USING FLECKVIEH IN DAIRY HERDS TO REDUCE THE IMPACT OF CLIMATE CHANGE

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1. BACKGROUND

The consequences of ongoing climate change in the world are causing a change in mindset towards dairy production. Generally it is accepted that climate change is associated with increasing temperatures caused by greenhouse gases of which the most important gasses are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide. Animals are responsible for a considerable amount of these greenhouse emissions. Methane is able to capture in the atmosphere 23 times more heat than carbon dioxide. Methane is produced in the rumen of ruminants and is also released from manure. A cow produces about 280*l* of methane on a daily basis. Some calculations have indicated that a 600kg cow with a milk yield of 4000*l* per lactation produces 103kg methane per year or about 26g per kg of milk. A cow producing 6000*l* of milk per lactation produces 113kg of methane at a rate of about 19g per kg of milk (Kirchgessner *et al*., 1991). Possible solutions for decreasing environmental pollution by dairy cows would imply changed production systems or the breeding of animals that are more suitable for production under difficult conditions. Generally it requires an improvement in the production and efficiency of dairy production systems through better feeding, housing management and genetics to reduce the direct effect of dairy cows on the environment. This means that more should be produced from fewer animals.

There is a general perception that low-input systems would have a smaller effect on the environment than large production systems that are currently becoming the norm. However, a low-input system is also a low-yield system. Most low input dairy systems operate on high forage and low concentrate intakes. However, a high-fibre diet enhances methane release per kg of milk in a three-fold manner: (i) by fermenting fibre, (ii) by low productivity and (iii) by low digestibility of fibre (methane production per kg digested organic matter increases). A substantial increase in the use of starchy concentrates (cereals etc.) for smallholders suffering from feed scarcity seems unlikely. So, efficient re-alimentation strategies will have to comprise ways to increase productivity by increasing digestibility of high-fibrous feeds (Kreuzer, 1997).

The greatest opportunity to produce enough food while at the same time reducing the environmental impact, can only be achieved through improved productive efficiency (Capper, *et al*. 2009). In 2008 the US dairy herd consisted of 9.3 million cows producing about 86 billion kg of milk in comparison to a production of 53 billion kg of milk from 25.6 million cows in 1944. This huge (more than 62%) improvement in milk yield with a similar reduction in number of dairy cows was achieved through a combination of higher genetic merit cows, improved ration formulation and better herd health and housing management aimed at improving animal care. A larger number of cows to produce the same amount of milk (at lower production levels) also results in an increase in the number of dry cows, replacement heifers and bulls. Therefore, a higher milk production not only reduces the number of cows but also reduces the nutrient requirement of the population for a given amount of milk being produced (Capper *et al*., 2009). This implies that today's intensive milk production systems produce considerably less manure (24%), methane (43%) and nitrous oxide (56%) per unit of milk than the 1944 system. The way cows are kept today also provides the opportunity to collect manure to produce methane for energy production.

Mostly, higher milk yields and less individual attention towards cows in large dairy herds, have caused a notable reduction in the fertility of dairy herds. This affects both herd profitability and genetic improvement. This would also increase the CO_2 and CH_4 production of a dairy herd as a larger proportion of animals would be producing milk at a low level (cows being near the end of the lactation) or cows being non-producing (dry). A reduction in the productive life of dairy cows also has a negative effect on total production of a dairy herd because total milk yield is reduced when the herd is at a low average lactation number.

Dairy farmers in South Africa have other possibilities to increase farm income. There is a large domestic market for high quality beef while being closer to Europe and the rest of Africa, making the export of beef a possibility for dairy farmers. In New Zealand the domestic market is oversupplied with beef and lower grades of beef products are being exported at a reduced price to the rest of the world. Because of the beef production potential, dairy farmers in South Africa could therefore consider other breeds that would improve the beef production of their dairy herds while not affecting milk yield or milk composition negatively.

