MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

Research and Development

Final Project Report

(Not to be used for LINK projects)

Date project completed:

30/09/98

Section 1 : Identification sheet

1. (a) MAFF Project Code: **OF0113**

(b) Project Title: Organic milk production: post-conversion phase

Institute of Grassland and Environmental Research, Trawsgoed,Aberystwyth

(f) Project start date: 01/10/95

Project end date: 30/09/98

***staff years of direct science effort**

Section 2 : Scientific objectives / Milestones

2. Please list the scientific objectives as set out in CSG 7 (ROAME B). If necessary these can be expressed in an abbreviated form. Indicate where amendments have been agreed with the MAFF Project Officer, giving the date of amendment.

1. Study the changes in soil nutrient status and the nutrient balance of the whole-farm system.
2. Monitor the changes in the level of herbage production and efficiency of herbage utilisation (UME values).
3. Monitor the changes in the production and health of organic dairy herds.
4. Determine the financial performance of organic dairy farms and compare the performance with comparable conventional farms using cluster analyses.

Section 4 : Executive summary

The main objective of the current project was to improve the understanding of the factors affecting both the physical and financial performance of dairy farms in the post-conversion phase and to compare their performance with comparable conventional dairy farms. An additional objective was to provide a framework for the development and sustainment of organic milk production. The project was based at the Ty Gwyn organic dairy farm at IGER Trawsgoed with ten linked commercial dairy farms also monitored during the study. These farms ranged in size from 45 to 450 ha with the size of the dairy herds ranging from 45 to 260 cows. Among the factors studied during the project were changes in the soil indices, with particular reference to the P and K concentrations in the soil. Estimates of the whole-farm budgets are a useful indicator of the sustainability of agricultural systems and changes in the nutrient balance of the whole-farm system at Ty Gwyn were calculated annually to determine the input/output ratio of nutrients within the system. The effectiveness of a crop rotation to meet the high forage requirements of the organic dairy herd was evaluated, including the effect on the stocking density of the farm, forage yields and forage quality. The performance of the organic dairy herd in relation to managing the farm within the organic standards and the implications on animal health of withdrawing the use of antibiotics on a routine basis were monitored throughout the study. The financial performance of all the farms was recorded during the study with the data compared with comparable conventional farms.

Key conclusions from the study were:

- Nutrient budgets showed the major N-input was from red and white clover, with an average surplus of 141 kg N/ha within the whole-farm system and only 16-28% of the total N recovered in milk and livestock sales.
- The average P and K levels in the soil were higher during the study than the values recorded during the conversion period. However, the values were lower in the third year of the study and the values recorded for the individual farms were influenced by the source of concentrate feeds (home-grown or purchased).
- Large differences were recorded between fields in nitrate leaching, ranging from 15-140 kg N/ha.
- The measurement of N-fixation showed a contribution of 45 and 40 kg N/1,000 kg DM of white and red clover, respectively.
- Herbage yields were 14% higher than the yields recorded during the conversion period and only 9% lower than those recorded pre-conversion when the farm received an annual input of 380 kg N/ha.
- The contribution of forage to the energy requirements of the dairy herd increased to 61 (whole farm) and 76.7 GJ of UME/ha as stocking rates, milk yields and milk quality increased.
- Stocking rates by the third year of organic management were only 8% lower than the rates recorded when the farm was an intensive system with high N inputs.
- No major health problems were recorded in the organic dairy herds. Despite the withdrawal of the routine use of antibiotics the number of cases of clinical mastitis was similar to those recorded in conventional herds. Somatic cell counts in the milk were significantly higher than comparable conventional herds.

The study has contributed to a greater understanding of the physical factors affecting the performance of organic dairy farms. The results have provided quantitative information on many factors that influence the performance of the organic system and have also provided a broad framework on the overall level of production that can be achieved under organic management. The scientific measurements undertaken during the study have been included in Part 1 of the Final Report.

