AGRICULTURAL RESEARCH INSTITUTE OF NORTHERN IRELAND

TO ASSESS THE POTENTIAL OF THE NORWEGIAN DAIRY CATTLE BREED (NRF) AS A MEANS OF IMPROVING THE FERTILITY AND HEALTH STATUS OF THE NORTHERN IRELAND DAIRY HERD

Our research aims to:

THIRD PROGRESS REPORT FOR AGRISEARCH

June 2005

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OVERVIEW

The second report on this project (February 2003) provided an overview of the preliminary findings of the study. The current report provides details of final data from lactations 1 and 2, together with preliminary findings from lactations 3 and 4.

SUMMARY OF THE BACKGROUND TO THE STUDY

The results of a number of farmer surveys undertaken by AgriSearch (under ARDC (NI)) highlighted that infertility, mastitis and lameness were the three most significant problems encountered on dairy farms in Northern Ireland. It was recognised that the costs associated with each of these problems, both direct and indirect, can be very substantial, and as such, may have major implications for the profitability of many dairy enterprises. A number of approaches have been suggested as having potential to help overcome these difficulties, including 'breeding', 'management' and 'nutrition'.

Within the context of 'breeding', 'breed substitution' has been advocated as a means of tackling some of these problems. Breed substitution refers to the introduction of an 'alternative breed' which possesses, either naturally or as a result of managed selection programmes, characteristics which are desirable. In the study being conducted by the Agricultural Research Institute of Northern Ireland, the Norwegian Dairy Cattle breed (NRF) was chosen for evaluation in a breed substitution programme. The choice of the NRF breed reflects the multi-trait selection programme within Norway, with this programme placing major emphasis on functional traits such as calving ease, mastitis resistance and positive fertility traits. For example, selection for high levels of fertility and resistance to mastitis have been ongoing in breeding programmes in Norway for over 20 years.

There is an overwhelming body of evidence from Norway to suggest that the selection programme within the NRF breed has resulted in improvements in both dairy cow health (fertility and mastitis) and milk production. However, in view of the very different farming systems that exist within Norway, compared to Northern Ireland, it was clear that the NRF breed would need to be evaluated under Northern Ireland conditions in order to assess its true potential for the local industry.

IMPLEMENTATION OF THE RESEARCH PROGRAMME, AND DATA COLLECTION

During the first three years of the study, data were collected during farm visits conducted six times per annum. The frequency of farm visits was reduced to four visits/annum during years 4 and 5. Mr Adrian McKeague was appointed by the Institute in April 2003 to manage the project on farms. Adrian played a key role in driving the project until July 2004, at which stage he moved on to new challenges. Dr Conrad Ferris, who has responsibility for the overall running and implementation of the project, now conducts farm visits, and will continue to do so until the end of the project. Visits are now being undertaken twice each year.

The annual meeting for all farmers involved in the study was held in Cookstown on 20th October 2004. This meeting provided an opportunity for Institute staff to update farmers on the progress of the study to date, as well as providing a forum for group discussion. The final meeting for participating farmers will be held in September 2006.

GENERAL COMMENT ON DATA PRESENTED WITHIN THIS REPORT:

All animals on the study have now completed their second lactation, with animals currently in their third, fourth and fifth lactations. The first and second lactation data presented within this report represents a complete data set. Third and fourth lactation data is still preliminary, and will change as more animals complete these lactations.

FARMS ON THE STUDY:

Fifteen of the original 20 farms remain on the study. Of the five farms that are no longer involved, one was depopulated as a consequence of a brucellosis outbreak, two ceased milk production, and two farms exited the study for 'management reasons'. The 15 farms remaining on the study are committed to seeing the study through to completion.

ANIMALS ON THE STUDY:

Of the 226 animals of each breed which commenced the study, a total of 187 animals remain, 105 NRF and 82 Holstein Friesian. The lactation 'status' of the animals remaining on the study is presented in Table 1. All animals have completed their first and second lactations, with the remaining animals currently in their third, fourth and fifth lactations.

Table 1 Status of animals on the study (May 2005)

	NRF	Holstein
1st lactation	0	0
2nd lactation	0	0
3rd lactation	26	24
4th lactation	41	33
5th lactation	38	25
Animals remaining on the study	105	82
Animals removed from the study	121	144
Total	**226**	**226**

REASONS FOR CULLING/REMOVAL OF ANIMALS

A total of 97 animals have been removed from the study for reasons described as 'non breed related' (Table 2). These include animals removed as a consequence of farmers no longer participating in the study, animals culled due to brucellosis, and animals culled for reasons related to tuberculosis legislation. These reasons can not be attributed to 'breed' effects. A further 167 animals have been removed from the study for reasons described as 'breed related', ie reasons that potentially could be related to breed differences. Of these animals, 98 were Holstein and 69 were NRF.

