IAFMM FISH MEAL FLYER

international association of fish meal manufacturers

Hoval House, Mutton Lane, Potters Bar, Herts. EN6 3AR U.K.
Tel: (Potters Bar) 0707 42343 Telex: 8811909 London

NO. 19 MARCH 1991

# FISH MEAL IMPROVES THE REPRODUCTIVE PERFORMANCE OF DAIRY COWS

*by*

I.H. PIKE
International Association of Fish Meal Manufacturers
and
R.J. ESSLEMONT
Department of Agriculture, University of Reading, U.K.

## Summary and Conclusions

There is now documented evidence from trials in Israel and Northern Ireland that fish meal improves fertility of dairy cows. This improvement should give the following benefits:

i) higher milk production because of a longer period of peak lactation with a shorter 'tail off' period;

ii) less slip in calving pattern, enabling greater exploitation of incentives for summer milk production in the U.K.;

iii) improved income from more calves;

iv) reduced culling rate;

v) reduced vet charges and insemination costs as a result of fewer services needed.

Based on conception rate improving from 44% to 64% (as in the Northern Ireland trial) these cost benefits amount to around £120 per cow per lactation, based on U.K. costings from Reading University (DAISY, 1990).

Feeding fish meal to high yielding cows in early lactation has been shown to increase milk yield. Alternatively, yield can be maintained and cuts made in concentrate feeding. The cost benefits resulting are £45 and £40 per cow per lactation respectively. This takes into account the extra cost of feeding fish meal.

The combined cost benefit of improved fertility and improved production efficiency are calculated at £160-£165 per cow per lactation.

For many years vets have recommended the inclusion of fish meal in the diet of cows with fertility problems. This recommendation has been based on hearsay rather than documented proof. Two recent research projects, one in Israel, the other in Northern Ireland, now provide evidence that fish meal in the diet improves fertility of dairy cows.

## 1. REPRODUCTIVE PERFORMANCE

In several studies the supplementation of lactation diets with high levels of soyabean meal has been shown to impair fertility (1, 2, 3, 4, 5). The reasons suggested for this effect have included the high rumen degradability of protein and resultant high rumen ammonia and blood urea concentrations (6, 7, 8, 9) and/or changes in the blood level of the hormone progesterone (10, 11).

Two studies where fish meal was used to reduce degradable protein and increase undegradable (or by-pass) protein, one in Israel and the other in Northern Ireland, showed improved reproductive performance.

In Israel, Bruckental et al (12) supplied additional protein to the diets in the form of fish meal or soyabean meal. The diets were based on cereals, cotton seeds, wheat or maize silage and oat grass or groundnut hay (see Appendix Table 5). The fish meal was fed at 1.4kg per head per day, and the fish meal and soyabean meal supplemented diets contained 21.6% crude protein compared with 17% in the unsupplemented diet with a similar energy content (12 MJ/kg). A total of 150 multiparous[1] and 90 primiparous[2] cows were used. Pregnancy rates 16 weeks after parturition (% proportion) were 0.65, 0.52 and 0.72 for the low protein diet (LSBM) and the high protein diet with soyabean meal (HSBM) or fish meal (HFM) respectively. This difference was significant ($P<0.05$) (see Table 1). Conception rate (proportion conceiving) was also higher in the fish meal fed cows (LSBM-0.48, HSBM-0.43, HFM-0.52) particularly in the older cows, fourth and later lactation (0.54, 0.38 and 0.59 respectively) (see Table 2).

[1] One or several previous lactations.

[2] No previous lactations.

### TABLE 1

**Israeli Trial**

**The Effect of Feeding Low (LSBM) or High Levels of Protein Containing Soya-Bean Meal (HSBM) or Fish Meal (HFM) on Pregnancy Rate[1] 16 Weeks after Parturition**

| Treatment | LSBM | HSBM | HFM | Significance |
|---|---|---|---|---|
| **First lactation** | | | | |
| No. of cows | 19 | 20 | 20 | |
| % Pregnant | 0.79 | 0.50 | 0.80 | HSBM < HFM + HFM |
| **Second and third lactation** | | | | |
| No. of cows | 34 | 34 | 32 | |
| % Pregnant | 0.59 | 0.59 | 0.66 | |
| **Fourth and later lactation** | | | | |
| No. of cows | 19 | 13 | 13 | |
| % Pregnant | 0.63 | 0.38 | 0.77 | HSBM < LSBM + HFM |
| **All parities** | | | | |
| No. of cows | 72 | 67 | 65 | |
| % Pregnant | 0.65 | 0.52 | 0.72 | HSBM < LSBM + HFM |

[1] Proportion of all inseminated cows.

