Does crossbreeding have a place in modern UK dairy systems?

A study of the performance of Montbeliarde cross Holsteins on British farms.

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Abstract

Lactational production indicators, namely 305 day milk yield, milk composition (% butterfat, % protein), fertility (number of services per conception) were compared between Montbeliarde cross Holstein (MX) cattle and pure Holstein (H) cattle. The data was collected from 12 farms across the west of England which had both H and MX cattle on the same farm. The farms were categorised into systems, so that the traits could be evaluated and breeds compared in each system. Farmers' perceptions of various traits for MX and H were also collected and correlated with the corresponding data.

It was found that MX had a higher butterfat and protein percentage and required fewer serves per pregnancy on TMR and partial TMR systems; however, this was accompanied by lower 305d milk yields (kg), total protein (kg) and total butterfat (kg) yields. On the grazing system, MX required fewer serves per pregnancy achieved, and had higher 305d milk yields, yielding larger amounts of protein and butterfat (kg) during a lactation.

Overall Montbeliarde X cattle performed best on a grazing system ($p<0.05$) whilst Holstein cattle performed best on a TMR system.

Introduction

Background

The Holstein dairy breed is championed for producing vast quantities of milk, and as such, has dominated the UK dairy industry since the Second World War. Over the years farmers have genetically selected for and successfully increased the yields produced by the Holstein breed. Since then however, a direct relationship between increased milk yield and the deterioration of fertility, cow health, mobility and longevity has been recognised, alongside a significantly reduced genetic pool in the Holstein breed (Pryce & Veerkamp, 2001; Berry, et al., 2003). This dependence on one breed makes dairy farming unusual when compared to other food producing sectors. Beef cattle, pigs, sheep and poultry all exploit crossbreeding and heterosis to create high producing, durable and commercially superior animals. So it seems a logical progression that the dairy industry would also start to utilise other breeds in their herd genetics.

In response to the decline in functional traits, as well as more recent industry pressures, there has been an increasing trend towards crossbreeding within modern UK dairy herds.

Current research demonstrates that crossbreeding the Holstein with other dairy breeds can improve fertility, survivability, lameness and milk constituents (Ezra, et al., 2016; Dezetter, et al., 2015; Ferris, et al., 2014). Cow and udder health have also been demonstrated to be improved by crossbreeding (De Haas, et al., 2013; L G D Mendonça, 2014) as well as an increased feed efficiency (Schwager-Suter, et al., 2001) - although this is open to debate (Aharoni, et al., 2006). Conversely, crossbreeding has shown a reduction in 305 day milk yield (Yaylak, et al., 2015; De Haas, et al., 2013). With all of this considered, a number of reports demonstrate that crossbreeding may lead to an overall more profitable business (Heins, et al., 2012a; Buckley, et al., 2014; Ferris, et al., 2014) with the possible added benefit of reducing the environmental footprint (Baumont, et al., 2014; Taube, et al., 2014).

Montbeliarde cross Holstein dairy cattle

In the UK, a number of farmers have started crossbreeding with the Montbeliarde - a French dairy breed. This breed combination creates an animal with similar stature to the Holstein but with an increased body condition score (Hazel, et al., 2013; Hazel, et al., 2014). Montbeliarde cross Holsteins are reported to have better fertility and fewer days open than pure Holsteins (Hazel, et al., 2013; Hazel, et al., 2014; Heins & Hansen, 2012; Heins, et al., 2006). Studies have also shown them to have higher survival rates and reduced cull rates (Hazel, et al., 2014; Heins & Hansen, 2012; Heins, et al., 2012a).

Whilst there are several benefits to this crossbred animal, studies suggest, these are traded off for a lower milk yield. Heins & Hansen (2012) reported Montbeliarde cross Holsteins produced on mean average 673 Kg less milk than Holsteins per 305d lactation. Whilst Malchiodi, et al. (2014) demonstrated an average 0.73kg per day decrease in milk yield when a Holstein is crossed with a Montbeliarde compared to a pure Holstein. In contrast, Heins, et al. (2012a) compared lifetime yields and showed that Montbeliarde cross Holsteins gave on average 4805kg more than the pure Holstein.

Montbeliarde cross Holsteins have higher fat and protein percentage composition of milk when compared to Holsteins according to two separate studies (Malchiodi, et al., 2014; Heins, et al., 2006a). However, one of the studies showed that the higher percentage of butterfat and protein observed with Montbeliarde cross' cattle is accompanied by a lower butterfat-plus-protein production in kilograms due to the overall reduced yield (Heins, et al., 2006a). Conversely, a separate study stated that "the 'Montbeliarde cross Holstein' cows were not different from pure 'Holstein' cows for fat-plus-protein production during any lactation" (Hazel, et al., 2014).

Contrasting studies have also described a difference in somatic cell counts (SCC) for the two breeds. One study by Malchiodi, et al. (2014) shows Montbeliarde cross Holsteins to have fractionally higher SCC's than pure Holsteins, with somatic cell scores (SCS) of 2.90 compared to 2.88. Whereas, another study shows a significantly lower SCS in Montbeliarde cross Holsteins in all 5 lactations included in the study, with the most significant difference in the 5th lactation animals which had 0.61 SCS lower for the crossbred animals compared to the pure Holsteins (Heins & Hansen, 2012). Walsh, et al. (2007) showed no significant difference for SCC, however, found that Montbeliarde crosses had a significantly higher average milk flow rate than Holsteins.

With all the factors combined, the overall profitability of Montbeliarde cross Holsteins was shown to be significantly greater than that of the Holstein in a study comparing 1491 animals across three herds in California. The results showed an increased profit of $0.22 cow/day and $2156 cow/lifetime for Montbeliarde cross Holsteins compared to pure Holsteins (Heins, et al., 2012a). An earlier study by R. W. Touchberry (1992) showed similar results with Holstein cross Guernseys, where the crossbred cattle produced 11.4% greater income per lactation than the purebred Holsteins. Whilst it is generally accepted that crossbreeding could be more profitable in forage based systems , Lesmeister, et al. (2000) has shown that it is possible crossbreeding could be more profitable in commercial conditions.

The study

Research investigating crossbreeding the Holstein with the Montbeliarde is fairly limited with little reported from the UK.

