Dairy Breeding Objective and Programs for Ireland

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Executive summary

- In March 2000, Irish Cattle Breeding Federation (ICBF) commissioned a Dutch / Irish consortium to carry out a project on breeding objectives and breeding programs for Irish dairy farmers. This report follows the initial discussion report, which was a summary of phase 1 ”The evaluation of the current situation”.

- An important outcome of consulting all key sectors of the Irish dairy industry in phase I, was a recommendation that the current RBI index should be revised to include weights for milk, fat and protein based on their industrial value and that this project should focus on including an initial breeding value for fertility in the new Breeding Index.

- In this study a procedure was developed that allows the estimation of breeding values for re-appearance and calving interval, traits that reflect the major components of fertility. Economic weights were calculated to weight these traits with breeding values for milk, fat and protein yield in an economic index.

- Expected selection responses and sensitivity of economic values was discussed with representatives of the industry and the following index was considered most suited to Irish circumstances:

  Breeding Index = -0.06 PD milk + 0.7 PD fat + 4.5 PD protein
  + 9.0 PD reappearance –1.6 PD calving interval

- For an Irish breeding program there are substantial probabilities of Irish bulls ranking in the top-10, especially when the genetic correlation is below 0.9 and when the number of bulls tested and effective number of daughters both exceed 25.

- Selection on the new breeding index is expected to increase milk, fat and protein yield, and protein and fat percentage, and improve re-appearance (longevity). The negative effect of selection on calving interval is reduced, or with accurate breeding values the genetic merit for calving interval is improved.

- Compared with selection on milk yield index only, including re-appearance and calving interval in a breeding index will result in an increase of genetic gain of up to 14% for proven bulls.

- An optimal breeding scheme is expected to improve profit with IR£17.8 per cow per year for a yearly investment of IR£4-5 per cow per year.

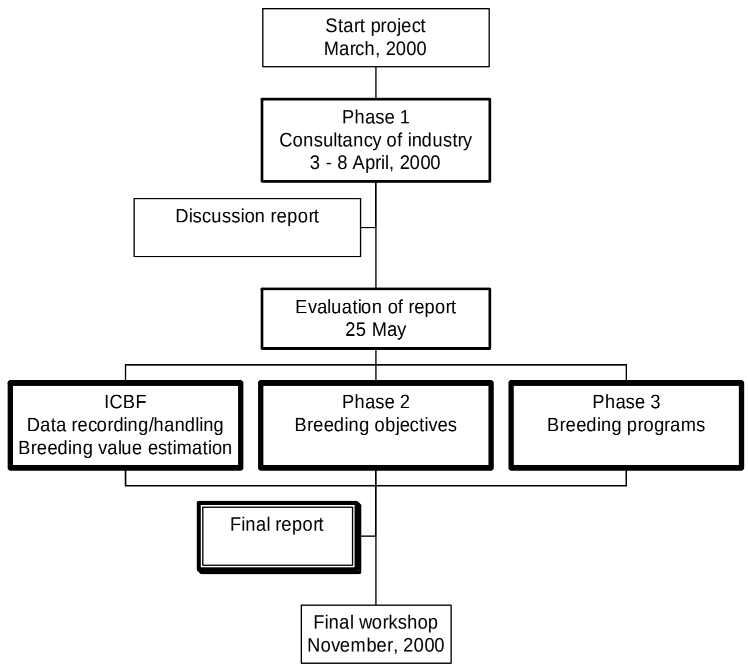
Chapter 1 Introduction

Background

Rates of genetic improvement for milk production traits have increased quite dramatically in Ireland during the past 15 years. Research at Moorepark has indicated that high genetic merit animals have an improved margin after all costs of about 0.8 p/kg milk. However, more recent work from Moorepark has indicated that, after considering reproductive performance of each group (infertile rates were 21% and 6% in the high and medium merit groups respectively) the improved margin after all costs was 1.5 p/kg in favor of animals of medium genetic merit. These results have stimulated discussions about the breeding objective for Ireland and the related need to identify breeding programs that will deliver the greatest long-term benefits to Irish milk producers. For these reasons, the Irish Cattle Breeding Federation and a Dutch-Irish consortium have carried out this project on breeding objectives and breeding programs for Irish dairy farmers.

Outline of the project

The outline of the project is given in Figure 1. The aim of the project is to establish the ongoing route for the establishment of a 'NEW RBI', taking into account not only milk production traits, but also functional traits such as fertility or longevity, and indicate breeding programs that optimize improvement in this 'NEW RBI'.



Phase 1: Consultancy

The aim of phase 1 was to collect facts, figures and views that are required to establish breeding objectives for Irish dairy farmers. An important outcome of phase 1 was to prioritize traits to be included in the calculations for a new RBI. Some traits might be included pretty quickly, because of their economic importance, and availability of traits for breeding value estimation. For other traits more research might be required in the long-term. Nine meetings were held with representatives from different organisations, including two open farmers meetings – see "Discussion report following phase 1: Consultancy of the industry" for details. The meetings were very informative for the project group, and participants were enthusiastic to be able to give input to the process of establishing a new RBI.

Several recommendations coming from the consultancy process were discussed with a cross-section of the industry in May, 2000. An important outcome of this meeting was that the further aim of this project should be to revise the current RBI to include weights for milk, fat and protein based on their industrial value, and to include an initial breeding value for fertility.

Aim of this report

In the first report we presented briefly the background to the development of a suitable breeding objective and breeding program for Ireland (Chapter 2) and summarised the major outcomes of the consultancy process (Chapter 3) underpinning the recommendations made in Chapter 4 of that report.

The aim of this report is to present the results and to describe the work done to derive the new index (Chapter 2) and to design an optimal breeding program for Ireland (Chapter 3).

Chapter 2 Derivation of breeding values and index weights

Introduction

Definition of the breeding objective should be the start of a genetic improvement program. In the previous report the general breeding objective is defined as increasing profit for dairy farmers including several traits of economic importance, but priority should be given to fertility and yield. Implementing a new index requires two steps:

- breeding value estimation procedures for milk, fat and protein yield and fertility
- weighting these breeding values in an index using their relative economic values

Breeding values estimation procedures for the yield traits are readily available by ICBF, so a breeding value estimation procedure for fertility needs to be developed only. Fertility contains many components, and ideally a breeding value for fertility should encompass all costs and returns associated with a change in fertility, and identify genetic variation among animals most accurately. In Ireland only calving dates are currently available for breeding value estimation, allowing the calculation of calving interval. The disadvantage of calving interval is that only animals with a next calving have this trait recorded. Thus, animals with the worst fertility have no records included, especially in seasonal calving systems. For this reason, a simultaneous analysis of calving interval and re-appearance in the first lactation is suggested. Animals that re-appear have calving interval information, and animals that do not re-appear are identified as being culled (for many reasons, but including fertility). Hence, breeding values for percentage re-appearance and calving interval estimated simultaneously, are expected to recover most genetic variation in fertility that can be recovered from calving dates, and include information on both components of fertility. Thus economic values for milk, fat and protein yield, calving interval and re-appearance will be calculated, variance components will be survival for grass based systems of milk production in Ireland.

Breeding values for calving interval and Re-appearance

Data handling

The data used in this study was obtained from all milk recording organisations in Ireland and similar to that used for the routine genetic analysis of milk production traits. Re-appearance (RAPU) was defined if an animal survived or not in the first lactation. Only cows with a completed or closed lactation or those with a chance to reappear in the second lactation were included in the analysis. For each cow, the age at first calving was calculated while the calving interval (CIV) was derived from calving dates (from first to second lactation). Cows that did not survive the first lactation (RAPU=0) where assigned a missing calving interval.

Reappearance was pre-adjusted for production to be consistent with breeding values for survival traits in most countries. The argument for this is that farmers might cull actively for yield and this would mask the variation in survival due to poor fertility if it is not taken into account. The 305-day cumulative milk yield of each cow was deviated from the mean of her HYS class. This was used in a preliminary regression analysis to derive correction factors for pre-correcting RAP.

Three calving seasons were defined by grouping calving months (January-April, May-August, September-December). Cows calving in the same herd in the same year and season were grouped in to one herd-year-season (HYS) class.