## TABLE 2

### Israeli Trial

### The Effect of Feeding Low (LSBM)or High Levels of Protein Containing Soya-Bean Meal (HSBM) or Fish Meal (HFM) on Conception Rate[1] Following the First Two Post-Partum Inseminations

| Treatment | LSBM | HSBM | HFM |
|---|---|---|---|
| **First lactation** | | | |
| No. of inseminations | 30 | 29 | 28 |
| Conception rate | 0.47 | 0.45 | 0.57 |
| **Second and third lactation** | | | |
| No. of inseminations | 52 | 50 | 53 |
| Conception rate | 0.46 | 0.44 | 0.47 |
| **Fourth and later lactation** | | | |
| No. of inseminations | 26 | 16 | 17 |
| Conception rate | 0.54 | 0.38 | 0.59 |
| **All parities** | | | |
| No. of inseminations | 108 | 95 | 98 |
| Conception rate | 0.48 | 0.43 | 0.52 |

[1] Conceptions as proportion of total inseminations, including inseminations of non-pregnant cows.

The improvement in conception rate[1] in a trial in Northern Ireland (13), comparing diets where fish meal (0.8kg) replaced a standard concentrate (fed at t hree levels - see below) was even greater (0.64 v 0.44) ($P < 0.05$) than that noted above, as shown in Table 3. The total number of cows used was 78, consisting of 66 multiparous and 12 primiparous. They were fed grass silage ad lib. and either 0.8, 4.0 or 7.2kg per day of a concentrate based on barley and soyabean meal.

[1] Cows were artifically inseminated using proven bulls from the Northern Ireland AI Centre.

## TABLE 3

### Irish Trial

### The Effect of Offering Fish Meal on Reproductive Performance of the Spring Calving Herd

| | No fish meal | With fish meal (0.8kg/day) | s.e. |
|---|---|---|---|
| Day to first progesterone rise | 29 | 35 | 2..3 |
| Duration of first progesterone rise (days) | 8 | 7 | 1.0 |
| Intervals: | | | |
| calving to first service (days) | 73 | 77 | 2.3 |
| calving to conception (days) | 107 | 94 | 4.7 |
| Conception rates to all services | $0.44^{a}$ | $0.64^{b}$ | |
| No. of services per conception | $2.31^{a}$ | $1.62^{b}$ | 0.18 |
| No of cows conceived/no. of cows | 40/41 | 37/39 | |

[a,b]Means with different superscripts within rows are significantly different ($P < 0.05$).

In the Israeli work, of the cows fed the high protein diet those receiving fish meal showed lower rumen ammonia levels and blood urea levels than those receiving soyabean meal. However, in the Irish work, the fish meal fed cows had the highest rumen ammonia and blood urea levels which may reflect the higher nitrogen intake. This would indicate these two parameters may not affect fertility.

## 2. MILK PRODUCTION

Both trials showed improved milk yields as a result of feeding fish meal. The differences were small for multiparous cows in the Israeli trial (40.0 v 40.8kg per day for multiparous cows and 31.2v 33.4kg per day for primiparous cows for HSBM v HFM respectively - see Table 4). Although milk protein content increased, milk fat content decreased with fish meal feeding. On the other hand, in the trial in Northern Ireland where the milk yield increased significantly with fish meal feeding (22.5 v 23.4kg per day over the experimental period of 90 days, 20.6 v 21.9kg per day over the last 21 days of this period), $P < 0.05$, milk fat content was unchanged but milk protein content increased significantly (14) (Table 5).