The aims of this study were to establish whether current research regarding Montbeliarde cross Holsteins, in other areas of the globe, translates to what can be found in the UK dairy herd with a different climate and management to their over-seas counterparts. A secondary objective was to investigate, how the Montbeliarde cross compares to the purebred Holstein within the various different dairy systems found in Britain and how the farmers managing those systems perceived the two breeds.

The performance of Montbeliarde cross Holstein and purebred Holsteins were compared for 305 day milk yield, services to positive pregnancy diagnosis and the butterfat and protein composition in 1458 cows, on 12 farms, categorised into three management systems based on the method of feeding cattle; TMR, Partial TMR and grazing. This data was then correlated with the perceptions of farmers’ managing those systems.

Materials and methods

Farm selection and data collection

Data was collected from farms which had both Montbeliarde cross Holsteins (MX) and pure Holsteins (H) milking on the same farm within the same herd. The requirements dictated that the feeding regime, parlour, housing and management were the same for the two breeds and that regular milk recording was carried out on the farm. Only first and second cross MX were recruited in the study (i.e. HxM and HxMxM).

Data was collected for 305 day milk yield, butterfat and protein percentage (average over 305days) and number of services for individual animals. If the cow had not done 305 days of lactation, the projected 305 day yield, Butterfat and protein was used.

Farmers' were then requested to complete a questionnaire about the management programme on the farm from birth to milking, including questions about the feeding at all stages of the animals life, parlour routine and housing arrangement. As part of the questionnaire the farmers' had to score MX and H, for eight different traits, on a 1-5 scale. A score of one would indicate the least favourable, and five, the most favourable.

Farms were then categorised into one of three categories as follows;

- 'TMR' – Cattle must be housed year-round, and fed a mixed ration of forages and grains/concentrates (+/- vitamins/minerals/additives) without additional concentrates fed in the parlour.

- Partial TMR – Farms may graze their cattle at certain times of the year and feed a mixed ration of forages and grains/concentrates (+/- vitamins/minerals/additives). In parlour feed was accepted in this category.

- Grazing – Farms that either grazed all year round, or housed in the winter on forage based diet. Feeding concentrates in the parlour was accepted for this category.

Twelve farms and 1458 animals were considered suitable for recruitment to the study. After the farms were categorised into systems, there were 153 H and 23 MX in the TMR system, 616 H and 420 MX in the partial TMR system and 149 H and 97 MX in the grazing system.

Data Analysis

The data was analysed using STATA version 14.1 (StataCorp, College Station, Texas) and multiple regression models were used to evaluate performance whilst adjusting for the influence of parity and farm effect on the results. Outcome variables were 305 day milk yield, number of serves to gain a positive pregnancy diagnosis and butterfat and protein percentages. The primary explanatory variables of interest were the breed (MX or H) and the system (TMR, Partial TMR or Grazing) they were in.

Breed was coded as a binary term (binbreed): 0 (denoting H) and 1 (denoting MX).

The three categories of dairy management system were represented by 1 ('TMR'), 2 ('partial TMR') and 3 ('grazing').

Finally, parity was expressed as 1 (1st lactation), 2 (2nd lactation), 3 (3rd lactation) and 4 (4th lactation and beyond).

Interaction terms were included in the model if they were biologically plausible and improved model fit.

Findings were deemed statistically significant when associated with a P-value of less than 0.05.

Results and discussion

Milk Yield

305d average milk yield

305d milk yield was evaluated with particular interest paid to comparing the milk yield (kg) for the two breeds in each of the three systems.

The results showed that compared to H, across the whole study, MX gave a statistically significant lower 305d yield producing 950 (95% CI 1625 – 274) litres less than Holstein cows (P 0.006), which was consistent with findings by Heins, et al. (2006a). It was also shown that MX performed the best on a grazing system with a statistically significant result (fig.1.).

MILK YIELD	Coef.	95% Conf. Interval	P>|z|
1.binbreed (MX)	-950.00	-1625.84 -274.16	0.006
System			
Partial TMR (2)	643.58	-984.56 2271.00	0.438
Grazing (3)	-1376.11	-3229.15 476.92	0.146
Binbreed/system interaction			
MX/partial TMR (1 2)	327.34	-379.71 1034.38	0.364
MX/Grazing (1 3)	1216.69	432.24 2001.14	0.002
Binparity			
2nd lactation (2)	816.76	582.25 1051.28	0.000
3rd lactation (3)	1725.30	1466.46 1984.15	0.000
4th lactation and above (4)	1805.43	1544.80 2066.05	0.000

Fig.1. Regression table for 305d milk yield (the variables are described in the 'data analysis' section of this report).

There was a significant interaction between breed and management system which was highly significant (P = 0.002) for Mx Grazing. When the two breeds were compared in the three different systems (fig.2.), H gave a higher 305d milk yield than MX in the TMR and partial TMR systems with differences of 950kg and 623kg respectively. However, MX gave a higher 305d milk yield than H in the grazing system with a mean difference of 267kg. This is demonstrated clearly in fig.3, showing a complete reversal in terms between the partial TMR and grazing systems.

	Predicted yield	**95% Conf. Interval**	
H on TMR (0 1)	8385.76	6951.39	9820.12
MX on TMR (1 1)	7435.76	5892.38	8979.14
H on Partial TMR (0 2)	9029.34	8262.33	9796.34
MX on partial TMR (1 2)	8406.67	7634.52	9178.82
H on Grazing (0 3)	7009.64	5839.33	8179.95
MX on Grazing (1 3)	7276.33	6083.10	8469.56