One way to overcome the effect of climate change by increasing production both as beef or milk products would be to use dual purpose breeds. The Fleckvieh, a Simmental derived breed from Germany, is one such a breed. Other similar Simmental derived breeds are the Montbelliarde in France and Abondance in Italy. Selection and breeding programmes in the Fleckvieh breed have been aimed at increasing the milk yield and milk composition of cows while maintaining the beef quality of cows and steers. Another option would be to employ crossbreeding in dairy herds using these dual purpose breeds. Until recently in South Africa, little attention has been given to crossbreeding in dairy cattle. However, an increasing number of dairy farmers are employing crossbreeding is their dairy herds as a management option. Programmes are, however, being conducted in a non-structured way. The effect of any crossbreeding programme has, however, not been determined locally. On-farm results are based on small numbers of animals and rely mostly on farmers' perceptions. In countries like New Zealand and Australia, Holstein cows are mostly being crossed with Jersey sires. In New Zealand almost 30% of the national herd is crossbred cows. Crossing Holstein cows with Jersey sires results in smaller animals that produce milk with a higher solids content. The smaller cows seem to be more suitable for their unique milk production systems. However, the milk yield of Holstein and Jersey cows in New Zealand differs only by a small margin. The national average milk, fat and protein production per lactation for Jersey and Holstein cows are 2790 and 3800 kg milk, 161 and 166 kg fat and 113 and 131 kg protein, respectively. The mature live weights of Jersey and Holstein cows are 355 and 450 kg, respectively. This means that Holstein cows in New Zealand are similar to large Jersey cows in South Africa.

As the milk yield and milk composition of Fleckvieh cows is higher than that of Jerseys and Holsteins respectively, this breed lends itself to crossbreeding programmes with dairy breeds. Worldwide, the potential of dual purpose breeds has received very little attention in crossbreeding programmes. Fleckvieh x Jerseys or Holsteins should also be suitable for the more extensive milk production systems in South Africa than the typical Jersey x Holstein crosses.

In this paper preliminary results of the crossbreeding projects being conducted at Elsenburg are presented. The aim of both projects is to determine the advantage of crossbreeding Holstein and Jersey cows with Fleckvieh sires in an effort to reduce the impact of dairy production on the environment.

2. RESEARCH PROJECTS

Two crossbreeding projects are currently being conducted at the Institute for Animal Production at Elsenburg. The research farm is situated approximately 50 km east of Cape Town in the Western Cape Province of South Africa. The area has a typical Mediterranean climate with short cold and wet winters and long dry summers. Milk production systems vary from highly intensive zero-grazing to pasture based systems. In the intensive systems cows receive total mixed rations, while cows on pasture in some cases receive hay or silage and concentrates up to 50% of the total diet.

In one study Holstein (H) and Fleckvieh x Holstein (FxH) heifer and bull calves were acquired from a commercial producer. Calves from both breeds were collected once a week at about three to five days of age and transported to Elsenburg. Calves for veal were weighed on arrival and fed colostrum until 10 days of age after which fresh milk was supplied at about 4*l* per calf per day. Calves were fed similarly and were marketed at approximately five to six months of age as veal. Another group of bull calves from both breeds were reared intensively up to three months of age, after which they were put on kikuyu pasture supplemented on a daily basis with a small amount of concentrate. These steers were marketed at 18 months of age as beef. At the same time H and FxH heifers were reared similarly to calve down for the first time at 24 months of age. The life time performance in terms of milk yield, milk composition and reproduction of crossbred and pure bred cows are being recorded. The aim is to keep cows for as long as possible in the herd. Progeny from H and FxH cows are at present being reared in the same way as previously described.

In a second study, the Jersey (J) herd at Elsenburg was divided into two groups according to estimated breeding values and age. One group of cows is being inseminated with Fleckvieh (F) sires and the other group with Jersey sires. After the first calving, treatments are switched and cows are inseminated with the other breed. This is to ensure that the female base of the progeny is similar. Bull and heifer calves born from these inseminations are being reared similarly as described in the Holstein trial. The only difference is that Fleckvieh x Jersey (FxJ) and Jersey steers will be marketed at 24 months of age.

The aim of the two studies is to compare the purebred Holstein and Jersey progeny to the Fleckvieh x Holstein or Fleckvieh x Jersey progeny.

3. PRELIMINARY RESULTS

Since the start of the project, H and FxH bull calves reared for veal and beef have reached marketing age. For veal, the carcass weight should not exceed 100 kg. For this reason calves were weighed weekly on a Thursday and those calves weighing at least 185 kg were slaughtered the following Tuesday so as not to exceed the 100kg carcass weight. Steers reared for beef were marketed as close as possible to 18 months of age. In Table 1 information on the growth performance of bull calves reared for veal and beef is presented.

Table 1: The growth performance of Holstein (H) and Fleckvieh x Holstein (FxH) veal calves and steers reared at Elsenburg (ADG = average daily gain, LW = live weight, * breeds differ at P<0.05).