Section 5 : Scientific report

Introduction

Changes in the physical performance of Ty Gwyn and ten linked organic dairy farms was monitored during the post-conversion phase. The changes in the soil indices, herbage production, animal production, stocking rates and utilisation of forage (UME) that were recorded during the study are highlighted below. Soil indices were determined during the Spring period and herbage yields recorded throughout the growing season. Animal production, stocking rates and changes in milk quality were recorded every month, with the utilisation of forage recorded annually. The dairy herds were also monitored to determine the occurrence of specific health problems with the information recorded on each farm by both the herdsperson and the visiting veterinary surgeon. In addition the reproductive efficiency of the Ty Gwyn herd was also monitored.

Nutrient budgets for Ty Gwyn farm

The nutrient budgets were calculated for the Ty Gwyn farm to provide information on the internal flow of nutrients within the whole-farm system. The N, P and K whole-farm budgets were determined at Ty Gwyn for each year from 1995/6 to 1997/8 and the budgets calculated for the earlier contract covering the organic conversion period from 1992/3 to 1994/5. Biological N fixation was the main form of N input to the farm but N in purchased feed was also important. In all years there was an appreciable surplus in the N balance with only 16 - 28% of the total N input recovered in milk and livestock sales and when averaged over the whole farm area, the balance was equivalent to an annual surplus of 141 kg N/ha. Inputs of P, mainly as purchased feed, were similar to the quantities of P exported from the farm in milk and livestock sales and averaged over the whole farm area the annual balance (excluding leaching losses) was equivalent to between -1 and +4 kg P/ha and it was concluded that P budgets were relatively well-balanced without the need for additional fertilisers. Purchased feed provided the main input of K to the farm but straw was also a significant source of K, with the balance between inputs and recoveries in products indicating an annual surplus equivalent to 15 kg K/ha. This was similar to the quantities estimated to be lost by leaching and it was concluded that budgets at Ty Gwyn were well-balanced without the need for fertilisers. Whole-farm nutrient balances for the organic farm were compared with N, P and K balances determined for the conventionally managed dairy farm adjoining Ty Gwyn. Surpluses of all three nutrients were significantly larger than those for Ty Gwyn, indicating potentially greater losses of N, P and K from the more intensively managed conventional farm, whether expressed on an area basis or per unit of milk production. Internal flows of N, P and K between fields and the dairy/farmyard were also determined for Ty Gwyn. Although some silage crops removed more N than was estimated to have been supplied by biological fixation, returns of N in slurry were sufficient to maintain positive balances in almost all fields, with nitrogen surpluses highest in grazed fields that had not been cut for silage. Phosphorus budgets for individual fields showed relatively large positive and negative fluctuations between years but over the 6-year period, slurry applications balanced P removals in most fields. Estimates of the quantities of K removed in silage were consistently greater than inputs in slurry. As the whole-farm budgets indicated that inputs and outputs of K were well-balanced, this discrepancy was considered to be an indication of inaccuracies in the estimates of the internal K transfers.

Soil nutrient content at Ty Gwyn and on collaborating farms

Measurements of soil pH and of extractable contents of P and K that had been started during the preceding contract were continued at Ty Gwyn and on the 10 linked farms in 1996 and 1998. Additional measurements were made at Ty Gwyn in 1997. About 80% of fields had a satisfactory soil pH greater than 6.0 and none of the other farms showed a consistent increase or decrease in mean pH between 1993 and 1998. In 1996, three quarters of fields had a satisfactory P index of 2 or greater. Mean contents were lower in 1998 and only 32% of fields were at index 2 or 3, however, the mean contents in 1998 were

similar to those measured in 1993. Although P contents fluctuated over the 6-year monitoring period the only consistent and statistically significant trend was a slight increase in the P status of soils at Ty Gwyn. In 1996, three quarters of fields had a satisfactory K index of 2 or greater, compared with 67% of fields in 1998. Variations in the mean contents for individual farms showed no consistent trends and final values were similar to those at the start of the 6-year monitoring period. Contents of extractable Mg were only measured in 1996 and 1998. Contents in all fields were lower in 1998 than in 1996; however, the relatively high Mg status of all soils in both years suggests that the observed decline is unlikely to be a true indicator of the longer-term rate of change.