Fig.2. Predicted average yield (95% CI) by breed and management system

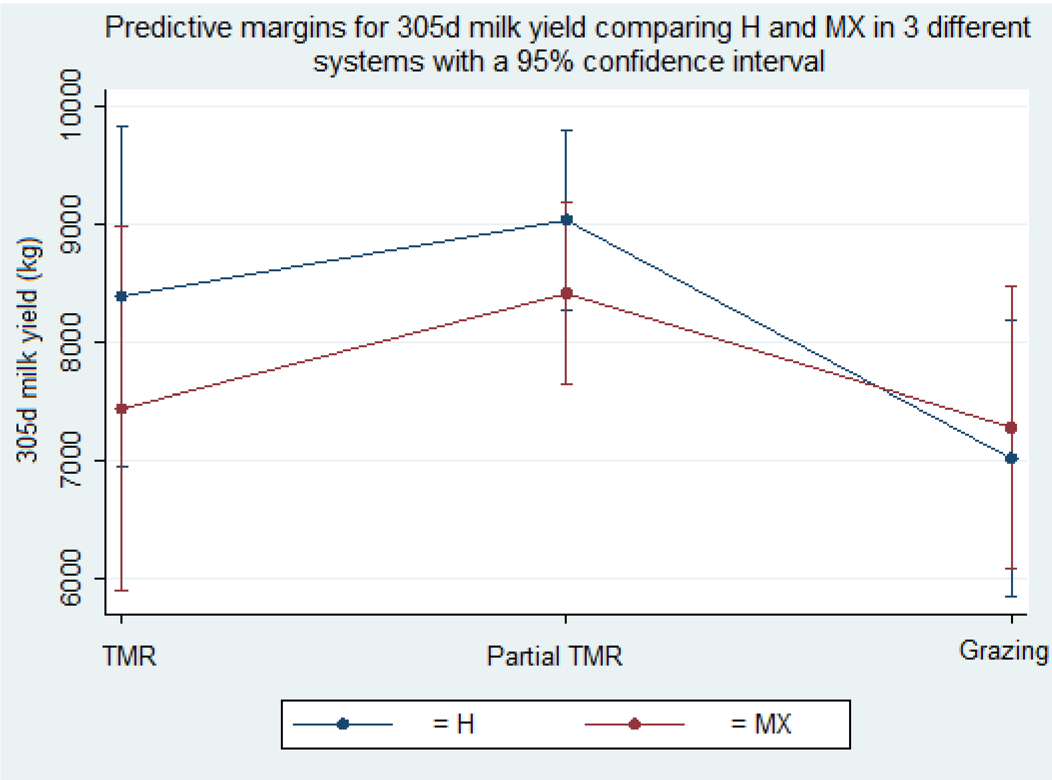

Fig.3. Predicted 305d milk yield (95% CI) comparing the effects of breed and system.

The results for partial TMR in this study were comparable to a large study looking at 7 commercial farms in California where MX cattle gave 596kg less than H per 305d lactation (Heins, et al., 2006a) and another with 6 commercial herds in California where MX gave 673kg less (Heins & Hansen, 2012). It is difficult to assess what sort of system is used in the californian study as other than stating that they are commercial farms, the feeding regime or management is little spoken of, however, the Holsteins on these farms were averaging nearly 10,000kg so it could be assumed that the input level is higher than that of a grazing system (i.e. partial TMR or TMR).

Another couple of studies in northern Italy compared H and MX in TMR systems. One carried out by Malchiodi, et al. (2011) looked at a single farm with 430 H and 18 MX and concluded that MX gave on average 49kg less per 305d laction than H. A second study by Malchiodi, et al. (2014) looked at 3 farms in northern Italy and found MX gave 223 litres less than H. Both of these studies gave a result that differed greatly from the 950kg per lactation drop in yield displayed in this report, for which there could be several reasons. The climate and mangement is likely to be much different in Italy than it is in the UK, and whilst the 2014 study included the highest number of farms, the dataset was still relatively small in all three studies.

A 5 year study monitoring a herd of 309 cows on a grazing system in Ireland found MX gave 136kg less than H over a 305d lactation (Walsh, et al., 2008). A difference of 403kg when compared to the results for grazing systems in this report where MX gave 267kg more than H in a 305d lactation. Climate and management should not be vastly different between the two groups, therefore the reason for this disparity in yield is more likely due to the difference in scale of the two studies. The study by Walsh, et al. (2008) was based on one farm so the farm effect would be difficult to account for. The proportion of H and MX also added up to fewer animals than the sample size used for grazing animals in this study therefore may be less reliable. On the otherhand Walsh, et al. (2008) monitored the herd for 5 years, whereas this study was just over the one lactation.

Across all studies it should be noted that the variability in the Montbeliarde breed is much greater than that of the Holstein and that the MX is just as variable, if not more so, which should be considered when comparing the results of different studies. The difference in lactation curve is also a consideration where predicted milk yields are used, as this will generally be predicted from a Holstein curve, which could lead to inaccuracy in MX results. On the other hand, Heins, et al. (2006a) calculated lactation curves for MX and H and stated that "breed groups were similar for persistency of production through lactation".

Yield and lactation number

The 305d average milk yield was compared for the two breeds in all lactations and the results plotted graphically (fig.4.).

For both H and MX the 1st lactation heifers produced a lower yield than the cows in subsequent lactations. There was an increase in yield in the second lactation and then a further increase in yield in the third lactation. The fourth lactation represented animals in their fourth lactation and beyond. There was a decrease seen between third and fourth lactations for H, whereas MX increased in yield from third to fourth lactation.