Genetic parameters

Genetic parameters were estimated on a subset of the data. Herd-year-month groups were selected that had at least 5 animals included. Other adjustment factors included: quadratic regression on age at calving and third order polynomial for Holstein percentage. The residual covariance between calving interval and re-appearance was undefined given the nature of the data (only animals re-appearing have calving interval available). A considerable bias was found in the correlation between CI and RAPU when milk yield was not included in the analysis simultaneously. Therefor three and five traits analysis were performed. The estimated variance components are given in Table 2.1.

Table 2.1 Estimated genetic parameters (genetic correlations below the diagonal, phenotypic correlations above the diagonal). A more conservative estimate for the heritability was used in the calculations.

	Reappearance adjusted for MY	Calving interval	Milk yield	Fat yield	Protein yield
Phenotypic s.d.	36	38	697	27	21
Heritability	0.01	0.04	0.56	0.52	0.54
Scaled heritability	0.01	0.03	0.41	0.38	0.39
Reappearance		0.00	0.00	0.02	0.02
Calving interval	-0.27		0.13	0.10	0.12
Milk yield	0.22	0.40		0.75	0.92
Fat yield	0.33	0.34	0.71		0.81
Protein yield	0.37	0.30	0.91	0.83	

Breeding value estimation

Breeding Values were estimated for all sires using the same dataset and model as previously defined for variance component estimation. Estimates of PD's for Re-appearance (%) and CI (days) for 434 bulls with at least 50 daughters are given in Table 2.2.

Table 2.2 Mean Predicted Differences (i.e., 0.5*EBV) for a group of proven bulls

	Mean	Min	Max	St. Dev
Re-appearance (%)	0.6	-2.5	4.6	1.2
Calving Interval (days)	0.8	-6.0	11.0	3.0

Economic values

Methodology

Economic values were obtained by simulating a typical default dairy farm and then evaluating the increase in profit that the farm would obtain by having genetically superior animals for milk, fat, protein yield, calving interval, and survival (or re-appearance). To avoid double counting each trait is increased in turn, whilst keeping the other traits constant. In other words, increases in fat and protein yield were simulated by increasing the percentages (keeping kilogram carrier constant). Similarily an increase in milk yield was simulated at constant fat and protein kg. For culling percentage default levels in each month were increased by a fixed proportion. For calving interval a more complex approach was required. This is because, apart from a longer lactation period, a long-term change in calving pattern had to be simulated.

Bio-economic model

The Moorepark Dairy Planner was used for this purpose (Walsh, 1985; Kelly, 1999). This extensive model resembles a dairy farm as closely as possible. Physical performance of the default farm simulated is shown in Appendix 1, the financial overview is given in Appendix 2, a description of the model parts is given in Appendix 3, a typical ration for January, February, March and April calving cows in Appendix 4, and the assumed milk payment scheme is described in Appendix 5. Opportunity costs were taken into account for land and labour. Although individual farms might differ from the farm simulated, economic values might not be affected, as economic values are the effect on profit of a small change for each trait. This marginal effect might be relative insensitive to assumptions made. To investigate sensitivity of economic values, economic values were calculated for a range of different herd parameters, cost and return situations also. Two special scenarios were investigated. In the first scenario there was no quota, a lower milk price with a fat to protein ratio of 1:3 an d a higher milk yield per cow. This was considered the most realistic scenario if EU milk quotas were discontinued in the year 2008. The consequence of a possible future change in industry practises, i.e. drying of all cows in January, was also simulated.

Handling of quota

The level of milk production in Ireland is currently limited by a quota introduced by the European Union in 1984. At producers' level the quota is on milk yield adjusted for fat content. Quota increase or decrease with changes in fat content compared with the reference year level in 1984 using the following formula: Adjusted Quota = Quota (1 + 0.18 (BF% reference year – current BF%)). For the calculation of economic values in this study three different scenarios were simulated. Firstly, it was assumed that quotas apply at industry level, but at farm level long term leasing or purchasing of restructuring milk is possible. Under this assumption quota becomes a variable cost for the individual farmer, rather than an output restriction and a fixed number of cows is assumed as base of evaluation. Secondly, it was assumed that farmers are locked into their quota and the consequence of genetic selection for higher yield will be a smaller number of cows (evaluation base is fixed output). It is uncertain if milk quotas will remain, and therefore as a third scenario it was desirable to calculate economic weights assuming no quota. Thus economic values were calculated for the following scenarios:

1. A fixed number of cows in an EU quota environment (S1). Any production in future years above the herd EU production quota would be subject to a charge of 7.5p/liter, and milk production is not constraint by production quotas but number of cows.
2. A fixed number of cows in a non-EU quota situation (S2), i.e. increase milk production is not constraint by production quotas but number of cows.
3. Fixed EU quota (output) with variable number of cows (S3), i.e. increase milk production is constraint by production quotas.

Additional to these three distinct scenarios, the quota lease price was also varied between 0 pence per litre (i.e. no quota scenario) and a very severe penalty for quota (15 pence per litre) and economic values were calculated.

Results herd simulation

Average milk, fat and protein yield were 5533, 204.7, 185.1 kg per cow respectively, based on a 365 day calving interval and a culling percentage of 15% for the default scenario (Table 2.3). A total of 55.1 cows calved producing 304,828 kg of milk of which 294,696 was sold comprising of 10,899 kg of fat and 9867 kg of protein. The remaining 10,132 kg of milk was fed to calves. In the default scenario the margin per cow and per litre are £272 and 4.92p, respectively, giving a total model farm profit of £15005.

Increasing genetic merit for milk yield in scenario S1, while maintaining the same level of fat and protein yield, resulted in a small increase in land use, milk production and extra lease of milk quota. However, milk returns and overall profit are lower, as payment is based on fat and protein yield, and there is a penalty attached to carrier. Increasing the genetic merit for fat and protein yield, while maintaining similar milk yield, increased margin per cow by £1.4 and £8.3 respectively, while margin/litre increased by 0.03p and 0.15p respectively. The greater financial increase for an increase in the genetic merit for protein is a result of the higher protein to fat price ratio, and the quota leasing charges related to fat.

Reducing culling percentage from 15% to 14.9% resulted in an increase margin per cow of £1.2. Reduced culling resulted in an increased number of cows finishing their lactation. The increased returns (£0.60 per cow) was however, cancelled out by the reduced income from livestock sales (-£0.40 per cow), plus the higher quota leasing, labour, land and concentrate costs. However, there was saving on livestock purchase of £1.52 per cow.

Increasing calving interval by one day resulted in a reduced margin per cow of £1.6. The lower margin per cow came from lower livestock sales (-£0.58) and higher total costs per cow (£6.85), plus higher milk returns (£5.19). The increased total costs were mainly as a result of increases in fertiliser (£1.52), land rental

(£1.24), silage making (£3.03), labour (£0.71) and quota leasing (£1.38) costs, while with concentrate costs there was a saving of £1.88/cow.

A 1% increase in the genetic merit for fat yield in a non-quota scenario with fixed number of cows (S2), increased margin per cow and per litre by £4.10 and 0.08p respectively. In S2, the increase in total receipts is greater than the increase in total costs. However, an increase of 1% in genetic merit for fat yield in a fixed output scenario (S3) results in an increase of £1.10/cow and 0.02p/litre, but overall farm profit is reduced. The reduced number of cows, plus the savings in costs did not compensate for the reduced sales of livestock and reduced milk returns. The latter primarily due to reduced protein sales.