### TABLE 4

### Israeli Trial

**The Effect of Feeding Low (LSBM)or High Levels of Protein Containing Soya-Bean (HSBM) or Fish Meal (HFM)on Food Consumption,Milk Yield, Milk Composition and Live-Weight Gain,from Calving to 24 Weeks in Multiparous Cows and to 16 Weeks in Primiparous Cows**

| | LSBM | | HSBM | | HFM | | |
|---|---|---|---|---|---|---|---|
| **Food intake (kg DM per day)[1]** | **21.8** | | **22.2** | | **20.5** | | |
| | Mean | se | Mean | se | Mean | se | Significance |
| **Multiparous cows** | | | | | | | |
| Milk yield (kg/day) | 39.3 | 1.4 | 40.0 | 1.2 | 40.8 | 1.2 | |
| Milk fat (g/kg) | 28.5[b] | 0.2 | 29.6[a] | 0.2 | 26.0[c] | 0.3 | * |
| (kg/day) | 1.12[ab] | 0.035 | 1.18[a] | 0.038 | 1.06[b] | 0.043 | * |
| Milk protein (g/kg) | 30.8 | 0.2 | 30.8 | 0.3 | 31.1 | 0.3 | |
| (kg/day) | 1.21 | 0.019 | 1.23 | 0.031 | 1.27 | 0.034 | |
| FCM yield[2] (kg/day) | 32.8 | 0.9 | 33.0 | 1.1 | 32.3 | 1.2 | |
| LW gain[3] (g/day) | 220[ab] | 20.3 | 160[b] | 23.1 | 310[a] | 18.5 | * |
| **Primiparous cows** | | | | | | | |
| Milk yield (kg/day) | 29.4[b] | 1.1 | 31.2[ab] | 1.3 | 33.4[a] | 1.0 | |
| Milk fat (g/kg) | 30.3[b] | 0.1 | 34.3[a] | 0.2 | 27.7[c] | 0.1 | ** |
| (kg/day) | 0.89[b] | 0.03 | 1.07[a] | 0.04 | 0.93[b] | 0.04 | ** |
| Milk protein (g/kg) | 31.3 | 0.3 | 31.3 | 0.5 | 31.5 | 0.2 | |
| (kg/day) | 0.92[b] | 0.03 | 0.98[ab] | 0.04 | 1.05[a] | 0.03 | * |
| FCM yield[2] (kg/day) | 25.4[a] | 0.8 | 28.3[a] | 1.1 | 27.6[ab] | 1.0 | * |
| LW gains[3] (g/day) | 220[a] | 15.2 | 170[b] | 18.0 | 230[a] | 14.1 | * |

abc Within rows, means not sharing a common superscript differ significantly.
1 Average food intake of a group of primiparous and multiparous cows.
2 Fat-corrected milk yield (40g fat per kg).
3 Mean live weight (LW) gain from time of post-partum minimal LW to the end of the experiment.