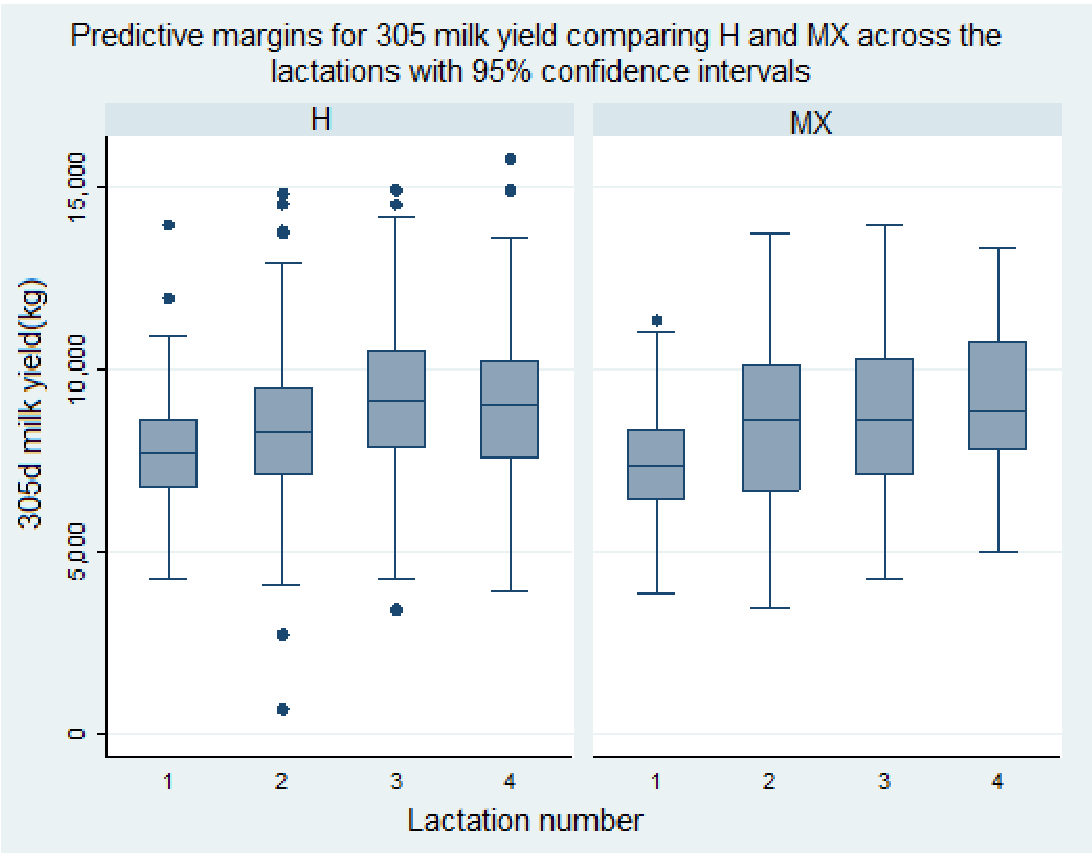

Fig.4. Graph to how the average milk yield of MX and H compares in each lactation

This continued increase shown by 4th lactation MX could be an indication towards longevity. However, whilst longevity is a trait supported by existing research (Weigel & Barlass, 2003), not too many conclusions should be taken from this as the number of animals in or above 4th lactation is quite small in comparison to the other 3 lactations and reasons for culling were not monitored in this study.

Butterfat

Percentage butterfat

The data for percentage butterfat over a 305d lactation was compared for each breed and system using the same regression model as for yield. The data was displayed in the output table fig.5. There were no statistically significant results in this data (P>0.05). However, it was apparent that MX gave a higher butterfat percentage than H across the whole study and a general trend was seen as the input level decreased (towards grazing) the butterfat percentage increased. This coincides with what would be expected and is backed up by studies by Heins, et al. (2006a) which had a large trial group and showed an average of 3.55% butterfat for H compared to 3.64% for MX. Another study by Malchiodi, et al. (2014) also correlated with these results with H giving 3.96% butterfat and MX giving 4.24% butterfat.

BUTTERFAT	Coef.	95% Conf. Interval	P>|z|
1.binbreed (MX)	0.177	-0.064 0.419	0.150
System			
Partial TMR (2)	0.406	-0.094 0.906	0.111
Grazing (3)	0.535	-0.024 1.095	0.061
Binbreed/system interaction			
MX/partial TMR (1 2)	-0.090	-0.343 0.164	0.488
MX/Grazing (1 3)	-0.144	-0.422 0.133	0.308
Binparity			
2nd lactation (2)	-0.035	-0.124 0.053	0.431
3rd lactation (3)	-0.025	-0.121 0.072	0.615
4th lactation and above (4)	-0.038	-0.131 0.055	0.424

Fig.5. Regression table for average butterfat percentage over a 305d lactation

When the butterfat percentages were predicted for each breed in each system (fig.6.), it was noted that MX gave a greater percentage butterfat than H in all three systems. The biggest difference between the two breeds was seen in the TMR system with a difference of

0.18%. The smallest difference between the butterfat of the two breeds was observed in the grazing system with a difference of 0.03% (fig.7.).

	Predicted butterfat percentage	95% Conf. Interval	
H on TMR (0 1)	3.65	3.219	4.084
MX on TMR (1 1)	3.83	3.348	4.310
H on Partial TMR (0 2)	4.06	3.808	4.308
MX on partial TMR (1 2)	4.15	3.890	4.400
H on Grazing (0 3)	4.19	3.834	4.541
MX on Grazing (1 3)	4.22	3.858	4.582

Fig.6. Predicted average butterfat percentage (95% CI) by breed and management system