Table 2 Reasons for loss of cows from the study

	Holstein Friesian	NRF
Animals commencing study	**226**	**226**
Total lost to date	**144**	**121**
'Non breed related reasons'		
Farm off study	25	32
Tuberculosis	11	12
Brucellosis	10	7
Total	**46**	**51**
'Breed related reasons'		
Infertile	44	18
Injury	10	7
Mastitis	8	5
Abortion	7	6
Udder quality	0	7
Feet and legs	6	4
Digestive system	4	3
Low yield	0	4
Liver/heart/lungs/kidney	5	1
Management reasons	2	3
Grass tetany	1	2
Clostridia diseases	1	2
Down cow	2	0
Ill thrift	1	1
Redwater	1	0
Blood clot	1	0
Ulcer	1	0
Milk fever	1	0
Temperament	0	1
Respiratory	0	1
Uterine infection	0	1
Endoreorditis	0	1
Unknown	3	2
Total	**98**	**69**

Within this group, the main reason for culling within both breeds was infertility, with 44 Holstein animals and 18 NRF animals culled due to infertility. Injury, mastitis and abortion were the three next most common reasons for culling, however there were only small differences between breeds in numbers of animals culled for each of these reasons. Seven NRF animals were culled due to 'udder quality'. Udder related problems have arisen during the third and fourth lactations, especially with animals in high input herds. Most of the udder problems can be attributed to weak median suspensory ligaments.

CALVING INFORMATION

Calving information for the first and second lactation animals on the study are presented in Tables 3 and 4 respectively. During lactation 1 and 2, animals of the NRF breed had a significantly higher calving temperament score (poorer temperament) compared to animals of the Holstein-Friesian breed ($P \leq 0.05$), although differences between breeds were smaller with second lactation animals. Animals of the NRF breed had easier calvings, both as maiden heifers ($P<0.001$) and when calving into their second lactation ($P<0.01$), although again the difference between breeds was smaller at the second calving. The percentage of calves born dead to maiden heifers of the NRF and Holstein breeds were 4.5% and 13.2% respectively, while the percentage of calves born dead to second lactation animals were 4.4% and 5.1% respectively. These trends appear to reflect the calving difficulty scores observed with each of the two breeds. Milking behaviour assessments were made within 48 hours of calving and at 3 weeks post-calving. During their first lactation animals of the NRF breed had significantly higher milking behaviour scores (poorer milking temperament), both immediately post calving, and at three weeks post-calving ($P<0.001$). When calving down into their second lactation, there was small differences between breeds in terms of milking behaviour during the first 48 hours post calving ($P<0.05$), while this difference had disappeared by three weeks post calving.

Table 3 Calving information for first lactation animals

	Breed			
	NRF	Holstein	SEM	SIG
Calving temperament	1.6 (n = 96)	1.2 (n = 92)	0.04	***
Scale: 1 = very quiet, 4 = aggressive				
Calving difficulty	1.5 (n = 204)	1.9 (n = 199)	0.06	***
Scale: 1 = unassisted, 5 = caesarean				
Calves born dead (%)	4.5 (n = 205)	13.2 (n = 199)		
Milking behaviour				
Where 1 = stands calmly, 4 = extremely agitated, milked with difficulty				
First 48 hours post calving	2.1 (n = 204)	1.8 (n = 197)	0.06	***
3 weeks post calving	1.3 (n = 204)	1.1 (n = 197)	0.04	***

Table 4 Calving information for second lactation animals

	Breed			
	NRF	Holstein	SEM	SIG
Calving temperament	1.2 (n = 88)	1.1 (n = 73)	0.03	*
Scale: 1 = very quiet, 4 = aggressive				
Calving difficulty	1.2 (n = 88)	1.4 (n = 73)	0.04	**
Scale: 1 = unassisted, 5 = caesarean				
Calves born dead (%)	4.4 (n = 86)	5.1 (n = 74)		
Milking behaviour				
Where 1 = stands calmly, 4 = extremely agitated, milked with difficulty				
First 48 hours post calving	1.3 (n = 88)	1.2 (n = 72)	0.035	*
3 weeks post calving	1.1 (n = 88)	1.0 (n = 72)	0.018	NS