## TABLE 5

### Irish Trial

### Effect of Level of Supplementation and the Inclusion of Fish Meal on Food Intake and Animal Performance

| | Without fish meal | | | With fish meal | | | | Significance of effects | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Supplementation level (kg/day) | 0.8 | 4.0 | 7.2 | 0.8 | 4.0 | 7.2 | s.e. | Level | Fish | inter-action |
| Days on treatment | 89.1 | 88.6 | 93.3 | 90.8 | 91.2 | 91.2 | 1.63 | | | |
| Food intake - total experimental period (tonnes): | | | | | | | | | | |
| Basal concentrate (180g crude protein/kg) | 0.09 | 0.35 | 0.64 | 0.02 | 0.29 | 0.55 | | | | |
| Fish meal | | | | 0.05 | 0.07 | 0.07 | | | | |
| Total supplement | 0.09 | 0.35 | 0.64 | 0.08 | 0.36 | 0.62 | 0.018 | *** | | |
| Silage dry matter (DM) | 0.85 | 0.78 | 0.74 | 0.85 | 0.83 | 0.80 | 0.036 | * | | |
| Food intake - final 21 day (kg/day) | | | | | | | | | | |
| Basal concentrate(180g crude protein crude protein/kg) | 0.8 | 4.0 | 7.2 | - | 3.2 | 6.4 | | | | |
| Fish meal | | | | - | 0.8 | 0.8 | | | | |
| Total supplement | 0.8 | 4.0 | 7.2 | 0.8 | 4.0 | 7.2 | | | | |
| Silage dry matter (DM) | 9.0 | 8.5 | 8.1 | 9.3 | 9.1 | 8.7 | 0.38 | * | | |
| Milk yield (kg) | | | | | | | | | | |
| Total experimental period | 1690 | 2077 | 2313 | 1777 | 2181 | 2363 | 63.2 | *** | | |
| Final 21 days (kg/day) | 16.2 | 20.7 | 25.0 | 18.1 | 22.9 | 24.8 | 0.77 | *** | * | |
| Milk composition (g/kg) Total experimental period | | | | | | | | | | |
| (fat | 37.6 | 38.7 | 39.4 | 38.4 | 40.2 | 39.0 | 0.86 | | | |
| (protein | 27.9 | 28.8 | 30.4 | 28.9 | 30.9 | 31.0 | 0.49 | *** | ** | |
| Final 21 days (fat | 35.4 | 37.1 | 38.1 | 35.0 | 38.3 | 37.6 | 0.95 | * | | |
| (protein | 26.8 | 27.2 | 29.6 | 27.4 | 29.7 | 30.5 | 0.59 | *** | ** | |

The Israeli cows were much higher yielding than the Irish cows (35kg v 23kg). Their daily feed intake was much higher (21.5 v 13.0kg), and the forage : concentrate ratio was 1:4 compared with an almost concentrate free diet, 3:1 and 2:1 ratios approximately in the Irish trial. The yield responses to fish meal were greater with the lower concentrate intakes (0.8 and 4.0kg per day) of the Irish trial (see Table 5). Even with an intake of 7kg per day, but with low milk yield, there was a small response to fish meal over the whole of this trial. These results confirm the view that responses to fish meal are greater where smaller amounts of concentrate are fed and/or where milk yields are high (15).

The depression of milk fat associated with feeding fish meal with high levels (15kg per day) of starchy feeds have been noted elsewhere (16). Lower rumen pH's and lower acetate : propionate ratios may reduce milk fat synthesis. In the Israeli trial average rumen pH was 6.8 compared with 7.2 in the Irish trial; acetate : propionate ratios were 2.3:1 and 5.2:1 respectively The level of fish meal fed in the Israeli diet was high (1.4kg per day). This would have provided 140g of fish oil in a diet where much of the lipid content would have been provided by oils with a predominantely unsaturated make-up, e.g. cotton seeds. It is recommended that no more than 1kg of fish meal is fed and that fish oil intake from the fish meal should be kept below 100g per day (17). With high starch corn : corn silage diets fed in several areas of the USA, the use of rumen buffers such as sodium bicarbonate and magnesium oxide have been shown to avoid milk fat depression when fish meal is fed (18).

## 3. COST BENEFITS OF FISH MEAL FEEDING

Fish meal feeding, as seen earlier improves reproductive performance and in many cases, improves milk yield. The cost benefits resulting are considered below:

### 3.1 Reproductive Performance - the Extra Return Resulting from Better Conception Rates.

Improved conception rates and better fertility affect the economic performance of a herd in several ways. The tail-end of lactation when milk yields are low is shortened, the new lactation is brought forward, and the dry period without milk production is shortened. This brings forward the beginning of lactation when yields are high. Milk yield is increased as a consequence.

Calving pattern can be maintained if conception is not delayed. This enables peak yields to be achieved in periods of higher milk prices such as the late summer in the UK.

Better conception increases the number of calves produced through shorter periods between calving (calving interval). The income from calves is increased.

Culling of cows which are not giving satisfactory milk production tends to be reduced. Replacing cows is expensive. Replacement cows are usually first calvers (heifers) which produce less milk than cows in subsequent lactations (primiparous).

The number of services (often done by artificial insemination) is reduced as conception rate improves. This reduces costs.