Table 2.3 Key herd parameters in the default situation, and when an increase in genetic merit is simulated (only shown where different from default). For milk, fat, protein yield, survival and calving interval under the "quota lease and fixed number of cows" scenario (S1), and for fat yield only under the two other scenarios

	Default	Fixed number of cows, quota (S1)					Fixed number of cows (S2)	Fixed output, quota (S3)
		Milk	Fat	Protein	Survival	CIV	Fat	Fat
Milk per cow (kg)	5533	5588			5536	5526		
Fat yield per cow (kg)	204.7		206.7		204.8	205.4	206.7	206.7
Protein per cow (kg)	185.1			187.0	185.2	185.9		
Calving interval (d.)	365.0					366.0		
Culling percentage	0.150				0.149	0.150		
Milk price (p/kg)	21.1	20.9	21.2	21.3	21.1	21.2	21.2	21.2
Acres used for silage	42.0	42.1	42.1	42.1	42.1	44.3	42.1	41.8
Total acres used	59.0	59.1	59.1	59.1	59.0	59.7	59.1	58.7
Quota lease	0.0	1071.7	1997.0		151.7	576.3		
Cows Calving	55.1							54.7
Livestock units (LU)	62.7				62.8	63.0		62.3
Stocking rate (LU/ac)	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
Labour units (h.)	1658	1659			1659	1662		1654
Milk produced (kg)	304828	307877			304978	304446		302763
Milk sales (£)	294696	297744			294845	294314		292699
Fat sales (£)	10899	10902	11007		10904	10937	11007	10933
Protein sales (£)	9867	9871		9966	9872	9905		9800
Milk returns (£)	64305	64232	64567	64780	64339	64591	64567	64130
Livestock sales (£)	20639				20617	20607		20499
Total costs (£)	69939	70058	70125	69956	69882	70283	69975	69661
Total profit (£)	15005	14814	15082	15464	15074	14915	15231	14968
Margin per cow (£)	272.4	268.9	273.8	280.7	273.6	270.7	276.5	273.5
Margin per litre (pence)	4.92	4.81	4.95	5.07	4.94	4.90	5.00	4.94
Feed costs per litre (pence)	4.32	4.29	4.33	4.33	4.32	4.38	4.33	4.33

Results economic values

The resulting economic values (or index weights) in £/unit are shown in Table 2.4. Comparison is however difficult as traits are expressed in different units. Therefore standardised economic weights are also shown. Increasing protein yield is the most important economically. The economic value for fat yield is dependent on the scenario selected. In the scenario where excess quota is compensated by a reduction in cow numbers (S3) the economic value for fat yield becomes negative.

Table 2.4 Economic values (in IR£ per unit and IR£ per genetic standard deviation) for milk, fat and protein yield, survival and calving interval

	Milk	Fat	Protein	Survival	CIV
			IR£ per unit		
Fixed number of cows, quota (S1)	-0.06	0.68	4.49	8.98	-1.63
Fixed number of cows (S2)	-0.04	2.00	4.49	10.47	-0.85
Fixed output, quota (S3)	-0.08	-0.33	4.49	7.86	-2.21
			IR£ per genetic standard deviation		
Fixed number of cows, quota (S1)	-0.47	0.19	1.00	0.56	-0.21
Fixed number of cows (S2)	-0.27	0.57	1.00	0.66	-0.11
Fixed output, quota (S3)	-0.61	-0.10	1.00	0.49	-0.28

Index weights in Table 2.4 can be used to calculate a combined index for every animal that has breeding values available. For example for the different scenarios the index calculations are:

Breeding Index IS1= -0.06 BV milk + 0.68 BV fat + 4.49 BV protein + 8.98 BV reappearance –1.63 BV calving interval
Breeding Index IS2= -0.04 BV milk + 2.00 BV fat + 4.49 BV protein + 10.5 BV reappearance – 0.85 BV calving interval
Breeding Index IS3= -0.08 BV milk – 0.33 BV fat + 4.49 BV protein + 7.86 BV reappearance – 2.21 BV calving interval

Each index is expressed in Punts and reflects the extra total profit expected from selecting a superior animal. Each index is theoretically the optimal index for each scenario, i.e. if there are no quotas and assuming the other costs and returns in the model are realistic, index IS2 should give the highest economic gain from selection.

Sensitivity analysis

Assumptions in the model

Table 2.5 shows the sensitivity of the economic values to several assumptions in the default model. Increasing farm scale by either, increasing yield/cow or simply milking more cows, had little effect on the economic values. The exception being that the economic value for calving interval was reduced at the higher milk yield level. At lower milk price, the economic values of both, milk and fat yield are reduced, while the importance of survival and calving interval increased, relative to protein yield. The opposite is true at higher milk price. At lower milk price, or a higher protein to fat milk price ratio, the economic value for fat is close to zero. The economic value for fat is likely to become negative, with scenarios that have a higher protein to fat price ratio and increased quota leasing costs. Increasing replacement costs increase the economic value for both calving interval and survival, relative to protein yield, while increase cull cow value has little effect. The scenario 2008 is very close to S1 and S2. The scenario in which cows are dried of on January gives a much higher economic value to fertility. However, several assumptions in the model might be violated if this scenario becomes more realistic.

Severity of the quota

Figure 2.1 shows the effect of quota leasing price on the economic values for milk, fat and protein yields. An important point is between 11 and 12 pence where the economic value of fat turns negative. Scenario S2 is obviously equivalent to the no quota leasing costs, but a lease price of 13 pence gives economic values for milk, fat and protein, and survival and calving interval of -0.08, -0.30, 4.49, 7.88 and -2.21, respectively. These are equivalent to the economic values for S3 (Table 2.4). Thus the major difference in economic values between scenarios 1, 2 and 3 can be explained by the severity of quota costs.

Figure 2.1. Economic values for milk, fat and protein yields assuming different quota lease prices.

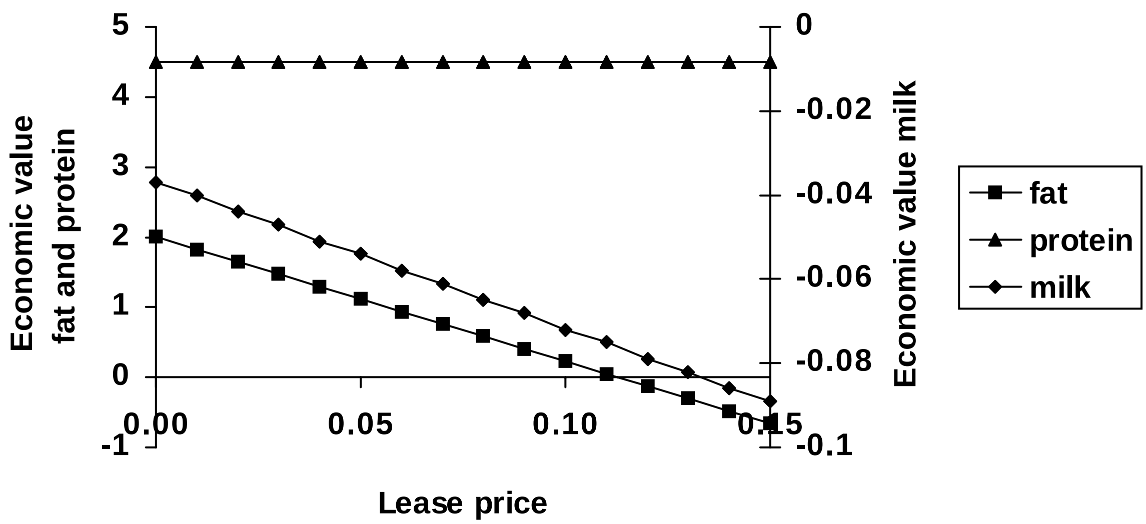


Table 2.5 Sensitivity of economic values to several assumptions in the default model.

	Default	Changes from default model											
	S1	Farm scale		Milk price		Fat to protein ratio		Cost price				Scenario 2008	Dry in January
Milk per cow (kg)	5533		7138									6086	5398
Farm size (acres)	59.0												60.1
Quota (kg milk)	294696	383105	383084										295437
Cows Calving	55.1	71.6	55.1										56.7
Gross milk price (pence)	24.0			26.4	21.8							19.2	
Fat price (pence)	235.3			258.8	213.9	177.8	347.8					142.2	
Protein price (pence)	470.6			517.6	427.8	533.3	347.8					426.7	
Price protein to fat	2.00					3.00	1.00					3.00	
Quota lease price	0.075												
Replacement heifer price	1100							917	1320				
Culled cow price	325									260			
Labour costs/month	1200										1560		
Milk (IR£ / kg)	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.06	-0.04	-0.06
Fat (IR£ / kg)	0.68	0.68	0.69	0.91	0.47	0.11	1.80	0.68	0.68	0.68	0.68	1.08	0.69
Protein (IR£ / kg)	4.49	4.49	4.53	4.96	4.07	5.12	3.27	4.49	4.49	4.49	4.49	4.07	4.49
Survival (IR£ / %)	8.98	8.98	9.65	9.48	8.52	8.97	8.99	7.12	11.21	9.57	8.78	9.73	8.89
CIV (IR£ / d.)	-1.63	-1.65	-0.61	-1.14	-2.07	-1.59	-1.69	-1.57	-1.70	-1.68	-1.84	-1.47	-13.78
Milk (IR£ / genetic s.d.)	-0.47	-0.47	-0.48	-0.42	-0.52	-0.41	-0.64	-0.47	-0.47	-0.47	-0.48	-0.32	-0.47
Fat (IR£ / genetic s.d.)	0.19	0.19	0.20	0.24	0.15	0.03	0.71	0.19	0.19	0.19	0.19	0.34	0.20
Protein (IR£ / genetic s.d.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Survival (IR£ /genetic s.d.)	0.56	0.56	0.60	0.54	0.59	0.49	0.78	0.45	0.70	0.60	0.55	0.68	0.56
CIV (IR£ / genetic s.d.)	-0.21	-0.21	-0.08	-0.13	-0.29	-0.18	-0.30	-0.20	-0.22	-0.22	-0.24	-0.21	-1.77