FERTILITY DATA

Twenty five percent of animals were already in calf at the commencement of the study, while a further 25% of animals were bred immediately the study commenced. With regards to the latter, on most farms the NRF animals entered into breeding programmes within a few weeks of being imported from Norway. Fertility data from these maiden heifers in year 1 has been excluded from the study. Fertility data for maiden heifers refers to the remaining 50% of animals that were either 2–3 months old or 8–10 months old when imported. These were either bred pure (ie NRF semen on NRF cows, and Holstein semen on Holstein cows), or bred to a stock bull. Of animals bred to AI, conception rates to first service were 67% and 57% for animals of the NRF and Holstein breeds respectively (Table 5).

Table 5 Fertility data

	NRF	Holstein
Maiden heifers		
Conception to 1st AI (%)	67	57
% of animals culled due to infertility	1.9	3.3
First lactation animals		
Conception to 1st AI (%)	55	42
Calving interval (days)	394	382
% of animals culled due to infertility	3.1	7.3
Second lactation animals		
Conception to 1st AI (%)	59	40
Calving interval (days)	380	382
% of animals culled due to infertility	4.4	11.5

With first lactation animals, conception rates to 1st AI were 55% and 42% for animals of the NRF and Holstein breeds respectively, while these conception rates were 59% and 40% with second lactation animals respectively. Calving intervals between the two breeds were very similar. This is likely to be due to the fact that NRF animals were in calf earlier in the breeding season, and as such calved earlier than the Holsteins. These 'earlier calving' animals may have been held longer before breeding commenced (longer involuntary waiting period), so as to maintain herd calving patterns. The percentage of animals culled as infertile increased with lactation number, and was consistently higher with the Holstein breed.

MILK PRODUCTION

First lactation milk production data are presented in Table 6. While 305-day milk yields were significantly lower with animals of the NRF breed ($P<0.05$), full lactation milk production data was not affected by breed ($P>0.05$). Breed had no effect on milk fat content, while milk protein content was significantly higher with animals of the NRF breed ($P<0.001$). Animals of the NRF breed had significantly lower somatic cell counts than animals of the Holstein breed ($P\leq0.01$). Lactation concentrate inputs were approximately 100 kg higher with the NRF animals, with this reflecting their earlier calving dates (and consequently longer winter feeding periods) in Year 1.

During their second lactation (Table 7), similar trends were observed, although neither 305 day or full lactation milk yields were significantly affected by breed ($P>0.05$). Milk protein content was significantly higher ($P<0.05$), and somatic cell counts significantly lower ($P<0.01$), with animals of the NRF breed.

The 3rd and 4th lactation data presented in Table 8 are based on incomplete data sets, and as such, caution is required in interpreting the data. During the third lactation, milk yields were significantly lower with animals of the NRF breed ($P<0.05$), while milk protein contents continued to be significantly higher ($P<0.01$). Breed had no effect on any of the lactation 4 parameters, although the numbers of animals for which data is available is very small.

Table 6 Milk yield and milk composition data in lactation 1

	NRF *(n = 193)*	Holstein *(n = 178)*	SEM	SIG
305 day performance				
Milk yield (kg)	5601	5816	71.3	*
Fat (g/kg)	38.8	38.2	0.25	NS
Protein (g/kg)	32.8	32.1	0.12	***
Full lactation performance				
Days in milk	*322*	*314*		
Milk yield (kg)	6004	6203	100.8	NS
Fat (g/kg)	39.1	38.4	0.25	NS
Protein (g/kg)	33.0	32.3	0.12	***
Milk energy (MJ/kg)	3.11	3.07	0.010	*
Milk energy yield (GJ)	18.6	19.0	0.30	NS
SCC (000)	93	151	14.2	**
SCC (log10)	1.77	1.93	0.028	***
Concentrate input (kg fresh)	1517	1426	27.5	*

Table 7 Milk yield and milk composition data in lactation 2

	NRF *(n = 157)*	Holstein *(n = 135)*	SEM	SIG
305 day performance				
Milk yield (kg)	6269	6479	86.0	NS
Fat (g/kg)	37.7	36.9	0.32	NS
Protein (g/kg)	33.1	32.5	0.17	*
Full lactation				
Days in milk	*304*	*305*		
Milk yield (kg)	6497	6763	106.8	NS
Fat (g/kg)	37.8	37.1	0.31	NS
Protein (g/kg)	33.3	32.7	0.17	*
Milk energy (MJ/kg)	3.07	3.03	0.014	*
Milk energy yield (GJ)	19.9	20.4	0.31	NS
SCC (000)	125	183	16.8	*
SCC (log10)	1.88	2.01	0.034	**
Concentrate input (kg fresh)	1445	1472	41.3	NS