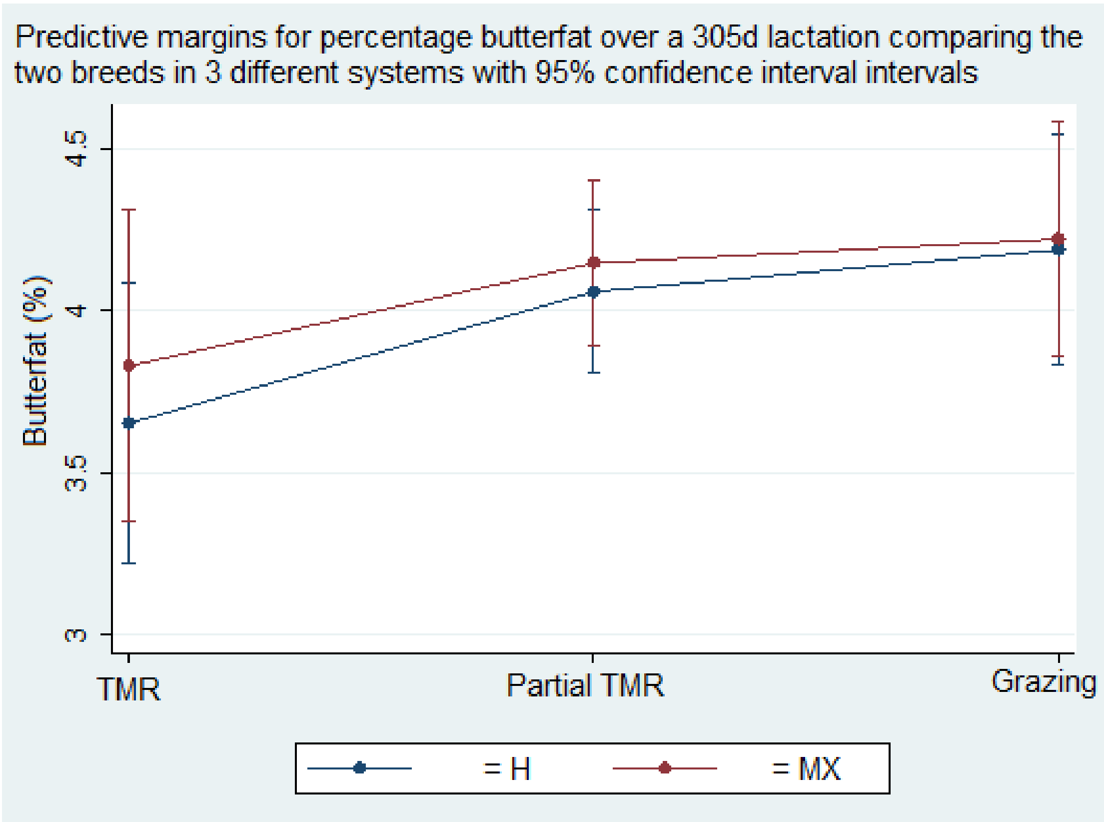

Fig.7. Predicted percentage butterfat (95% CI) comparing the effects of breed and system

These findings are consistent with the results found by Heins, et al. (2006a) who found H gave a butterfat percentage of 3.55 where MX gave a higher butterfat percentage of 3.64. Malchiodi, et al. (2014) also found H to have a lower butterfat percentage than MX with 3.95% compared to 4.24%.

Unfortunately existing data comparing the two breeds in different systems is minimal but Walsh, et al. (2008) looked at the breeds on grazing systems and found that H gave 3.83% butterfat whilst MX gave a lower 3.78% butterfat. The two figures for butterfat percentage were not statistically different in this study and were comparable to the very simular butterfat percentages (0.03% difference) found by the two breeds on a grazing system in the dataset published here.

Total butterfat (kg):

305d total butterfat (kg) of the two breeds was then calculated for all three systems. Despite MX having a higher butterfat % on all three systems, H gave a higher total butterfat in the TMR and partial TMR systems. The greatest difference between the two breeds was on the TMR system with a difference of 27kg total butterfat.

There is a complete reversal in terms between the partial TMR and grazing systems which can be easily visualised in fig.8. This change between partial TMR and grazing systems imitates the data found for milk yield (see fig.3.). This is to be expected however, due to the close link between total butterfat and milk yield, but shows that the differences in butterfat percentages were not large enough to overcome the effects of yield. Therefore the breed with the highest yield also gave the highest total butterfat in that particular system.

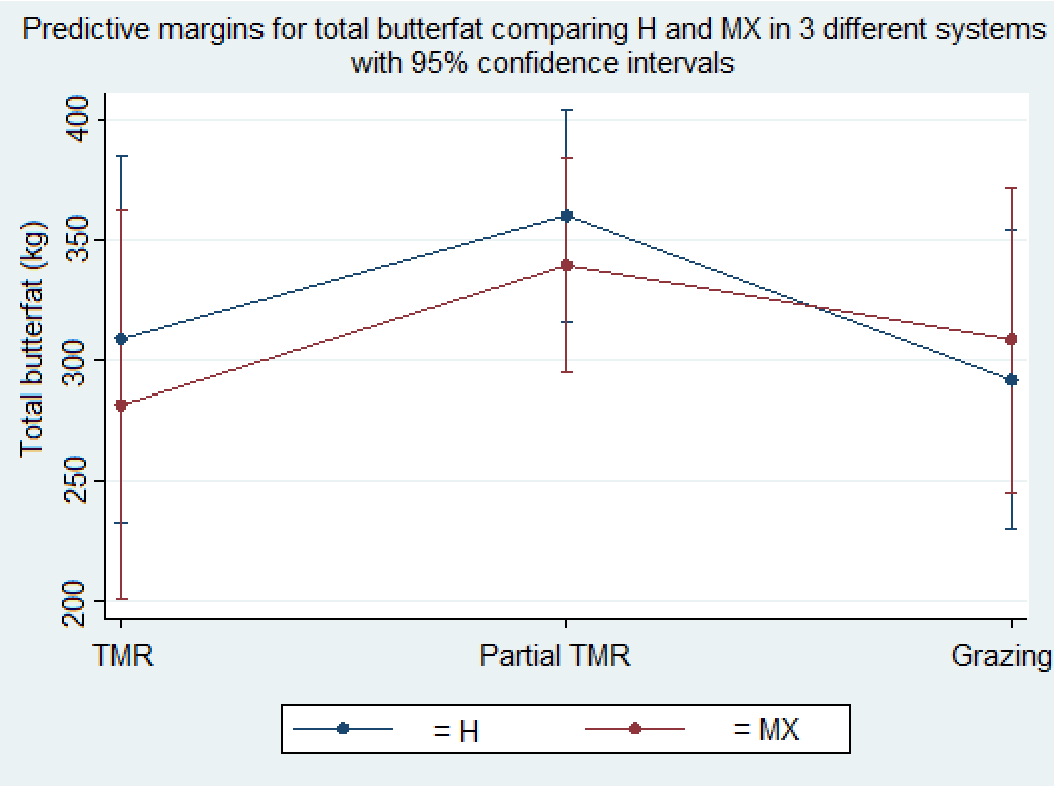

Fig.8. Predicted total butterfat (95% CI) comparing the effects of breed and system

The results found in this dataset for TMR and partial TMR were comparable to studies by Heins, et al. (2006a) and Walsh, et al. (2008), who both found that H gave a higher total butterfat than MX in and average 305d lactation. Heins, et al. (2006a) looked at higher input systems and found that the higher total butterfat (kg) for H was accompanied by a lower butterfat percentage.

Protein

Percentage protein

Average 305d protein percentage was analysed using a similar multiple regression model as for butterfat. It was shown that the protein percentage was higher for MX across the TMR and partial TMR systems and the same for both H and MX on the grazing system. There was a statistically significant difference (P 0.004) between the two breeds across the whole study with MX having a greater affinity to produce a higher protein percentage than H.

This correlates with studies by Heins, et al. (2006a) and Malchiodi, et al. (2014) who both found MX to produce and higher protein percentage than H.