Selection on different yield indices

Top 1000 bulls on RBI

In Table 2.6 are the results when all three indices are calculated for the May 2000 top 1000 bulls on RBI. Compared with the RBI, there is more spread and a wider range of values for bulls. Still on average these bulls increase profit considerable, and this increase is largest in the scenario where there is least impact of quota (S2).

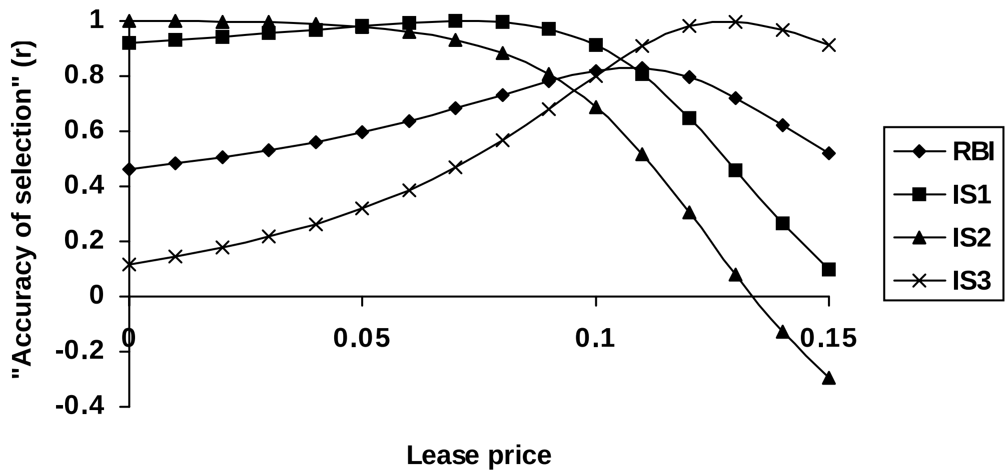
Table 2.6 Results when RBI, and the three new indices (without survival and calving interval) are calculated for the May 2000 top 1000 bulls on RBI.

	RBI	IS1	IS2	IS3
Mean	119	IR£38	IR£59	IR£20
Standard deviation	2.9	6.8	13	4
Minimum	116	17	19	8
Maximum	134	67	96	42
Range	18	50	75	34

If the four indices in Table 2.6 lead to different bull selection is an more important question (i.e. indices might differ, but as long the ranking of bulls is similar, you end up picking the same bulls). A correlation of 0.92 was found for the top 1000 bulls ranked on IS1 and IS2. Hence similar bulls will be selected on these two indices and therefore there is little discussion needed on which index is best. The same was true for all scenarios investigated in Table 2.5. The correlation between IS1 and all other yield indices in Table 2.5 was 0.97 or higher, except when the protein to fat ratio was 3:1 the correlation was 0.94 and when the ratio was 1:1 the correlation was 0.73. Thus only when the relative price of protein is reduced compared to fat there is a re-ranking.

A different story are the correlations of IS3 with IS1 and IS2, these were 0.49 and 0.12, respectively. Thus selection on IS3 leaves little benefit for a scenario without quota (S2), and is inefficient when scenario S1 is more realistic. This re-ranking of bulls is demonstrated clearer in Figure 2.2. The direction of selection among these bulls clearly changes under severe quota circumstances. The turning point is a 11-12 pence lease price where the economic weight for fat becomes negative and direction of selection is different from a moderate or no quota scenario. Selection on IS3 among these bulls appears wasted when quotas disappear.

Figure 2.2 Correlation between top 1000 bulls ranked on optimal index for a range of lease prices or RBI, IS1, IS2 or IS3.



Predicted effects of selection

To assist in choosing between the scenarios for the weights on milk, fat and protein yield, more detailed prediction of the effects of selection on yield are calculate using the genetic parameters. A more precise calculation of the selection response follows in the next Chapter, here it is assumed that 0.22 genetic standard deviation progress is made each year. The results in Table 2.7 show that whatever scenario is taken, genetic selection can improve the margin per cow considerable. Even in scenario S3 where the output per farm can not be increased, an increase in profit is expected. Also, all scenarios increase yield of solids and improve milk quality. Index IS3 gives more emphasis on increasing protein percentage compared with index IS1 and IS2.

Table 2.7 Predicted effects of selection for ten years using a simple breeding scheme (i.e. 2.2 s.d.) and one of the three profit indices. Margin only applies within the scenario that the index is developed for.

	Current production	IS1	IS2	IS3
Margin within each scenario (IR£)	0	+114	+182	+64
Milk yield	5533	6368	6415	6158
Fat	205	242	244	234
Protein	185	216	216	213
BF%	3.70	3.80	3.80	3.80
P%	3.35	3.39	3.37	3.45

Predicted effects of selection on farm economics

To evaluate the economic consequences of the different profit indices more closely, the production levels following from ca. 10 years of selection in Table 2.7 are inserted in the economic model. Full details of the outcome are in Appendix 6, and several conclusions can be drawn:

- Compared with the default situation, genetic selection improves total profit whatever index, scenario or combination of these two is used. The increase in profit is due to cost reduction and higher returns.
- Each index gives the highest profit in the scenario it id designed for. When extra profit is expressed per cow which we have to inseminate today (the formal way this should be done),

then profit increases by IR£114, IR£186 and IR£56 for index IS1, IS2 and IS3, respectively. Hence this is close to the predictions in Table 2.7, considering only a linear prediction is made.
- IS3 leads to higher costs for milk production. When ignoring the quota costs (S2), the cost price per kg milk is 0.61 and 0.74 pence higher compared with IS1 and IS2. This is partly compensate by the 0.28 and 0.37 pence higher price per kg milk (i.e. that processors can pay for higher quality milk), but when all returns and costs are expressed per kg protein, IS3 has lower returns and higher costs. Labour is an important component of these higher costs.
- In the no-quota scenario (S3) the benefit from IS3 cows is partly due to higher livestock sales.
- Scenario S1 reflects best the future constraints to increase milk production at farm level. In term of farm economics it is very close to S2 and S3

Synthesis

Variance components were estimated for milk, fat and protein yields, and reappearance (adjusted for yield) and calving interval. Economic values were derived for three distinct scenarios dealing with quota. Bull rankings, selection responses and economic effects of selection were compared. Direction of selection was robust to assumptions made, apart from the quota scenario. If severity of quota would increase significantly, a negative weight for fat would be more appropriate,

After discussing the different options with representative of the dairy industry it was considered that S1 was most appropriate for the Irish dairy industry because: (1) It reflects best what is happening in the Irish dairy industry i.e. reduced number of dairy farmers with a cost associated with the increased quota on these farms. (2) It also reflects a non-quota environment in that increased milk production is linked to a reduced milk price (quota cost) and that it penalises fat. Present indications are that in a freer market situation there is likely to be a higher protein to fat price ratio.

Breeding Index = -0.06 BV milk + 0.68 BV fat + 4.49 BV protein + 8.98 BV reappearance –1.63 BV calving interval

Th e expected effects of selection are given in Table 2.8. Although the index predicts the extra profit from daughters independent of accuracy, there is a shift in balance with a large number of daughters. For a proven bull the information from reappearance and calving interval is adding more to the index as these are estimated more. The extra increase in profit from adding re-appearance and calving interval ranges from 4 to 15%.