Measurements of nitrate leaching and N-fixation at Ty Gwyn

The nutrient budgets calculated for Ty Gwyn indicated that the farm may produce appreciable N surpluses that may be lost by leaching and as gaseous emissions unless the surplus N is accumulated within the farm system. Direct measurements of nitrate leaching in two permanent pasture fields using ceramic cup samplers indicated leaching losses of 114 - 140 kg N/ha from one field, with nitrate concentrations greater than the EC limit of 11.3 mg N/l for most of the winter. Nitrogen budgets and stocking rates indicated that this was a particularly productive field and likely to have a greater potential for N loss than the majority of fields on the farm. In 1995/6 and 1996/7, losses from the second field were equivalent to only 39 and 15 kg N/ha. However, the loss in 1997/8 increased to 112 kg N/ha, largely as a result of an untimely slurry application in January. Under the management practised at Ty Gwyn, fields that are cultivated and sown with cereals for harvesting as whole-crop silage are undersown with a grass/clover mixture. Measurements of the mineral-N content of soil profiles in selected fields in autumn 1995 and 1996 indicated that the undersown crop was able to utilise any additional N mineralised in the autumn following cultivation and, as a result, the risk of nitrate leaching was similar to that in non-cultivated fields. Measurements of mineral-N in the soil profile in the two fields in which the ceramic cup samplers were installed indicated that both methods produced similar estimates of the quantities of N leached and confirmed the much greater loss from one of the fields. In the calculation of N budgets for Ty Gwyn, biological N fixation is estimated from the yield of clover, assuming fixation of 54 and 40 kg N/1000 kg yield of white and red clover, respectively. Nitrogen fixation was measured in three fields at Ty Gwyn using the ^{15}N isotope dilution method to confirm this relationship and the measured values were similar to the published values, equivalent to 45 and 40 kg N/1000 kg white and red clover, respectively.

The production and utilisation of herbage at Ty Gwyn

The herbage yields were recorded from all the fields to determine the contribution of the different types of sward to the total production and the contribution of forage. The crop rotation for the farm was based on cereals (Years 1 and 4), Italian ryegrass/red clover (Years 2/3) and perennial ryegrass/white clover (Years 5-9). The swards were mainly grazed but also cut for conservation as silage. Of the total land area of the farm 25% was maintained as permanent pasture, producing from 7-10 t DM/ha. Average herbage yields during the post-conversion period (1996-1998) were 14% higher than the yields recorded during the conversion period. Slot seeding during the autumn with rye or Westerwold ryegrass into ageing Italian ryegrass/red clover swards increased spring yields by up to 70%, leading to an earlier turn-out date for the dairy herd. Italian ryegrass/red clover swards yielded from 9-13 t DM/ha from three cuts per annum when slurry was applied twice a year and the swards contributed to the improvements in both the fertility and structure of the soil. Perennial ryegrass/white clover swards produced from 8-11 t DM/ha with white clover contributing 30-35% of the total yield. The overall white clover content of the permanent pastures remained relatively constant during the project, although differences were recorded between growing seasons.

The establishment of spring barley for conservation as whole-crop cereal silage contributed to the winter forage stocks required by the dairy herd and also provided an effective cover crop for undersowing and establishing grass/clover swards. The results from the study show the potential benefits of red and white clover in relation to their ability to provide nitrogen for crop growth and, when compared with grass, their

improved nutritional characteristics including a higher protein content. The UME values (Utilised Metabolisable Energy) were calculated to estimate the changes in the efficiency of forage utilisation on the farm from 1995/96 to 1997/98. The UME values increased from 47.5 to 61.0 GJ/ha (whole farm) and from 55.3 to 76.7 GJ/ha (dairy herd). The increase in UME values was due to higher stocking rates, increased milk production, improved milk quality and a reduction in the level of concentrates fed The values were comparable with the those recorded on both low-input conventional systems and other organic dairy farms.

