Studies of the composition of milk produced on organic and conventional dairy farms

A comparative study of organic and conventionally produced milk in the UK was recently undertaken to determine whether there were significant differences between the two types of milk. At the start of the study, little information was available, particularly from the UK, on the composition of organic milk. In particular, large-scale, longitudinal studies accounting for seasonal variation and management practices were lacking. The study was completed by Dr Kathryn Ellis in fulfilment of a PhD thesis at the University of Liverpool. In the following paper, Kathryn summarises the study design, results and conclusions.

Project design

Pilot study

This study addressed these issues by means of an initial three month pilot study involving farms and milk processors from Scotland, the north west of England and Wales, covering a range of compositional factors to identify the main areas of interest. This included persistent environmental pollutants (POPs) including dioxins, polychlorinated biphenyls (PCBs) and polybrominated diphenylethers (PBDEs). Additional analysis included a mycotoxin, and a fatty acid as well as basic milk composition and hygiene data.

Main study

Based on data generated in the pilot study, thirty seven farms (19 conventional and 18 organic) and three processed milk sources were recruited for a longitudinal study, collecting monthly bulk milk samples from each farm and processed source for one year. Samples were analysed for fatty acid content (60 fatty acids), and vitamins A and E and beta-carotene. Standard milk composition and hygiene data including fat, protein, urea, Bactoscan and Bulk Tank Somatic Cell Count (BTSCC) as well as mastitis incidence were obtained from farm records. Farm and management factors were recorded to identify practises that may be associated with differences in specific compounds in milk.

Results

Pilot study

Based on the limited number of samples collected in the pilot study, there was little evidence to suggest major differences in milk POP content, which was very low in both milk types. Individual farm management (particularly regarding feeding regimen and breed type milked) and season were the most important factors affecting milk composition. The control of sub-clinical mastitis on the organic farms studied could be improved to optimise production and improve animal welfare.

Main study

Herd production

On average, organic herds differed from conventional in having lower yields (6,542 vs. 7,726 litres/cow/year), a higher geometric mean BTSCC (227,000 vs. 172,000 cells/ml), higher mean milk fat percentage (4.11 vs. 3.95%) and a lower recorded monthly clinical mastitis incidence (2.5 vs. 5 cases/100 cows in milk/month).

Milk fatty acids

Although both organic and conventional milk is relatively high in saturated fatty acid content, the overall fat percentage in whole milk is low (~4%) in the context of a balanced diet. There are several key seasonal, farm management and cow nutrition factors that affect fatty acid content, with mono-unsaturated fatty acids (MUFA) and poly-unsaturated fatty acids (PUFA) increasing and saturated fatty acids decreasing over the summer.

Both organic and conventional milk are very good sources of conjugated linoleic acid (CLA), with no significant difference between production system. However, differences were seen between milk types for other fatty acids: farm-gate organic milk was higher in total PUFA content particularly some essential fatty acids in the omega-3 fatty acid group (C20:5, C22:5 and C18:3) throughout the production year (Figure 1). Processed organic milk also contained higher proportions of omega-3 fatty acids and total PUFA compared to processed conventional milk. Conventional farm-gate milk was higher in the concentration of MUFA, especially oleic acid (C18:1) (Figure 2).

Figure 1 Proportion of Omega-3 fatty acids of total fatty acids in organic (▲) and conventional (■) milk each month for the 12 month study