Adding extra predictors, like type traits, insemination data, additional lactation or body condition score might help improving the accuracy of breeding values for re-appearance and calving interval. These traits might also be available earlier than calving intervak and re-appearance.

Table 2.8 Predicted effects of selection per year with relatively low accuracy (50 daughters) or a proven bull.

	50 daughters		Proven bull	
Profit (IR£)	11.7	12.1	12.7	14.5
Reappearance	0.29	0.35	0.31	0.59
Calving interval	0.29	0.10	0.32	-0.13
Milk yield	68.8	58.1	75.2	57.6
Fat yield	3.0	2.8	3.3	2.7
Protein yield	2.6	2.4	2.8	2.4
		3.8%		14.7%

Chapter 3 Optimal breeding program

Introduction

At present Irish cattle breeding schemes are rather small in scale compared to their international counterparts. This results in a threat that all or most of Irish cows will be inseminated by foreign bulls. The latter has two drawbacks: (1) in the long term Irish breeders will have to follow international genetic trends, while the Irish situation might ask for more specific genetics; (2) a substantial part of the revenues from cattle breeding will go abroad.

The aim of this part of the project was therefore to perform a preliminary study on the competitiveness of larger scale Irish breeding programs. The focus will be on three aspects of the breeding program:
- Competitive position relative to foreign sires
- Economic optimisation of progeny testing
- Genetic gain.

Competitive position relative to foreign sires

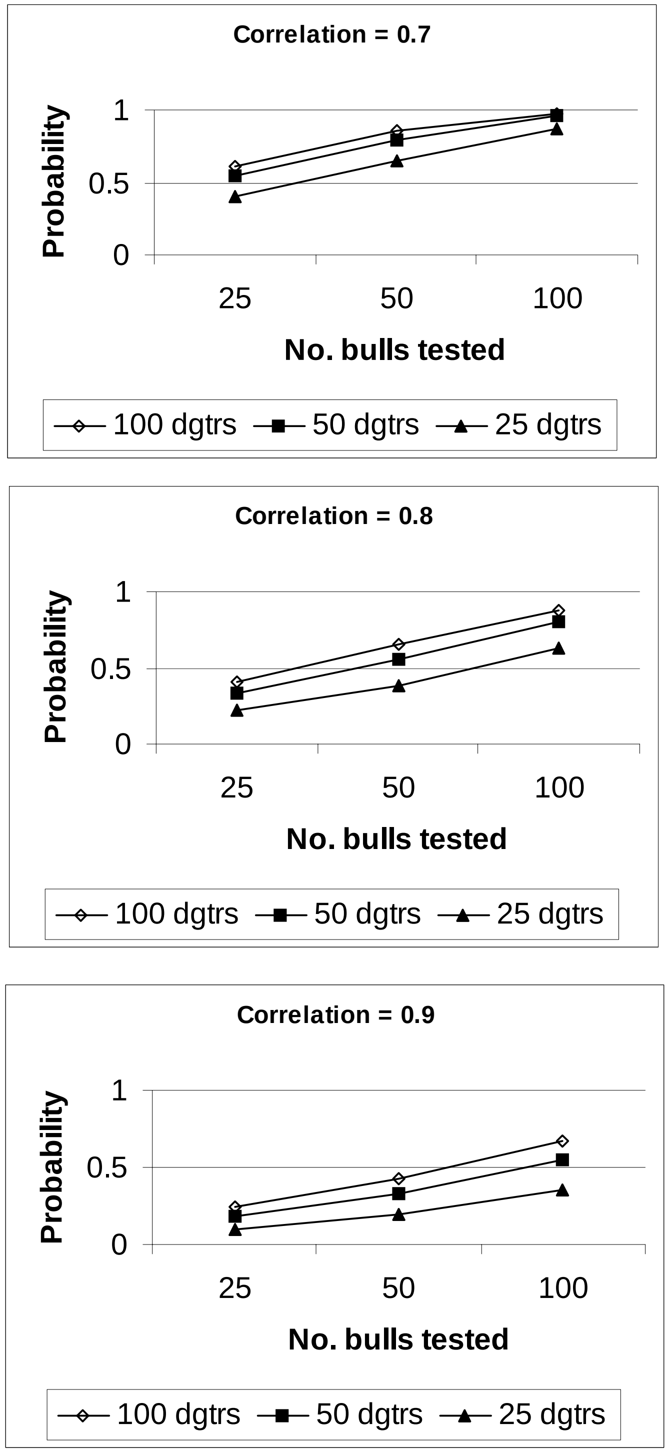
We will consider here the probability of having Irish bull(s) within the top 10. For this to happen, the EBV of at least one Irish bull has to exceed the genetic level of the 10th best foreign bull. The threshold that this Irish bull needs to exceed is the EBV of the 10th best foreign bull. In the following we will calculate the probability that at least one bull from the Irish breeding program exceeds this threshold. The assumptions made to perform these calculations are:

- the genetic level of young Irish bulls equals that of foreign bulls. This assumption is justified even when foreign genetics is superior because Irish young bulls can be produced by contract matings abroad. In fact, the genetic level of Irish young bulls can exceed that of foreign young bulls, because the Irish bulls are selected for the Irish breeding goal, which differs from the foreign breeding goal.
- world wide there are about 2000 young bulls tested in countries that are active in exporting semen.
- foreign bulls obtain about 80 daughters each.
- genetic correlation between the average foreign breeding goal and the Irish breeding goal is varied between 0.7 and 0.9. This correlation is lower than 1 because: a) e.g. milk production in Ireland is biologically a somewhat different trait than milk production abroad, because of specific Irish circumstances; b) the recorded traits that are slightly different, e.g., longevity versus reappearance in a second lactation; c) the weighting of the traits in the breeding goal differs.
- number of young bulls tested in Ireland is varied from 25 – 100.
- because contract matings for Irish bulls occur in a large world wide population, it is assumed that increasing the number of progeny tested bulls in Ireland hardly reduces their genetic level.
- number of daughters per Irish bulls is varied from 25 – 100 effective daughters.
- heritability of the Irish breeding goal is 0.31, i,e. close to the heritability of the new breeding index described in the previous chapter

Figure 3.1a, 3.1b and 3.1c show the probability that one or more Irish bulls rank within the top-10 of the Irish index. The number of bulls tested may be expressed as a number per year but also as a number per, say, 2-3 year period, where we assume that a bull that enters the top-10 stays there for 2-3 years. In the latter case, the graphs show the probability that one Irish bull is within the top-10 at any point in time.

These graphs show substantial probabilities of Irish bulls ranking in the top-10 especially when the genetic correlation is below 0.9 and the number of bulls tested and effective number of daughters both exceed 25.

Figure 3.1 The probability that an Irish bulls enters the top-10 of the Irish breeding value index, as a function of the number of bulls tested, the effective number of testdaughters per bull, and the genetic correlation between the Irish and foreign breeding goals.



Economic optimisation of progeny testing

It is important to have bulls in the top 10 in Ireland to maintain a market share, however obviously a larger breeding scheme has not only the highest gain, but also the highest costs. Therefore costs of the breeding scheme should be taken into account when optimising size. Here we will optimise the size of the progeny test under a fixed budget, B, where the budget is used for :
- buying (or contract mating) and raising young bulls
- obtaining records from test daughters

This implies that the budget, B, equals:

$$B = t * (n*C+K)$$

where t = number of bulls tested; n = effective number of test daughters per bull; C = costs per effective test record; K = fixed costs of buying/raising a bull. Given this fixed budget we want to choose the number of bulls to progeny test, t, and the number of test records, n, such that the probability of having a progeny tested bull in the Irish top-10 is maximised.