The cost benefits involved through changes in conception rate seen in the Irish Trial described earlier (0.44 v 0.64) are detailed in the Appendix using figures from the U.K. Summarising these costings, for a 100 cow herd the improvement in profit would be £11,671. This is based on costings provided by the University of Reading in their DAISY costings scheme (DAISY 1990)

### 3.2 Milk Production - the Extra Return from High Milk Production or Reduced Concentrate Feeding.

In a large trial carried out with 13 commercial herds in the South West of England, fish meal improved milk production by 9.1% in early lactation, and by 1.34 litres per day averaged over the 16 weeks of the trial. The milk yield response in the Irish Trial (1.3kg per day) is similar. Costing out diet changes and improved returns from the increased milk production, an extra return of 38.2p per cow per day or £45 over the 120 days of early lactation is calculated. Alternatively using fish meal to reduce the amount of concentrate fed and improve utilisation of forage has been shown to represent a saving of almost £40 per cow per lactation.

# APPENDIX 1

## 1.COST BENEFITS OF FISH MEAL FEEDING-DETAILED COSTINGS

### 1.1. Reproductive Performance - The Extra Return Resulting from better Conception Rates

Delays in conception are caused by extended intervals to first service, poor heat detection and low pregnancy rates. In a practical situation, the farmer tends to give up serving cows when they are not in calf when they reach about 180 days after calving.

Poor fertility affects the economic performance of a herd in several ways. Firstly, longer intervals to conception reduce annual milk yields. Infertile cows extend their lactation by 0.6 of a day for every one day delay in conception beyond 85 days. This extension is, of course, at the end of lactation when the cow is producing only 10 litres or so per day. The delay in conception puts off the beginning of a lactation and also increases feeding costs during a longer dry period. At the start of lactation, on a daily basis, the cow produces three or more times the amount of milk that she produces at the end. The effect of a delay in conception is to reduce annual yields by about 20 litres for each days delay in conception. This reduces income and margin.

If improvement in fertility leads to shorter calving intervals, herd yields may rise and may exceed the farm's quota! Hence to calculate the value of a day gained on the calving interval two figures are needed. One is for farmers whose extra yield pushes the herd over quota and makes the farmer lease extra in (buy more quota). The other is for farmers who can incorporate the extra yield in the present quota. At present one is about £3.49 and the other is £2.09 per day (Appendix Table 1).

**APPENDIX TABLE 1**

**Cost of a Day Lost or Gained on the Calving Interval[1]**

| | Case 1 No Quota | Case 2 Quota |
|---|---|---|
| 20 litres at 18.75p | 3.75 | |
| 20 litres at 11.75p (lease at 7p | | 2.35 |
| less concs at 0.28 kg/litre | | |
| 5.6kg per day at £140/tonne | 0.78 | 0.78 |
| Plus £80 Calf Loss per Day[2] | 0.22 | 0.22 |
| Plus Calving Pattern Effect | 0.30 | 0.30 |
| | **£3.49** | **£2.09** |

[1] U.K. Costings taken from the 'DAISY' database, Reading University, 1990.

[2] The value of £80 per calf represents the average price achieved for calves produced by the whole herd, and the loss per day is calculated on the basis of the loss of one calf in 365 days.

The second effect of fertility differences in a herd is to move calving patterns. Because of milk price incentives to encourage summer milk in the U.K., there are higher margins for cows calving at this period in the year (currently cows calving in August attract the highest prices for their milk production over the whole lactation period, milk prices being highest in August, September and October). A slip in the calving pattern from this season to other times of the year costs about 30p per day. The third element is the cost of reduction in annual calf income as calving intervals slip. Calf prices are lower at present (say £80 per calf as opposed to £150 a year ago) so the cost per lost day is now 22p (Appendix Table 1).

The fourth component of the cost of a fertility factor such as pregnancy rate, is the effect of culling rate. Farmers tend to give up serving cows when they find the animals are still empty at about 6 months after calving. Many farms do have, in addition, a limited open season for serving, so any animal not in calf by a certain date in the year is culled (Appendix Table 2). Optimum culling rates are 18% with as few as possible of these being sold for failure to conceive. Culling is most effective if cows are sold for old age, low yield and, if necessary, because of mastitis. Well run farms can achieve a culling rate for failing to conceive of less than 7% and also manage an average calving interval of less than 372 days.