PROTEIN	Coef.	95% Conf. Interval	P>|z|
1.binbreed (MX)	0.169	0.055 0.283	0.004
System			
Partial TMR (2)	0.095	-0.000 0.191	0.050
Grazing (3)	0.201	0.094 0.308	0.000
Binbreed/system interaction			
MX/partial TMR (1 2)	-0.104	-0.223 0.016	0.090
MX/Grazing (1 3)	-0.171	-0.302 -0.040	0.010
Binparity			
2nd lactation (2)	0.066	0.025 0.108	0.002
3rd lactation (3)	-0.000	-0.045 0.045	0.996
4th lactation and above (4)	-0.057	-0.100 -0.014	0.009

Fig.9. Regression table for average protein percentage over a 305d lactation

The biggest difference was seen in the TMR system where MX gave an average 0.17% more protein than H and the smallest difference was seen in the grazing system where MX and H were not statistically different for percentage protein (fig.10.). A trend was found where the higher the input level the greater the difference between the two breeds (this can be visualised in fig.11.).

	Predicted protein percentage	95% Conf. Interval
H on TMR (0 1)	3.11	3.028 3.193
MX on TMR (1 1)	3.28	3.151 3.408
H on Partial TMR (0 2)	3.21	3.159 3.253
MX on partial TMR (1 2)	3.27	3.217 3.325
H on Grazing (0 3)	3.31	3.244 3.379
MX on Grazing (1 3)	3.31	3.232 3.387

Fig.10. Predicted average protein percentage (95% CI) by breed and management system

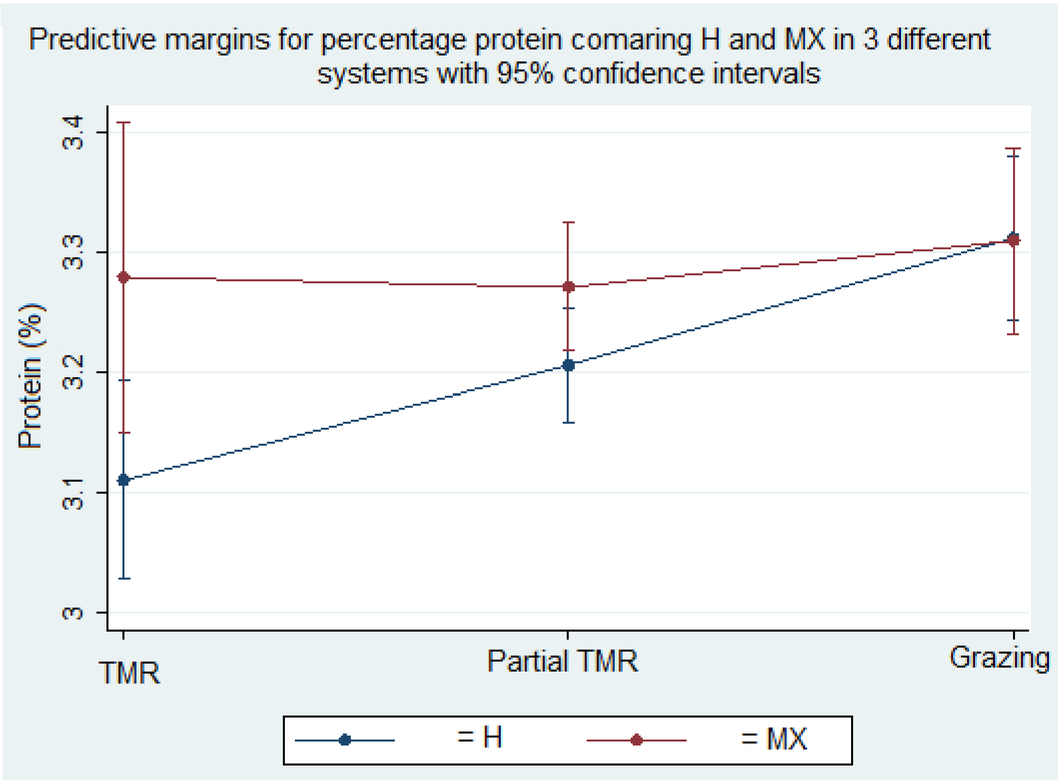

Fig.11. Predicted percentage protein (95% CI) comparing the effects of breed and system

This difference seen by the two breeds in the three systems is echoed in current research, although not within the same study.

Malchiodi, et al. (2014) studied 3 farms operating TMR systems in northern Italy and found that H gave a protein percentage of 3.74% whilst MX gave a protein percentage of 3.82%; A difference of 0.08%. Walsh, et al. (2008) looked at the breeds within a grazing system and reported no significant difference between the two breeds for percentage protein, correlating with the results found in this study.

Total protein

The same regression model was used again to compare the total protein of the two different breeds in each system.

The total protein for H was higher than MX in the partial TMR and TMR systems, but lower than MX in the grazing system. There is a close relationship between total protein and milk yield (simular to total butterfat), so the same reversal in terms (fig.9.) is seen between partial TMR and grazing as is seen for total butterfat and milk yield. This indicates that the milk yield has more influence on the total protein than the protein percentage does.

The greatest difference between the two breeds is seen in the TMR systems where H gives 21kg more protein in a 305d lactation than MX. The smallest difference was seen in the grazing system where MX gave 8kg moreprotein than H.