Table 8 Preliminary milk yield and milk composition data in lactations 3 and 4

	NRF	Holstein	SEM	SIG
3rd lactation	*N = 95*	*N = 69*		
305 days				
Milk yield (kg)	6676	7187	167.6	*
Fat (%)	3.78	3.65	0.062	NS
Protein (%)	3.34	3.26	0.024	*
Full lactation				
Days in milk	*303*	*310*		
Milk yield (kg)	6880	7539	211.2	*
Fat (%)	3.80	3.67	0.061	NS
Protein (%)	3.35	3.28	0.023	*
4th lactation	*N = 29*	*N = 13*		
305 days				
Milk yield (kg)	6348	6233	334.7	NS
Fat (%)	4.04	3.90	0.148	NS
Protein (%)	3.42	3.35	0.051	NS

MILK BACTERIOLOGY

As highlighted in the previous report, milk samples were taken from all four quarters ('quarter samples') of second lactation animals at approximately 150 days post calving in 2002. This process was subsequently repeated in 2003 with the remaining second lactation animals. A total of 141 NRF animals and 119 Holstein animals (from 16 farms) were sampled. Each 'quarter sample' was analysed for somatic cell counts, and also examined for the presence of bacteria. In addition, if bacteria were isolated, the species of bacteria present was identified. The outcome of this sampling procedure is presented in Table 9.

Table 9 Breed effects on bacteriological analysis of milk from quarter samples

	HF	NRF	SEM	SIG
Cows with bacteria isolated (%)				
Front right	33.6	28.6	3.16	NS
Front left	32.7	29.7	3.17	NS
Back right	41.3	30.7	3.26	*
Back left	34.5	37.7	3.29	NS
All quarters	35.5	31.7	1.61	NS
SCC (000)				
Front right	133	102	18.5	NS
Front left	270	214	55.6	NS
Back right	254	115	34.5	**
Back left	153	148	23.6	NS
All quarters	202	145	18	*
SCC (LOG10)				
Front right	1.68	1.47	0.043	***
Front left	1.75	1.51	0.05	***
Back right	1.66	1.47	0.049	**
Back left	1.65	1.49	0.048	*
All quarters	1.68	1.48	0.024	***
Of quarters with bacteria isolated, proportion infected with:				
Staphlococcus aureus	43.9	19.9	8.71	*
Other Staphlococcus sp.	28.4	25.6	2.25	NS
Streptococcus	8.8	7.2	1.37	NS
E. Coli	0.5	0.2	0.03	NS
Other	5.4	8	1.27	NS

With the exception of the 'back left' quarter, the proportion of cows with bacteria isolated tended to be lower with animals of the NRF breed, compared to animals of the Holstein breed, although this difference was only significant ($P<0.05$) for the back right quarter. Mean cell counts, averaged across all quarters, were 202, 000 and 145, 000 for animals of the NRF and Holstein breeds respectively ($P>0.05$). Within each of the quarters there was a trend (significant for the back right quarter) for animals of the NRF

breed to have lower somatic cell counts, compared to animals of the Holstein breed. When examined on a LOG basis, to take account of the 'skewed' nature of cell count data, somatic cell counts were significantly lower for animal of the NRF breed in all quarters. The main types of bacteria isolated from milk samples were *Staphylococcus aureus*, 'other' *Staphylococcus* species, *Streptococcus* species, and *E. coli.* Of quarters with bacteria isolated, 43.9% and 19.9% were infected with *Staphlococcus aureus* for the NRF and Holstein breeds respectively, with this difference being significant. *Staphylococcus aureus* are contagious pathogens and are transmitted from infected to uninfected glands or teats during the milking process. The lower level of infection with animals of the NRF breed suggest that the physical structure of the teats of NRF animals make them less susceptible to bacteria penetration. The degree of infection with Other *Staphlococcus* species, *Streptococcus* species and *E.Coli,* did not differ between breeds.

CONDITION SCORES AND LOCOMOTION SCORES

The decision was taken not to continue with locomotion scoring and condition scoring assessments after lactation 2. The complete data sets for these two parameters are now available, and are being modelled statistically.