Production system	Parameters	H	FxH	Ratio (FxH/H)
Veal	Number of animals	14	13	-
	Start weight (kg)	46.4	41.2	0.89
	LW at slaughter (kg)	189	200	1.06*
	LW at 5m of age (kg)	197	209	1.06*
	ADG to marketing (kg/day)	1.016	1.071	1.05
Beef	Number of animals	14	14	-
	Start weight (kg)	45.3	44.1	0.97
	LW at 18m of age (kg)	494	533	1.08*
	Cold carcass weight (kg)	243	267	1.10*
	Dressing (%)	0.492	0.501	1.02
	ADG to marketing (kg/day)	0.814	0.889	1.09*

Holstein bull calves to be reared for beef were heavier on arrival at Elsenburg, while the crossbred calves were heavier at marketing for veal or beef. The average daily live weight gain of crossbred calves was higher than for purebred Holstein calves. The growth rate distribution of veal calves also showed that a larger number of crossbreds had average daily gains in excess of 1 kg per day than Holstein calves.

The comparative milk traits of H and FxH cows are presented in Table 2. The milk yield of H and FxH varied from 4550 to 9319 and from 3222 to 9224 kg with coefficients of variance of 19 and 23%, respectively. While the average milk yield of H cows was higher than that of FxH cows, this difference was not significant (P=0.30). Because of higher (P<0.05) fat and protein percentages in the milk of crossbred cows, the fat and protein yields of FxH cows were similar to H cows. Due to the lower milk volume and similar fat and protein yields, the expected milk price for FxH cows would be approximately 6% higher than that of milk from H cows.

Table 2: The mean(±se) 305-d milk yield and milk composition of first lactation Holstein (H) and Fleckvieh x Holstein (FxH) cows receiving a total mixed ration (* breeds differ significantly at P<0.05).

Parameters	H	FxH	Ratio (FxH/H)
Number of cows	22	23	-
Milk yield (kg)	6519±261	6109±289	0.94
Fat (%)	4.02±0.07	4.29±0.06	1.07*
Fat yield (kg)	259±8	260±11	1.00
Protein (%)	3.32±0.05	3.49±0.04	1.05*
Protein yield (kg)	215±8	213±9	0.99
Lactose (%)	5.58±0.24	5.16±0.17	0.92
Persistency (%)	105±4	102±4	0.97

On average, cows from the two genotypes did not differ for live weight at first calving, i.e. 631±10kg for FxH *vs.* 608±13kg for H cows (P=0.17), although absolute figures favoured the FxH genotype. Holstein cows lost more weight than crossbreds from calving to nadir, i.e. -50±10 *vs.* -18±8kg, while FxH cows gained weight at a faster rate than H cows towards the end of the lactation.

Table 3: Reproduction parameters of first lactation Holstein (H) and Fleckvieh x Holstein (FxH) cows receiving a total mixed ration.

Parameters	H	FxH	Ratio (FxH/H)
Number of cows	22	23	-
Age at first AI (m)	14.7	15.0	1.02
Age at first calving (m)	26.4	25.7	0.97
Interval to first AI (days	90	74	0.82
% First AI <80 dim	55	65	1.18
Heat detection rate (%)	39	48	1.23
% PD < 200 dim	76	82	1.08

Comparative reproduction parameters of H and FxH cows are presented in Table 3. Age at first calving is related more to management than inherent fertility. Fleckvieh x Holstein needed fewer days from calving to first insemination while the percentage of cows inseminated for the first time within the first 80 days after calving was higher for FxH in comparison to H cows. This could be because FxH cows experience an easier calving down process resulting in a quicker recovery of the reproductive tract. Cows experiencing calving problems have a longer recovery period after calving. The heat detection rate for crossbreds was higher in comparison to purebred Holsteins. This refers to the number of inseminations from first to last insemination.

In Table 4 the growth performance of J and FxJ veal calves and steers is presented. As expected, the birth weight of FxJ bull calves was higher than that of purebred J bull calves. The live weight of veal calves at marketing was similar. This is due to marketing requirements. Age at marketing for FxJ veal calves was earlier than that of J veal calves, i.e. 6.3 *vs.* 7.1 months of age. The average daily gain of FxJ calves was more than 50% higher than that of J calves resulting in a higher LW at marketing at 21 months of age. Further investigation is needed to determine the effect of breed on the stocking rate on pasture. In the present trial steers received the same amount of supplementary feeding while pasture conditions were the same for the two genotypes.

Table 4: The growth performance of Jersey (J) and Fleckvieh x Jersey (FxJ) veal calves and steers reared at Elsenburg (ADG = average daily gain, LW = live weight, * breeds differ significantly at P<0.05).