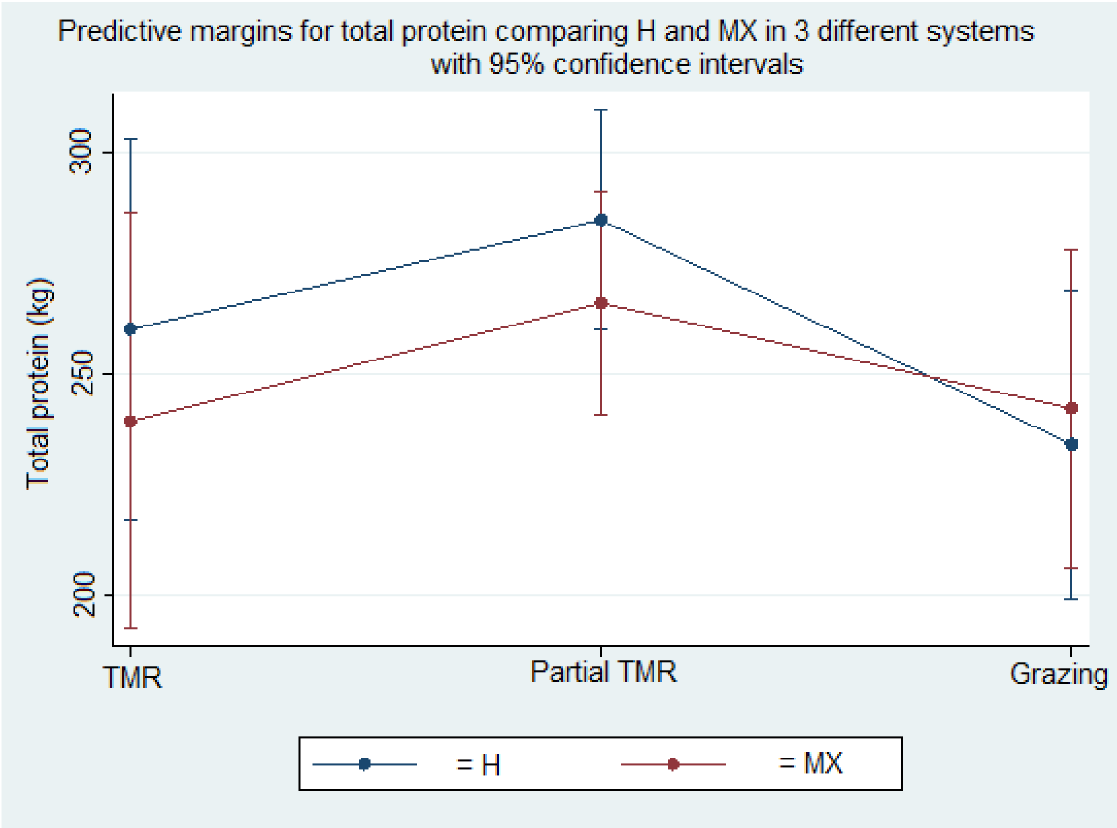

Fig.12. Predicted total protein (95% CI) comparing the effects of breed and system

The total protein results found here corresponded with existing research. A large study by Heins, et al. (2006a) on relatively high input farms in California found that there was a statistically significant difference between the total protein yield of the two breeds. In this study H gave 305kg per lactation whilst MX gave 293kg per lactation with a difference of 12kg which correlates well with the findings of the partial TMR system.

Walsh, et al. (2008) studied a grazing system and found that H produced 202kg total protein whilst MX produced 198kg total protein; a difference of 4kg. This wasn't too dissimilar to the findings in the study reported here. The difference in protein production between the two studies was mainly due to milk yield differences. In the study by Walsh, et al. (2008) the total protein production was higher for H, but so was the milk yield. In the study displayed in this report the total protein was higher for MX on the grazing system but again so was the milk yield.

Fertility

Number of services

The number of services required before an animal was diagnosed as pregnant (PD+) was analysed for each of the two breeds on the three different systems. A similar multiple regression model was applied to eliminate the farm effect and differences caused by parity.

Across the study it was found that MX took fewer serves than H to gain a PD+ with 0.19 fewer serves than H on average (95% CI -0.771 and 0.390), however, this wasn't statistically significant (fig.13.).

FERTILITY	Coef.	95% Conf. Interval		P>|z|
1.binbreed (MX)	-0.190	-0.771	0.390	0.520
System				
Partial TMR (2)	0.173	-0.394	0.740	0.551
Grazing (3)	0.622	-0.024	1.267	0.059
Binbreed/system interaction				
MX/partial TMR (1 2)	-0.119	-0.729	0.491	0.702
MX/Grazing (1 3)	-0.650	-1.325	0.025	0.059
Binparity				
2nd lactation (2)	-0.102	-0.316	0.112	0.349
3rd lactation (3)	-0.090	-0.326	0.145	0.452
4th lactation and above (4)	-0.099	-0.335	0.137	0.412

Fig.13. Regression table for average serves to gain a positive pregnancy diagnosis

MX took fewer serves to gain PD+ on all three systems, with the biggest difference of 0.84 serves in the grazing system and the smallest difference of 0.19 serves on the TMR system (Fig.14.).

It appeared that MX would need the same number of serves irrelevant of system, requiring around 1.6 serves on all three systems. H, however, fluctuated between the systems and required fewer serves on the TMR system (1.8), than on the grazing system (2.4 serves).

	Predicted serves	95% Conf. Interval
H on TMR (0 1)	1.77	1.277 2.272
MX on TMR (1 1)	1.58	0.903 2.266
H on Partial TMR (0 2)	1.95	1.680 2.214
MX on partial TMR (1 2)	1.64	1.361 1.915
H on Grazing (0 3)	2.40	1.990 2.803
MX on Grazing (1 3)	1.56	1.115 1.996

Fig.14. Predicted average number of serves to conception (95% CI) by breed and management system