PRELIMINARY ECONOMIC EVALUATION

Based on the production data available to date, a preliminary economic comparison of the two breeds has been undertaken. Once a more complete data set is available, a more comprehensive analysis will be undertaken by Economics Division, Newforge. The analysis presented in Table 9 is based on an assumed farm with a 750 000 litre milk quota. Milk yield and milk composition data used were based on mean data for lactations 1-3, as presented in Tables 6-8. These production data have not been weighted for the different herd structures that arise from differences in culling patterns. One hundred and ten Holstein-Friesian animals and 116 NRF animals were calculated to be necessary to fill the 750 000 litres of milk quota available. A base milk price of 18 pence per litre was adopted, with this being adjusted for compositional bonuses. The economic value of the milk produced by animals of the NRF and Holstein Friesian breeds was 18.2 and 17.8 pence per litre respectively. Herd replacement rates were calculated to be 32 and 26% for the Holstein Friesian and NRF breeds respectively.

Lifetime replacement rates were determined by projecting rates of animal losses during lactations 1–3, into lactations 4–6. Thirty-five Holstein Friesian and 30 NRF replacement animals were required annually, with replacement rearing costs assumed as £780/replacement. The number of animals culled each year was assumed to be the same as the number of replacements brought into the herd annually, with the value of a cull assumed as £250. The number of calves sold each year was also assumed to be the difference between the number of animals born, and the number of animals required as replacements. No account of differences in calf mortality was taken within this simple analysis. The value of calves sold from each breed was assumed as £30.

Concentrate inputs were assumed as 1.4 tonnes per lactation (Table 6), with the cost of the concentrate assumed as £140/t. Inputs of grazed grass and grass silage were assumed as 2.6 and 1.5 tonnes respectively with animals of both breeds, while the cost of grazed grass and grass silage was assumed as £73 and £85/t utilized DM respectively. In this preliminary economic analysis, sundry costs have been assumed to be equal for each of the two breeds.

Gross margins per cow were calculated to be £482 and £473 for animals of the Holstein Friesian and NRF breeds respectively, while gross margins per litre were 7.1 and 7.3 pence respectively. Thus this preliminary economic appraisal indicates that there was little difference in gross margins between each of the two breeds.

Table 10 Preliminary economic appraisal of each of the two breeds

	HF	NRF
Available quota (litres)	750000	750000
Cows required to fill quota	110	116
Average lactation yield (l)	**6835**	**6460**
Average milk fat (g/kg)	**37.4**	**38.3**
Average milk protein (g/kg)	**32.6**	**33.3**
Milk price received (pence/litre)	**17.8**	**18.2**
Milk sales (£)	133410	136225
Replacement rate	**0.32**	**0.26**
No replacements/year	**35**	**30**
Replacement costs/annum (£)	27388	23544
Number of culls/year	**35**	**30**
Value of cull (£)	**250**	**250**
Cull sales/annum (£)	8778	7546
Number of calves sold/annum	**69**	**81**
Calf sales/annum (£)	2080	2441
Cost replacement, less culls/year (£)	18610	15998
HERD OUTPUT (£)	116880	122669
OUTPUT/COW (£)	1065	1057
Concentrate cost/annum (£)	**21507**	**22754**
Grazing cost/annum (£)	**20827**	**22034**
Silage cost/annum (£)	**13990**	**14802**
Sundries (AI, vet, misc)	**70**	**70**
HERD VARIABLE COSTS (£)	64005	67717
VARIABLE COSTS/COW (£)	583	583
GROSS MARGIN PER COW (£)	482	473
GROSS MARGIN/LITRE (pence/litre)	7.1	7.3

COMPLETION OF THE STUDY

This study is due for completion in Spring 2006, with the final report due early summer 2006. However it is proposed that completion of the study is delayed until June 2006 to allow completed lactation certificates for Spring 2005 calving animals to be collected on farms in May/June 2006. At completion of the study approximately 90% of animals

remaining on the study will have completed lactation 4, and approximately 40% will have completed lactation 5. It is estimated that approximately 20% of the original animals will remain on the study at this stage.

Within this timescale, it is proposed that the final report will be submitted to AgriSearch during October 2006, thus allowing time for a full analysis of the production data, and a full economic analysis to be undertaken. Production of a farmers booklet will be targeted for November 2006. Work on a full Scientific paper covering lactations 1 and 2 will commence during the summer months (2005). A press release is planned for Summer 2005 to highlight the findings of the study to date.

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