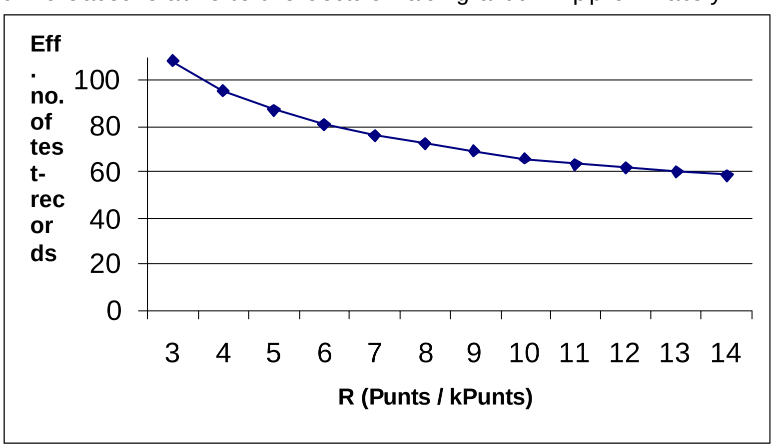
The costs of buying and raising young bulls are varied but a default value of K=10,000 Punts is assumed. The costs of a test records are varied as well, but the default value is C=70 Punts. In fact only the ratio of these two costs is relevant for the optimisation, and the default value of this ratio is:

$$R = (C / K)*1000 = 7 \text{ Punts/kPunts}$$

i.e. in this ratio R, the costs K are expressed in thousands of Punts (in order to make the values of R less extreme). To save the day, another simplification occurs: the optimum number of test-daughters per bull does not depend on the total budget but only on the ratio of the costs, R. Strictly, this simplification only occurs if we maximise the probability of having a bull in the top-10 (as was done here), but it will also approximately occur when we maximise genetic gain instead.

In Figure 3.2 the ratio of the costs of an effective test-record over the costs of raising a bull is varied from 3 – 14 Punts/kPound and the optimum number of progeny per young bull is plotted. The optimum number of test records is rather flat and varies between 60 and 100, where the larger numbers are obtained when R is low, i.e. when a test record is cheap relative to the raising of an extra bull. Note that the optimum numbers in this figure are expressed in effective numbers, the actual number of test records will be larger because herd sizes are limited.

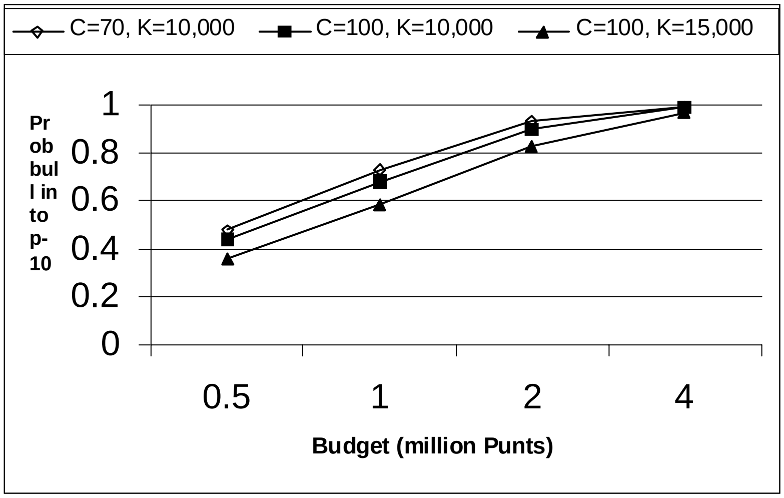
Figure 3.2 The optimum effective number of test records per young bull when the ratio, R, of the costs of having a test record increases relative to the costs of raising a bull. Approximately R = 7 in Ireland.



In Figure 3.3 the probability of having an Irish bull in the top-10 as a function of the budget for progeny testing when the costs of raising a young bull (K) and the costs of an effective test record (C) are varied.

At the costs C and K in Graph 3, it seems that the budget for progeny testing has to exceed 1-2 million Punts in order to have a reasonably high probability of an Irish bull entering the top-10. As before this budget can be expressed either per year, or per 2-3 year period (if this is the average time a bull stays in the top-10). If the budget is expressed per 2-3 year period we want a higher probability of having a bull in the top-10, because costs of having no bull in the top-10 for a 2-3 year period are rather high.

Figure 3.3 The probability of having an Irish bull in the top-10 as a function of the budget and the costs of raising a bull (K) and the costs of a test record (C).



A budget of about 2 million punts per year implies a costs of 4 punts per first insemination (assuming 500,000 first inseminations). Hence, the costs of an Irish progeny-testing scheme seem a lot lower than buying foreign semen. In the next paragraph the financial returns of such a scheme are estimated.

Genetic Gain

In this section we predict the genetic gain that will be generated by the Irish breeding scheme, both in terms of improved yield as in economic margin. It is important that the Irish breeding schemes generates a genetic gain that is competitive with the foreign schemes, such that it will not be highly dependable on import of foreign genetics for a long period of time. The advantage of having an Irish scheme that is not highly dependable on import of genetics is that the direction of the genetic gain is determined by the Irish breeding goal instead of by the foreign goal. Hence, we will predict genetic gains here as if the Irish breeding scheme is a closed scheme.

These predicted genetic gains make also a cost-benefit analysis at the national level possible. Because foreign genetics can increase genetic gain above that of a closed scheme, the predictions made here should be considered as conservative estimates of genetic gain. Also, if the Irish breeding scheme is competitive with foreign schemes, the genetic gain with and without foreign genetics will not differ much.
The detailed assumptions made about the Irish scheme are given in Table 3.1. In short the scheme contains 300,000 milk and pedigree recorded cows, which are sired by AI service sires. It is assumed that the top-30 bulls are used for AI service. In practice this number will be higher, but after weighing by the contributions of the sires this number seems reasonable. In order to compare the schemes at equal risk/inbreeding, the coefficient of variation of 10 years of selection response is set at 10%, this means that if the predicted response after 10 years is 100 the realised response will vary between 80 and 120 (i.e. varies between 80 and 120%). This restriction on the variability of the selection response also implies a inbreeding restriction of about 0.5 % per year. It is assumed that about 2 bull dams need to be selected in order to obtain 1 young bull, which means no or very limited use of MOET. The progeny test assumes

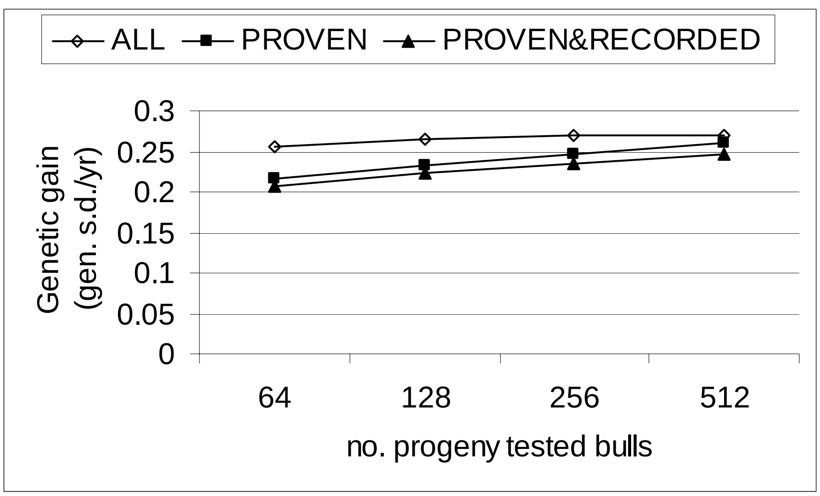
that about 100 daughters per young bull are obtained. The restrictions on the age of the animals that are eligible for selection are varied.

Table 3.1 Parameters of the progeny testing scheme.

No of milk and pedigree recorded cows		300,000
No of AI service bulls		30
No of number young bulls progeny tested per year		N_{YB} (is varied)
No of daughters per progeny tested bull		100
Number of bull sires		Optimised
Number of bull dams		$2*N_{YB}$
Eligible for selection :	ALL	all reproductive ages
	PROVEN	> 5-yr-old bulls
	PROVEN&RECORDED	>5-yr-old bulls & >3-yr-old cows

Figure 3.4 shows the genetic gains generated by the breeding schemes expressed in genetic standard deviations per year. The optimum of the number of progeny tested bulls seems to be very flat. The reason why more progeny tested bulls does not always result in more genetic gain is that the number of test-daughters approaches 100 % of the total young heifer population when 512 young bulls are progeny tested. If all heifers are test-daughters of young bulls, we do not have any genetic progress in the selection of sires for cows path anymore which results in a reduced genetic gain. If only proven bulls are selected, genetic gain is reduced by about 8%, and if also cows are required to have at least one lactation, genetic gain is reduced by about 13%.