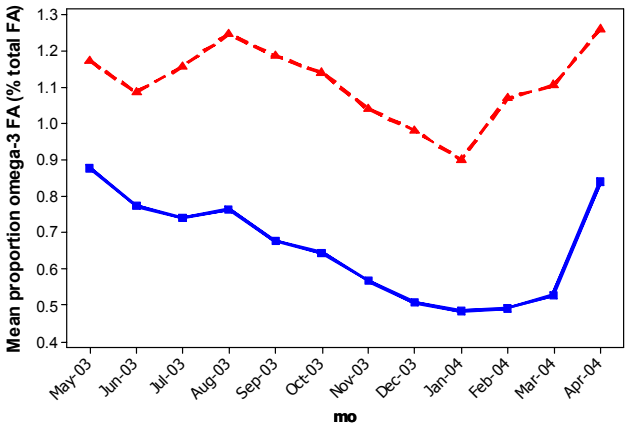
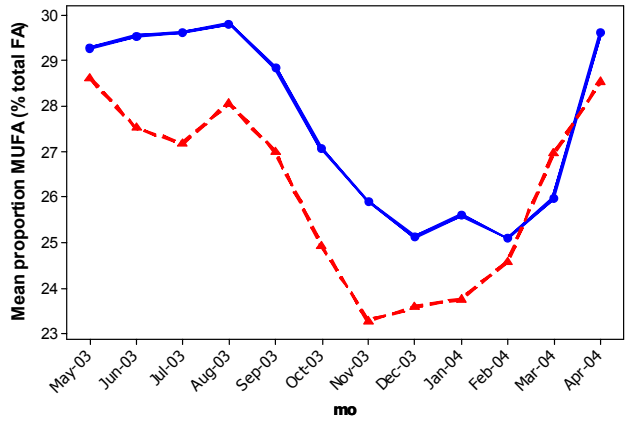


Figure 2. Proportion of MUFA in organic (▲) and conventional (■) milk each month for the 12 month study

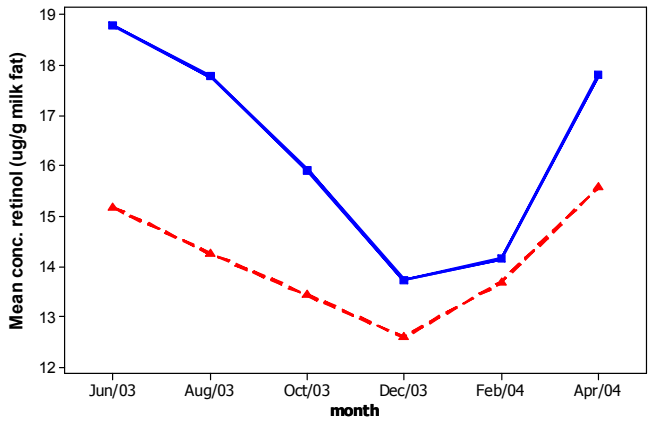


Additionally, organic milk may have a part to play in the diet by having a more optimal (lower) omega-6:omega-3 fatty acid ratio compared to conventional milk. Despite accounting for management and feeding variables, an 'organic' effect remained significant for some fatty acids.

Milk vitamin content

Season, herd yield and access to fresh pasture were all important factors in determining the milk content of vitamins A, E and beta-carotene. Increased milk yield was associated with decreased vitamin E and beta-carotene content. Farming system was less important, except in the case of vitamin A, for which there was a slightly lower concentration in organic farm-gate milk (Figure 3.) although this was not seen in the processed milk. The higher concentrations in the conventional farms may be due to increased concentrate feeding with pre-formed vitamin A supplemented in dairy cow feeds.

Figure 3. Mean vitamin A content in organic (▲) and conventional (■) milk per month for the 12 month study



Cow cleanliness

This study used a cow cleanliness scoring system over a wide range of farms. When cows were at grass, there was no effect of farming system, but dry cows were cleaner than lactating cows. There was a trend for all cows to have a higher hygiene score (become more dirty) as they were housed. When all cows were housed, cows grouped in high or mid-yielding groups were more likely to be in a dirtier hygiene score group, as were cows housed in straw yards. However, there was a significant difference between different farming systems with housing system, where organically managed cows in straw yards were more likely to be cleaner then conventional cows. Overall, despite increased use of straw yards on organic farms, organically managed cows were more likely to be in a cleaner score category, especially organic dry cows. There was a suggested link between cow hygiene and milk hygiene, with dirtier herds having higher BTSCCs, but no significant link with Bactoscan count or mastitis incidence.

Overall summary

This study demonstrates that there are differences between organically and conventionally produced milk, particularly the fatty acid content. Milk with higher omega-3 fatty acid content could be presented as a valuable contribution to a *balanced* diet to consumers, but it is important to emphasise that both organic and conventional milk is an excellent source of CLA as well as other vitamins and minerals. The vitamin content of milk is likely to reflect the level of supplementation given in-feed to cows. This study contributes to the increasing amount of interest in organic agriculture, and has increased understanding of organic production practices and their impact on food production. Additionally, it highlights the generally excellent standards of UK dairy production across all systems.