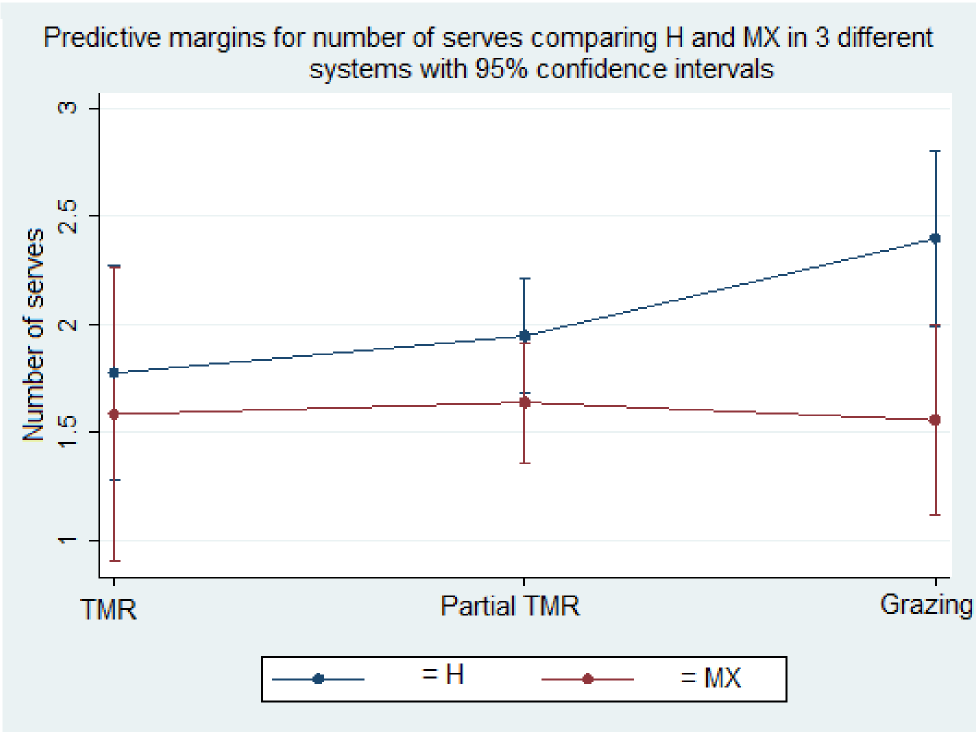

Fig.15. Predicted number of services (95% CI) comparing the effects of breed and system

Whilst few studies looked at number of services, however, Walsh, et al. (2008) studied services to conception ad found H required 1.98 services and MX require 1.97 services between which there was no statistical significance.

Other studies echoed the better fertility seen by MX in this report but looking at other forms of fertility measurement.

Heins, et al. (2006) looked at conception rates and found H to have a lower conception rate at first service than MX with 22% and 31% respectively, whilst Heins & Hansen (2012) showed than MX had fewer days open than H.

Very little research has so far been published looking at the fertility performance of the two breeds in different systems, so currently there is no data to compare to the results presented here.

Farmers' perceptions

In a study of farmers' perceptions; farmers scored H and MX out of five for 8 different traits. A score of '1' was considered the least favourable and '5' considered most favourable.

System	Breed	Yield	Quality	Lameness	Fertility	Calving ease	Temp.	Cow health	Calf health	Overall score
TMR	H (avg.)	4.00	3.00	3.00	3.00	3.50	4.00	3.00	3.50	27.00
	MX (avg.)	2.00	3.00	4.00	3.00	3.00	3.50	3.50	3.00	25.00
Difference	MX-H	-2.00	0.00	+1.00	0.00	-0.50	-0.50	+0.50	-0.50	-2.00
Partial TMR	H (avg)	4.64	3.00	2.71	2.43	3.36	4.14	2.86	3.50	26.64
	MX (avg.)	4.21	4.29	3.71	4.29	4.29	4.00	4.43	4.14	33.36
Difference	MX-H	-0.43	+1.29	+1.00	+1.86	+0.93	-0.14	+1.57	+0.64	+6.72
Grazing	H (avg.)	4.00	2.67	3.00	2.00	3.33	4.33	2.00	2.33	23.66
	MX (avg.)	4.67	4.00	3.00	3.33	4.00	3.33	4.00	4.00	30.33
Difference	MX-H	+0.67	+1.33	0.00	+1.33	+0.67	-1.00	+2.00	+1.67	+6.67
Overall mean difference	MX-H	-0.59	+0.87	+0.67	+1.06	+0.37	-0.55	+1.36	+0.60	+3.80

Fig.16. Average (mean) farmer perception scores out of five comparing MX and H in different systems for eight traits

Across all the herds in the study H scored, on average (mean), higher for milk yield (+0.59) and temperament (+0.54), whereas MX scored higher for milk quality (+0.87), lameness (+0.67), fertility (+1.06), calving ease (+0.37), cow health (+1.36) and calf health (+0.63).

There was a noticeable difference between the perceptions of farmers in different systems. H scored, on average, higher than MX, in 4 out of 8 traits for the TMR system, 2 traits in the partial

TMR and 1 trait in the grazing systems. All three systems perceived H to have superior temperament whilst MX to have better cow health, lameness rates and fertility.

MX was perceived to be an average of +3.80 higher than H considering all traits and all systems. Farmers on TMR systems scored MX lower than H (-2.00) over all traits whereas both partial TMR and Grazing systems scored MX higher than H, with scores of +6.72 and +6.67 respectively.

Farmers in the grazing systems scored MX higher than H for yield. Partial TMR farmers scored MX slightly less (-0.43) than MX for yield whereas TMR farmers scored MX drastically less (-2.00) than H for yield.

For milk quality (which encompasses butterfat, protein and somatic cell counts) MX was scored equal to H in TMR systems and higher in partial TMR systems (+1.29) and grazing systems (+1.33).

Fertility was scored as equal in the two breeds on the TMR systems and much higher for MX in the partial TMR (+1.86) and grazing systems (+1.33).

During the questionnaire, farmers were asked to comment on any other traits which vary between the two breeds and impact the running of the business. Several farmers indicated higher cull cow values, higher bull calf values and 'willingness to live' as significant traits in favour of MX.

Overall, the perceptions of the farmers' corresponded relatively accurately with the results in the study. The TMR farmers, however, tended to underscore MX for milk quality and fertility. On the other hand, the partial TMR farmers slightly over scored MX for milk quality. Grazing farmers' appeared to perceive the two breeds the most accurately within their system.

Conclusion

The results displayed in this paper demonstrate that on a UK grazing system a Montbeliarde cross provides superiority over the Holstein for almost all traits. It would therefore be reasonable to expect that the Montbeliarde cross would be the most profitable animal on a grazing system.

On a partial TMR system, whilst milk yield, total butterfat and total protein were shown to be lower, the results correlate closely with a large study in California (Heins, et al., 2006a) which demonstrated the reduced yield was balanced by fertility, cull cow values and longevity to produce a more profitable animal.

Finally, this dataset showed that out of all three systems the Holstein was most suited to the TMR system, however profitability of each breed is difficult to comment on, whilst milk yield, protein and butterfat yield is higher for the Holstein on this system, the Montbeliarde cross still outperformed the Holstein for fertility.

Hybrid vigour was not accounted for in this report due to the dataset available. The majority of farmers involved in this study were only a few years into their crossbreeding ventures; however, it would be interesting to study how the 3rd and 4th generation crosses perform in the future to further aid farmers in their breeding decisions.

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