Figure 3.4 Genetic gain (in genetic stand. dev. /yr) as a function of the number of young bulls tested. (ALL = all animals are eligible for selection; PROVEN = only proven bulls are selected for AI service and as bull-sires; PROVEN&RECORDED = same as PROVEN and only cows with at least one lactation are selected as bull-dams).



The genetic gains of in Figure 3.4 are high. For instance, if we would select for milk production alone, which has a genetic standard deviation of 500 kg, a genetic gain of 0.27 gen. s.d. /yr equals 135 kg milk per year, or 1350 kg milk over 10 years. Similar response rates are achieved in some competing foreign schemes, but as mentioned before they are selecting for a somewhat different breeding goal. MOET could be used to intensify the selection within a closed nucleus herd and further increase genetic gains.

Overall benefit of the breeding scheme and index

The predicted genetic gains per trait per year are given in Table 3.2 for an optimal breeding program. In the previous chapter it was shown that gains depend on teh acuracy of selection. Overall, using the new breeding index in this simulated breeding scheme is expected to increase profit with IR£17.8 per cow per year (i.e. IR£178 over ten years as genetic improvement is cumulative). Everything else being equal, and performing simple sums, there is thus a considerable margin between the costs 4 punts per cow per year for an optimal progeny testing scheme and the yearly increase in profit per cow per year.

Table 3.2 Annual selection response per trait and for profit per cow per year using different number of daughters per bull. Gains are calculated for a standardised gain in profit of 17.8 punts per cow per year.

Trait	IS1
Profit	IR£17.8
Reappearance	0.51 %
Calving interval	0.14 days
Milk yield	85 kg
Fat yield	4.0 kg
Protein yield	3.5 kg

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Appendix 1: Default farm characteristics

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Total
Farm Size (acres)	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	59.00	
No. of LU	56.97	62.86	65.48	63.57	61.92	61.26	60.94	63.00	64.56	64.70	64.29	63.06	752.60
Farm stocking rate (LU/ac)	0.97	1.07	1.11	1.08	1.05	1.04	1.03	1.07	1.09	1.10	1.09	1.07	12.76
Cows Calving	0.00	27.55	22.04	5.51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	55.09
Cows culled +died	1.42	1.03	0.82	0.71	0.82	0.65	0.31	0.28	0.31	0.32	0.39	1.21	8.27
Milk Sales(kg)(less whole milk fed)	6,330	8,461	25,235	38,276	40,367	37,038	33,025	29,946	25,436	21,602	15,861	13,118	294,696
Silage(acres)	0	0	0	0	25	0	17	0	0	0	0	0	42
0-7-30 used (50kg bags)	0	0	0	50	0	50	0	0	0	0	0	0	101
0-10-20 used (50 kg bags)	0	0	0	0	0	0	0	0	0	88	0	0	88
Total grazing CAN (50kg bags)	0	0	0	68	34	84	42	84	59	0	0	0	371
Total grazing urea(50kg bags)	59	0	34	0	0	0	0	0	0	0	0	0	93
Total silage CAN(50kg bags)	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Silage Urea (50kg bags)	0	0	0	88	0	42	0	0	0	0	0	0	130
Total lime used (tonnes)	0	0	0	0	0	0	0	0	0	44	0	0	44
Total CAN Use (50kg bags)	0	0	0	68	34	84	42	84	59	0	0	0	371
Total Urea Use (50kg bags)	59	0	34	88	0	42	0	0	0	0	0	0	223

	Total	/adj.ac	/cow	/L	/gal
Feed costs(punt)	13182.24	223.43	239.28	4.32	19.66
Conc costs(punt) cows only	3707	62.84	67.30	1.22	5.53
Conc (cows only)kgs	23614		428.64		

	Grass	Silage	Con.	Total
Kg DM Demanded	187,889	81,768	28,872	298,529
Kg DM Supplied	187,889	81,768	28,872	298,529
Balance	0.00	0.00	0.00	0.00
Total KG DM/L.U./DAY	8.21	3.57	1.26	13.04

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MILK YIELD TOTAL KG.	6330	11667	29660	40358	40751	37074	33025	29946	25436	21602	15861	13118
	266	457	1103	1436	1409	1244	1166	1092	969	904	684	545
	231	391	967	1292	1301	1178	1074	1009	888	805	584	479

Appendix 2: Default farm financial performance

Profit & Loss Account for year ending 31 Dec				/adj.ac	/cow calving	/L milk produced
RECEIPTS						
Milk		64305.10		1,089.92	1,167.25	21.10
Livestock		20639.10		349.82	374.63	6.77
TOTAL FARM RECEIPTS - OPERATIONS			84944.21	1,439.74	1,541.88	27.87
VARIABLE COSTS (PUNT)						
Concentrates	4600.11			77.97	83.50	1.51
Fertilizer, lime & Reseeding	5565.71			94.33	101.03	1.83
Land rental	5899.97			100.00	107.09	1.94
Livestock purchases	9091.91			154.10	165.03	2.98
Machinery hire	451.56			7.65	8.20	0.15
Milk replacer	0.00			0.00	0.00	0.00
Silage making	3016.41			51.13	54.75	0.99
Vet. AI & Medicine	3016.24			51.12	54.75	0.99
Quota lease	0			0.00	0.00	0.00
TOTAL VARIABLE COSTS		31641.92		536.31	574.35	10.38
FIXED COSTS (PUNT)						
Car use	2494.22			42.28	45.27	0.82
Electricity	696.22			11.80	12.64	0.23
Labour & living exp	19899.92			337.29	361.22	6.53
Machinery Operation & Repair	2451.06			41.54	44.49	0.80
Phone	360.00			6.10	6.53	0.12
Insur.,A/Cs,T'port,Sundries	1881.50			31.89	34.15	0.62
Loan interest on O/D ac.	0.00			0.00	0.00	0.00
Interest repay'ts- term loan	5413.14			91.75	98.26	1.78
Bank Charges	0.00					
TOTAL FIXED COSTS		33196.07		562.65	602.57	10.89
DEPRECIATION CHARGES (PUNT)						
Land improvements	1136.15			19.26	20.62	0.37
Buildings	1640.02			27.80	29.77	0.54
Machinery	2376.02			40.27	43.13	0.78
New fixed assets	0.00			0.00	0.00	0.00
TOTAL DEPRECIATION CHARGES		5152.19		87.33	93.52	1.69
TOTAL FARM COSTS	69990.17		69990.17	1,186.28	1,270.44	22.96
Interest earned	51.39			0.87	0.93	0.02
Sale fixed assets(Profit-Loss)	0.00			0.00	0.00	0.00
			51.39	0.87	0.93	0.02
FARM NET PROFIT (before tax)			15005.42	254.33	272.37	4.92

Appendix 3: Description of the model

Herd planner The herd planner starts with a given number of cows, which is broken down by month of calving. This provides information on the number of animals (young stock and milking cows) at the start and end of each month, and the number of animals culled, died, purchased or sold in each month. Replacements are bought as in-calf two year olds, partly from the own young stock (0.55 of the female calves were reared), and partly from outside. All male calves are sold after a month. Livestock valuations are used in the financial part of the model.

Milk production and feed requirements The lactation curves for milk yield and milk composition as affected by calving date and lactation stage arre obtained from spring calving herds (Crosse, 1986). Feed requirements for milk production, maintenance, live-weight change and pregnancy are calculated using standard equations (AFRC, 1993). The average live-weight curves during lactation is the weighted average of the weight curve in different lactations, similar to those used by others (Van Arendonk, 1985).
Feeding systems applied are based on current best practices on seasonal spring calving, pasture-based systems (O'Donovan, 2000). A feeding regime with fixed ratios of grass, silage and concentrate for each month of calving is used. This regime is not influenced by milk yield, and the amount of feed offered is used to cover energy requirements. As part of the sensitivity analysis, this system is compared with diets calculated using the effective energy systems (Emmans, 1994). In this system a least cost concentrate ration is fed, depending on energy requirement, the feed intake capacity of grass silage and concentrate (that depends on the weight of the cow and the feed quality) and substitution ratio.