**Appendix Table 2**

**Cost of an Extra Cull**

| | |
|---|---|
| Cull Sale | £370 |
| Heifer Cost | £750 |
| *Difference* | *£380* |
| Lower Margin from Heifer Lactation | £70 |
| Lower Value of Calf[1] | £70 |
| **Total** | **£590** |

[1] A calf born to a cow in the herd is assumed to be sired by a Charolais or Simmental bull and would be worth £100; the calf born to a heifer would be sired typically by an Aberdeen Angus bull, producing a smaller headed calf for ease of heifer calving, worth about £30. Replacing a cow with a heifer effectively produced a calf worth £70 less.

The national level of pregnancy rate in dairy herds is 52%. Heat detection rates average 55%. In a herd with a poor fertility (40% pregnancy rate and 50% heat detection) that starts to serve at 50 days post partum and gives every cow 7 oestrus cycles in which to get pregnant, there will be a calving interval of 390 days and a culling rate 21% of cows for failing to conceive (Appendix Table 3). In a highly fertile herd (80% heat detection and 60% conception) the calving interval will be 25 days shorter and the barren cow culling rate will be 1%. The cost of the extra cull is high as the replacement heifer costs over twice the sum received for the older cow. The heifer gives less milk and has a less valuable calf.

To cost the effect of improving pregnancy rates, if everything else is assumed to be the same, one should take into account the effect of a decline in such a factor, on reducing calving interval, culling rate, the lower cost of semen and the diminished vet costs.

An improvement in herd pregnancy rate of 20% points (44% up to 64% see Irish Study) with heat detection being kept at an assumed 50% gives a reduction in calving interval of 11 days and a cut in culling of 11% points.

**Appendix Table 3**
**Effect of Fertility in Cows on Calving Interval and Culling Rate Fertility Indices**

| At 50% heat detection, at conception rate of :- | | | | | | | |
|---|---|---|---|---|---|---|---|
| 40% | | 44% | | 64% | | 100% | |
| CI | % culls | CI | % culls | CI | % culls | CI | % culls |
| 390 | 21 | 386 | 20 | 375 | 9 | 365 | 1 |

CI = Calving Interval
%Culls = % of herd not pregnant after 7 oestrus cycles

In addition, there are 0.69 extra serves per conception costing say £18 per time. This amounts to £12.42 per cow or £1,242 for the herd. The extra vet costs for the inspection of 10 more cows in the low fertility herd will amount to £100 (at £10 per time). In a 100 cow herd this will improve profits by £11,671 at current costings (Appendix Table 4).

**Appendix Table 4**

**Cost of Difference of 20% in the Pregnancy Rate**

| | £ |
|---|---|
| 100 cows, 11 days at £3.49/day | 3839 |
| 11 extra culls at £590 per cull | |
| Services | 1242 |
| Vet Costs | 100 |
| **Total** | **11671** |

The extra return per % point increase in pregnancy rate is £583 per 100 cows or £5.83 per % per cow per year.

This figure of £5.83 per cent difference in pregnancy rate can be applied to the other trials, though small differences are usually due to random variation. Thus a difference of 7 percent points in pregnancy rate in 50 cows is worth £2,042.

### 1.2 Milk Production - the Extra Return from Higher Milk Production or Reduced Concentrate Feeding

In a large trial carried out with 13 commercial herds in the South West of England, replacing sugar beet pulp or barley with fish meal improved milk yield by 2.7 litres per day, or 9.1% in early lactation, and by 1.34 litres per day averaged over the 16 weeks of the trial (15). The response in the trial in Northern Ireland of 1.3kg per day (21.9 v 20.6kg) in the last 21 days of lactation is very similar to the results from the U.K. trial above (13). In the Israeli trial, as discussed earlier, responses were somewhat less because, it is believed, higher concentrate : forage ratios were used (12).