Production system	Parameters	J	FxJ	Ratio (FxJ/J)
Veal	Number of animals	16	22	-
	Birth weight (kg)	26.8±1.5	31.3±1.3	1.17*
	End LW (kg)	192.9±2.7	195.7±1.3	1.01
	ADG (kg/day)	0.765±0.017	0.859±0.015	1.12*
	Carcass weight (kg)	92.2±2.3	99.6±1.0	1.08*
	Dressing (%)	0.48±0.008	0.51±0.004	1.06*
	Marketing age (m)	7.2±0.1	6.3±0.1	0.88*
Beef	Number of animals	11	7	-
	Birth weight (kg)	27.7±1.3	33.0±1.6	1.19*
	LW at 21 of age (kg)	334.9±15.3	475.5±22.4	1.42*
	Cold carcass weight (kg)	159.6±9.4	238.0±10.0	1.49*
	Dressing (%)	0.49±0.02	0.51±0.01	1.04
	ADG (kg/day)	0.475±0.027	0.681±0.040	1.43*

Although only a small number of first lactation J and FxJ cows have completed a first lactation, the milk yield of FxJ cows tended (P=0.16) to be higher than that of J cows. The milk yield of J and FxJ cows varied from 4277 to 5747 and from 4481 to 6353 kg with coefficients of variance of 10 and 13%, respectively. The fat and protein percentages of the milk of J and FxJ cows were similar. The persistency of FxJ cows tended (P=0.13) to be lower than that of J cows. The reason for this is not clear although being a small number of cows in that group the mean milk yield could be affected by season.

Table 5: The mean(±se) 305-d milk yield and milk composition of first lactation Jersey (J) and Fleckvieh x Jersey (FxJ) cows utilizing kikuyu pasture and limited concentrates.

Parameters	J	FxJ	Ratio (FxJ/J)
Number of cows	13	7	-
Milk yield (kg)	5023±160	5422±218	1.08
Fat (%)	4.59±0.09	4.45±0.11	0.97
Fat yield (kg)	230±6	240±8	1.04
Protein (%)	3.47±0.02	3.43±0.06	0.99
Protein yield (kg)	175±5	186±7	1.06
Lactose (%)	4.73±0.03	4.76±0.03	1.01
Persistency (%)	96±5	84±3	0.88

A larger number of cows for both genotypes could change the outcome of the trial. Meeske *et al*. (2009) found that the milk yield of first lactation FxJ cows was also about 7% higher than J cows on a kikuyu/ryegrass pasture production system. Although direct comparison is not possible it is however interesting to note that the absolute milk yield of these cows was considerably lower than in the present study, i.e. 3702 *vs.* 3959kg for J and FxJ cows respectively.

4. CONCLUSION AND RECOMMENDATIONS

While these projects are at a very early stage, it seems that overall herd production would be increased by crossbreeding H and J cows with a dual purpose breed like the Fleckvieh. Fleckvieh crossbred veal calves and steers being subjected to the same environmental conditions were heavier than purebreds. The milk yield of FxH cows was marginally lower than that of H cows, while fat and protein percentages of their milk were higher resulting in similar fat and protein yields. The difference in milk yield between J and FxJ cows was smaller. Crossbreeding with F increased the beef potential of J substantially. The daily live weight gain for FxJ veal calves was higher resulting in a shorter growing out period to reach a carcass weight of 100kg at marketing, i.e. 6.3 *vs.* 7.2 months. The growth rate of FxJ steers up to 21 months of age was 43% higher than that of J steers attaining a live weight of 475 kg in comparison to 335kg for J steers. Further studies need to be conducted to determine the optimal stocking rate on pasture for pure- and crossbred animals.

More data are required to confirm these preliminary results. Some reproduction parameters for first lactation FxH cows were better than H cows although the dataset was too small to provide conclusive results. The possibility of genetically low methane-producing breeds or animals within a breed should be tested as well. Münger & Kreuzer (2008) tested 10 purebred Holstein, Simmentaler and Jersey cows each for methane-producing abilities. These cows emitted on average the same quantity of methane per kg of dry matter intake. Measured methane emissions differed from estimated values. There seems to be a definite diurnal emission pattern of greenhouse gasses in dairy cows (Jackson *et al*., 1993). Emission rates increases rapidly after each feeding and slowly declined between feedings and at night. Non-lactating animals produce considerably less methane than lactating cows.

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