Land and capital Land area is treated as an opportunity costs, with additional land rented when required, or leased when not needed for on farm feeding of animals. Grazing management, silage harvesting, and grass production are similar to that reported previously (Dillon *et al.*, 1995). Total yearly grass production is taken as 14.1 tons of dry matter per hectare. Hectares for first and second cut silage (ratio 3:2 respectively) and for grazing are optimised to provide silage and grass requirements. Costs for fertiliser application, reseeding, and silage making (contractor, additives, polythene) are based on the actual number of hectare required for silage and grazing. Land improvement and buildings are depreciated at 10% per annum and machinery at 20%, using the reducing balance method (O'Mahony, 1992). The book value at the start of January, for buildings and static machinery is in its 6th and 7th year since purchase, respectively. A 15 year bank term loan is required to fund the cost of the land improvement and buildings. The interest rate is fixed at 10% and is currently in its 7th year, where the interest portion of the repayment is considered an expense.

Labour requirements and cost. Labour requirement is divided between time associated with milking (droving, milking and yard washing), and other farm tasks. Droving cows for milking, yard washing and other milking-related activities, other than actual milking are given a fixed time of 1.4 hours per day (O'Shea *et al.*, 1998). Actual milking time per cow, per milking, is calculated as 73 seconds to enter the parlour, washing and putting on clusters, 175 seconds fixed milking time, plus 20 seconds for each 1kg milk (Gleeson, *Personal Communication)*. Actual milking time is divided by the number of cluster units in the milking parlour.
Other labour tasks are based on a fixed labour of 2.63 hours per day, plus 0.0356 hours per cow present, per day (O'Shea *et al.*, 1998). Total labour requirement per year as calculated, is for filled assuming 1,848 hours per labour unit, per year, and a costs of IR£14,400.

Other costs Variable costs (fertiliser, concentrate, replacements, contractor charges, medicine and veterinarian, AI, silage costs, re-seeding) were based on current prices (Teagasc, 1999). Similarly, fixed costs (machinery, maintenance and running costs, farm maintenance, car, electricity, telephone, insurance) were also based on current prices (Teagasc, 1999). Ideally, future prices should be used, but it is difficult to predict all prices for future scenarios. Therefore, it was decided to keep current price level, assuming that the relative current price levels are best predictors for the relative future price levels. Sensitivity analysis will be used to show how future price changes may effect economic values.

Appendix 4: Typical ration

Typical rations over a 365 day lactation (including dry period) for cows calving in different months of the year, calculated using two different feeding systems. The feed budget system is used in the simulations.

	Month of calving			
Least concentrate system	Januari	Februari	March	April
Total intake (kg/d)	4395	4449	4446	4355
Grass intake(kg/d)	2701	2818	2562	2563
Silage intake(kg/d)	1280	1386	1427	1198
Concentrate intake(kg/d)	414	246	457	595
Grass proportion	0.61	0.63	0.58	0.59
Silage proportion	0.29	0.31	0.32	0.27
Concentrates proportion	0.09	0.06	0.10	0.14
Feed budget system				
Total intake (kg/d)	4391	4434	4518	4488
Grass intake(kg/d)	2733	2781	2690	2620
Silage intake(kg/d)	1041	1195	1485	1531
Concentrate intake(kg/d)	616	458	344	337
Grass proportion	0.62	0.63	0.60	0.58
Silage proportion	0.24	0.27	0.33	0.34
Concentrates proportion	0.14	0.10	0.07	0.08

Appendix 5: Milk payment scheme

There is general agreement within the dairy industry that future breeding goals should reflect future industrial value of milk (first report). Hence, milk payment was based on fat, plus protein kilos delivered, minus the cost of 3.2p per kilo milk carrier. This cost for carrier included 0.88p for levies reduction, 0.84p for transportation (Keane *et al.*, 1998), and 1.28p for processing (O'Callaghan and Kelly, 2000). The relative price ratio of 1:2 for fat and protein, was based on world market price and international trends assuming an existing quota scenario (Simms *Personal Communication*). The gross milk price of 24p per litre was based on a reference 36.0 g/kilo fat and 33.0 g/kilo protein currently used by most dairy manufacturing companies. The average monthly calf and cull cow prices from 1996-1998 and feeder cow prices for 1998 were used (Teagasc, 1999).

	BF	P
Reference milk	3,60%	3,30%
Gross price kg milk	24	
Price ratio	1	:2
Gross price for fat kg	235	470
-VAT REFUND RATE (%/MONTH)	240	481
Deduction per kg carrier:		
EU levy	0.353	
Bord bainne levy	0.059	
Bord bainne dev. Levy	0.075	
TEAGASC levy	0.016	
Dept of Agric inspection levy	0.058	
IFA/ICMSA fund	0.02	
Bovine disease	0.299	
Cost for transport	0.84	
Cost for cooling	0.2	
Cost for processing	1.28	
Total deduction pence/kg	3.2	

Appendix 6: Effect of selection on farm economics

		S1			S2			S3		
Herd parameters	default	IS1	IS2	IS3	IS1	IS2	IS3	IS1	IS2	IS3
Milk per cow	5533	6368	6414	6157	6368	6414	6157	6368	6414	6157
Fat yield per cow	205	242	244	234	242	244	234	242	244	234
Protein per cow	185	216	216	213	216	216	213	216	216	213
Total acres used	59.00	63.12	63.29	62.31	63.12	63.29	62.31	53.60	53.30	54.76
Quota lease	0	3845	4053	2983	0	0	0	0	0	0
Milk sales	294696	340695	343225	329050	340695	343225	329050	289290	289035	289161
Cows Calving	55.09	55.09	55.09	55.09	55.09	55.09	55.09	46.78	46.39	48.41
Milk returns	64305	75926	76136	74339	75926	76136	74339	64470	64116	65328
Livestock sales	20639	20639	20639	20639	20639	20639	20639	17525	17381	18137
Labour costs	19900	20099	20110	20049	20099	20110	20049	18796	18745	19008
Total costs	69939	75309	75586	74130	71464	71533	71146	64248	63971	65387
Total profit	15005	21257	21190	20849	25101	25243	23832	17747	17525	18078
Margin per cow	272.37	385.84	384.63	378.45	455.63	458.20	432.60	379.38	377.75	373.41
Margin per acre	254.3	336.8	334.8	334.6	397.7	398.8	382.5	331.1	328.8	330.1
Margin per lit. milk	4.92	6.06	6.00	6.15	7.15	7.14	7.03	5.96	5.89	6.07
Returns per litre milk produced:										
Milk	21.10	21.64	21.55	21.92	21.64	21.55	21.92	21.64	21.55	21.92
Livestock	6.77	5.88	5.84	6.08	5.88	5.84	6.08	5.88	5.84	6.08
Costs per litre milk										
Concentrates	1.51	1.43	1.42	1.45	1.43	1.42	1.45	1.43	1.42	1.45
Fert., lime & Reseed	83	1.69	1.69	1.73	1.69	1.69	1.73	1.69	1.69	1.73
Land rental	1.94	1.80	1.79	1.84	1.80	1.79	1.84	1.80	1.79	1.84
Livestock purchases	2.98	2.59	2.57	2.68	2.59	2.57	2.68	2.59	2.57	2.68
Machinery hire	0.15	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Milk replacer	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silage making	0.99	0.90	0.89	0.92	0.90	0.89	0.92	0.90	0.89	0.92
Vet. AI & Medicine	0.99	0.86	0.85	0.89	0.86	0.85	0.89	0.86	0.85	0.89
Quota lease	0.00	1.10	1.15	0.88	0.00	0.00	0.00	0.00	0.00	0.00
Labour & living exp	6.53	5.73	5.69	5.91	5.73	5.69	5.91	6.31	6.30	6.38
Other fixed costs	4.36	3.81	3.78	3.93	3.81	3.78	3.93	4.18	4.17	4.23
Depreciation charges	1.69	1.47	1.46	1.52	1.47	1.46	1.52	1.70	1.71	1.71
Total costs per litre	22.94	21.47	21.39	21.86	20.37	20.24	20.98	21.57	21.50	21.94
Returns										
Pence per kg fat	590.0	586.7	583.3	594.4	586.7	583.3	594.4	586.7	583.3	594.4
Pence per kg protein	651.7	656.5	658.0	653.5	656.5	658.0	653.5	656.5	658.0	653.5
Costs										
Pence per kg fat	641.7	582.0	579.1	592.7	552.2	548.0	568.9	584.7	582.0	595.0
Pence per kg protein	708.8	651.1	653.3	651.6	617.9	618.3	625.4	654.2	656.6	654.1