Taking a 1.3kg per day response, feeding approximately 0.8kg of concentrate the cost of feeding fish meal, taking fish meal price at £320 per tonne, and concentrates at £140 per tonne would be 14.4p per day. If the phosphorus constitution of the fish meal is taken into account, a reduction of 2p per day in concentrate cost should be possible, that is, feeding fish meal would increase cost by 12.4 per cow per day. The value of the extra milk at 18.75p per litre (prices in U.K., November 1990) would be 6.3p per cow per day or around £17 over a whole lactation. However, feeding fish meal only in early lactation (120 days) to high yielding cows (over 30 litres per day) when receiving diets with high forage : concentrate ratios (around 7kg of concentrate), a response of around 2.7 litres per day would be expected (19). This would give an extra return of 38.2p per cow per day, or around **£45 over the 120 days** of early lactation.

In a situation where feeding strategy is strongly influenced by milk quota restrictions, increasing milk yield is an option where milk production on a farm is below quota. Another option is to reduce cow numbers by increasing yield. If neither situation applies, then reducing feed costs whilst maintaining milk production may be more appropriate. Fish meal can be used in this way, reducing concentrate feeding and improving utilisation of forages. Although the costings of this approach given in the booklet 'Milk Quotas - New Feeding Strategies to Reduce Milk Production Costs' relate to a price situation some years ago, current prices are not dissimilar. It is appropriate, therefore, to reproduce the costings below, based on the finding that 4kg of compound feed could be replaced with 0.75kg fish meal plus 1.25kg of sugar beet pulp, milk production remaining the same (15):

"Assuming prices of compound feed to be £150 per tonne, fish meal £320 per tonne, sugar beet pulp £110 per tonne, then the effect of replacing 4kg of compound feed (60p) by 0.75kg of fish meal (34p) plus 1.25kg sugar beet pulp (14p) would be to save 22p per cow per day at constant milk yield). Allowing for a possible increase of 1kg silage dry-matter intake valued at 7.5p, but a sparing of supplementary phosphorus because of that provided by fish meal valued at 2p, a silage dry-matter intake valued at 7.5p, a nett saving of 14.5p is indicated. As milk yield was not reduced, there is scope for further reduction of compound usage.[1]"

This daily saving could represent almost **£40 per cow over a lactation.**

1 from "Milk Quotas - New Feeding Strategies to Reduce Milk production Costs"; see (15)

# Appendix 2

### Appendix Table 5

### Israeli Trial
### Composition of Trial Diets (12)

| | Level of Protein | | |
|---|---|---|---|
| | Low | High | |
| Supplemental protein | SBM | SBM | FM |
| Ingredients: | | | |
| Concentrate A[1] | 569 | | |
| Concentrate B[2] | | 498 | 531 |
| Soya-bean meal | 42 | 132 | |
| Fish meal[3] | | | 73 |
| Cotton Seeds | 129 | 134 | 134 |
| Citrus peels | 35 | 36 | 35 |
| Wheat or maize silage | 135 | 123 | 140 |
| Oat grass or groundnut hay | 89 | 77 | 87 |
| Chemical composition of the total mix: | | | |
| Crude Protein | 170 | 216 | 216 |
| Crude fibre | 153 | 131 | 126 |
| Calculated metabolizable energy (mJ/kg DM) | 12.1 | 12.4 | 11.9 |

[1]Contains (kg/t DM):maize grain 500, barley grain 260, cotton seed meal 180, calcium dihydrogen phosphate 6, calcium carbonate 33, bentonite 16 and vitamin and micro-elements mix 5. Diet pelleted and contained 160g CP per kg.

[2]Contains (kg/t DM): maize grain 480, barley grain 240, soya-bean meal 220, minerals and vitamins as in concentrate A. Diet pelleted and contained 180 g CP per kg.

[3]Fish meal produced in Denmark, containing (g/kg): CP 720 to 760, ether extract 100, ash 130.

## References


1. *DRORI, D. and FOLMAN, Y.* 1973. Protein requirements of lactating cows and rats. Israeli-Swedish Seminar in Dairy Husbandry, Agricultural College, Sweden. Report 26, pp.10.1-10.15.

2. *BRUCKENTAL, I., AMIR, S., DRORI, D., KROL, O. and KENNNIT, H.* 1979. Protein requirement of high producing dairy cows. Hassadeh **59**: 2540-2542.

