		
Only Wagyu (Japanese Black)	20	66.7
Plus other breeds[b]	10	33.3
Management practices to fattening animals		
Routine hoof trimming		
Yes	25	83.3
No	5	16.7
Routine health check		
Yes	25	83.3
No	5	16.7
Dehorning		
Yes	23	76.7
No	7	23.3
Nose ring		
Yes	19	63.3
No	11	36.7
Separating stock cattle before introducing them into the herd		
Yes	20	66.7
No	10	33.3
Equipment of additional identification tags[c]		
Yes	20	66.7
No	10	33.3
Housing management		
Floor Type		
Rice husk	5	16.7
Sawdust	25	83.3
Frequency of cleaning a floor (times)		
> 1/half a month	3	10.0
> 1/one month	23	76.7
> 1/two months	4	13.3
Cooling methods[d]		
Only fan system	24	80.0
Plus others[e]	5	16.7

[a] Includes cow-calf, crossbred (dairy-beef) production systems and a local governmental experiment farm.
[b] Some farmers also feed dairy cattle or the crossbreds.
[c] In Japan, all cattle owners have the obligation to attach an ear tag to every bovine animal for the purpose of preventing the spread of Bovine Spongiform Encephalopathy and ensuring the safety of beef under the Beef Traceability Law.
[d] One farm was excluded from the present analysis because they did not use a fan system.
[e] Farmers having another way of cooling cows in addition to fan system.

2.3. Carcass data

The carcass data for the 30 farms used in the interview survey were collected from July 2014 to March 2015 for carcass evaluation in the different projects. The carcass characteristics considered in the present study were carcass weight (CWT), marbling score (BMS), *longissimus* muscle area (LMA), rib-thickness (RT), subcutaneous fat thickness (SFT) and carcass unit price (CUP). Measurements of BMS, LMA, RT and SFT were collected at the sixth-seventh rib section (Hirooka et al., 1996; Maeno et al., 2014). The BMS was scored using a 12-point scale used in the Japanese carcass market: from 12 (the highest marbling) to 1 (the lowest marbling). In Japan, the carcass value is primarily determined by the marbling score (Hirooka and Sasaki, 1998; Ibi et al., 2006). The LMA was measured by grid approximation, and the RT was measured as the distance between the *latissimus* muscle and the pleura membrane measured at the mid-point of the rib ends. The SFT was the distance between the *latissimus* muscle and the carcass surface measured on the orthogonal line parallel with the carcass surface from the edge of the *iliocostalis* muscle. The CUP was decided by buyers at auction for each carcass and reflects the quality of the