Animal production at Ty Gwyn

The performance of both the individual cows within the herd and the whole herd was recorded to provide information on the level of milk production and changes in both the milk quality and the stocking rate. The stocking rate on the farm was significantly lower during the conversion period, however, improvements in the level of crop production on the farm led to an increase in the stocking rate from 1.54 cows/ha (conversion period) to 1.84 cows/ha in Year 3 post-conversion (1997/98). The herd size increased from 72 to 88 Holstein-Friesian cows, with the average lactation number of the cows in the herd declining from 3.85 to 2.78 as extra heifers entered the herd to increase the herd size and also provide replacements for cows culled under the BSE Selective Cull Scheme. Increases recorded in the stocking rate and milk yield/cow led to the total milk production from the farm increasing from 366k litre in the conversion period to 492k in 1997/98, with over 60% of the total milk output produced during the grazing season. Average annual rolling milk yield/cow increased from 5,158litres (conversion period) to 5,596 litres in 1997/98 with lactation yields increasing from 5,663 to 6,105 litres/cow. A decrease in the quantity of concentrates fed from 1.45 to 1.21 tonnes/cow improved the milk production from forage from 2,213 to 2,702 litres/cow and the contribution of home-grown forage to the diets increased to 84% with organic feeds contributing 90% of the total annual feed required by the dairy herd.

Animal health and welfare at Ty Gwyn and on the collaborating farms

The study showed no major health problems on the farms during the study. Large differences were recorded between farms in their approach to the use of alternative remedies for treating specific ailments. Health problems on the farms was recorded by the herdsperson and visiting veterinary surgeon and the data collected from the farms every three months.

Differences were recorded between the farm in the breed of cattle kept. On five farms the Ayrshire (1) and Holstein-Friesian (4) were the sole breeds. On the other five farms the Holstein-Friesian was the main breed with either pure or crossbred cows of either the Ayrshire, Brown Swiss, Meuse Rhine Issel or Normande breeds also kept in the herd. Herd size ranged from 45 to 273 cows, with the management of the majority of the herds based on an all-the-year calving pattern. Winter housing was either in cubicle housing (5 herds) or straw-bedded yards (5). The average number of cases of clinical mastitis was 34.7 cases/100 cows (range between farms: 15.3 to 66.1), similar to the number of cases reported on conventional farms. Differences were recorded between farms in the type of housing used for the dairy herds and the number of cases of clinical mastitis were markedly higher in herds kept on straw-bedded yards compared with those housed in cubicle sheds. An average of 57% of the cases of mastitis were treated with alternative remedies. The average somatic cell count in the bulk tank milk was 243,933 cells/ml with large differences recorded between farms (range 172,000 to 386,000). Although all the organic herds grazed clover/grass swards, including swards with high clover contents, the incidence of bloat was low on the farms and no cases were reported on 5/10 farms. On all the farms the incidence of metabolic disorders, including milk fever, ketosis and hypomagnesaemia was lower than comparable conventional farms.

The number of lame cows in the individual herds ranged from 4 to 75 cases/100 cows with an average of 22 cases recorded, with lameness on some farms attributable to either the grazing of kale during the autumn period or walking on rough stone tracks to the grazing fields. Reproductive efficiency is an

important factor in the management and profitability of dairy herds. Analysis of the reproductive performance of the Ty Gwyn herd showed a satisfactory reproductive efficiency for the herd and during the 3-year study there was an average of 99 days from calving to conception, 1.9 serves/pregnancy and a pregnancy rate of 88% of cows served. The average culling rate from all the organic herds was 12%, with infertility and mastitis the two main reasons for culling cows and in comparison with data from conventional herds the number of cows culled due to problems of lameness was very low. However, there may be a correlation on some farms between a low culling rate and high somatic cell counts – a potential problem if the cell count thresholds set by Milk Marque are adopted by other organic milk buyers.

Financial evaluation of the farms and other performance indicators

This work was sub-contracted to the Welsh Institute of Rural Studies (WIRS) and ADAS, with WIRS responsible for the analysis of the data and completion of Part 2 of the final report.As stated in Section 3 (Milestone 03/01) of the report the collection and analysis of the financial data from the ten farms was not completed by the end of the contract (30/09/98). However, with the exception of one farm, all the data has now been collected and the full analysis of the data and writing of Part 2 of the final report is now being carried out by the WIRS staff.