3. *JORDAN, E.R. and SWANSON, L.V.* 1979a. Effect of crude protein on reproductive efficiency, serum total protein and albumin in the high-producing dairy cow. J. Dairy Sci. **62**: 58-63.

4. *FOLMAN, Y., NEUMARK, H., KAIM, M. and KAUFMANN, W.* 1981. Performance, rumen and blood metabolites in high-yielding dairy cows fed varying protein percents and protected soybean. J. Dairy Sci. **64**: 759-768.

5. *KAIM, M., FOLMAN, Y., NEUMARK, H. and KAUFMANN, W.* 1983. The effect of protein intake and lactation number on post-partum body weight loss and reproductive performance of dairy cows. Anim. Prod. **37**: 229-235.

6. *FERGUSON, J.D., BLANCHARD T.L., HOSHALL, D. and CHALUPA, W.* 1986a. High rumen degradable protein as a possible cause of infertility in a dairy herd. J. Dairy Sci. **69**: Sup.1 p120 (Abstr.).

7. *FERGUSON, J.D., BLANCHARD, T.L., SHOTZBERGER, S. and CHALUPA, W.* 1986b. Effect of rumen degradable protein on fertility. J. Dairy Sci **69**: Sup.1. p120 (Abstr.).

8. *KAUFMANN, W. and LUPPING, W.* 1982. Protected proteins and protected amino acids for ruminants. In Protein Contribution of Feedstuffs for Ruminants. Edt. Miller, E.L., Pike, I.H., VanEs, A.J.H. Butterworths.

9. *BLANCHARD, T., FERGUSON, J., LOVE, L, TAKEDA, T., HENDERSON, B., HASLER, J. and CHALUPA, W.* 1990. Effect of dietary crude-protein type on fertilisation and embryo quality in dairy cattle. American Journal of Veterinary Research, **51**: 905-908.

10. *JORDAN, E.R.and SWANSON, L.V.* 1979b. Serum progesterone and luteinizing hormone in dairy cattle fed varying levels of crude protein. J. Dairy Sci. **48**: 1154-1158.

11. *FOLMAN, ROSENBERG, ASCARELLI, KAIM and HERTZ.* 1983. The effect of dietary and climatic factors on fertility and on plasma progesterone and oestriadiol 17ß levels in dairy cows. J of Steroid Biochem **19**: 863-868.

12. *BRUCKENTAL, I., DRORI, D., KAIM, M., LEHRER, H. and FOLMAN, Y.* 1989. Effects of source and level of protein on milk yield and reproductive performance of high-producing primiparous and multiparous dairy cows.Anim. Prod. **48**: 319-329.

13. *ARMSTRONG, J.D., GOODALL, E.A., GORDON, F.J., RICE, D.A. and McCAUGHEY, W.J.* 1990. The effect of levels of concentrate offered and inclusion of maize gluten or fish meal in the concentrate on reproductive performance and blood parameters of dairy cows. Anim. Prod. **50**: 1-10.

14. *GORDON, F.J. and SMALL, J.C.* 1990. The direct and residual effects of giving fish meal to dairy cows receiving different levels of concentrate supplementation in addition to grass silage. Anim. Prod. **51**: 449-460.

15. *MILLER, E.L. and PIKE, I.H.* 1985. Milk Quotas - new feeding strategies to reduce milk production costs. (IAFMM).

16. *HOOVER, W.H., MILLER, E.L., STOKES S.R. and THAYNE, W.V.* 1989. Effects of fish meals on rumen bacterial fermentation in continuous culture. J. of Anim Sci (Suppl. 1) 67:507 (Abstr).

17. *OPSTVEDT, J.* 1985. Fish Lipids in Animal Nutrition. Technical Bulletin Number 22. (IAFMM).

18. *VANDERSAL, J.H., DOUGLASS, L.W. and ASCHBRENNER, R.A.* 1989. J. of Anim. Sci.Suppl. 1. **67** (Abstr.).

19. *MILLER, E.L., GALWAY, N.W., PIKE, I.H. and NEWMAN, G.* 1981. Milk production response of dairy cows fed a supplement of fish meal on commercial farms. IAFMM Technical Bulletin No. 14.