Acknowledgements

The Organic Milk Suppliers Co-operative (OMSCo), for their financial support of this project. The farmers and milk processors who gave their time and support to this project.

Kathryn Ellis is currently at the Division of Animal Production and Public Health, Faculty of Veterinary Medicine, University of Glasgow

The Provision of Guidance on Fertility Building Crops in Organic Farming

The Organic Studies Centre have been collaborating with researchers at ADAS, IGER and Abacus Organic Associates for the last four years on a Defra-funded project aimed at providing guidance to organic farmers on fertility building crops. The project is now in its final stages and two events have been organised to present the results to farmers and growers.

The events will be held at:

HDRA, Coventry on 30th January, 2006 and

at **The White Hart Hotel, Okehampton** on 1st February 2006

from 11am to 3pm.

Speakers at the event will include soil scientists and organic farming specialists Dr Mark Shepherd (ADAS), Dr Steve Cuttle (IGER), Dr Gillian Goodlass (ADAS), Stephen Briggs (Abacus) and Dr John King (ADAS).

Topics to be covered will include:

Management of legumes and effects on N fixation

Designing crop rotations (balancing N accumulation and utilisation)

How do we make best use of the N that is fixed?

A calculation system for estimating N accumulation, N release and N losses in organic crop rotations

For further details contact Stephen Roderick on 01209 722113 or at s.roderick@cornwall,.ac.uk

The Impact of Organic Farming on the Rural Economy in England

A major study of the impact of organic farming on the rural economy has just been completed by researchers at the University of Exeter Centre for Rural Research.. The study involved an extensive survey of both organic and non-organic farmers and incorporated a broad range of social and economic indicators. The results and implications are summarised by Dr Matt Lobley, Assistant Director at CRR..

Introduction

Against a background of apparently growing demand for organic produce and various claims (that are frequently still contested) regarding the beneficial impacts of organic farming on the environment, human health and the rural economy, the research on which this article is based sought to address the question of whether organic farming provides an additional benefit to the rural economy over and above that of conventional agriculture.

The main objectives of this DEFRA funded project were to:

1. Review current state of knowledge of wider socio-economic impacts of organic farming through a review of literature and input of stakeholders via a panel of experts seminar.

2. Examine differences in the socio-economic footprint between organic and conventional farming in terms of pattern of sales and input purchases, quantity and 'quality' of labour inputs, integration with local socio-economic networks, contribution to tourism and rural development.

3. Examine differences in socio-economic footprint between different types of organic and conventional farms (following the approach outlined under Objective 2).

4. Develop policy implications in consultation with DEFRA and other stakeholders.

In order to explore these issues a postal survey was conducted in 2004 of 655 organic and non-organic farmers in England and this was supplemented by in-depth face-to-face interviews with 22 farmers and stakeholders in three study areas in South West, Eastern and Northern England.

For the purposes of the project, the definition of organic farming was based on certified compliance. By extension, remaining farms were classified as non-organic although in reality non-organic farms exist on a spectrum of farming systems, some of which are 'near-organic'. In terms of identifying and understanding benefits to the economy, the concept of a 'socio-economic footprint' was developed to illustrate and measure the impact of different types of farm in terms of their economic activities, accessing of grant aid, connectedness to and participation in the local community. This is a much broader perspective than a traditional economic analysis and, as a consequence, the results of the research may be more complex.

Impacts and characteristics

Respondents to the survey spent a total of £65m in purchases (excluding labour) for their businesses and generated £90.5m in sales. At an aggregate level, organic farms spent less on purchases and generated a lower volume of sales. The organic sample was slightly smaller (302 compared to 353 non-organic farms) and when the value of sales is standardised and expressed on a per hectare basis, organic farms out-perform non-organic farms (generating average sales of £2,837 per ha compared to £1,953 per ha for non-organic farms). That said, it is increasingly recognised that in terms of economic impacts and rural development potential it is not just aggregate values that are important but also how closely businesses are linked to their local economies, so that the money spent is retained in the local economy and supports other businesses and individuals. This can be thought of as 'economic connectivity' and was explored through an analysis of the spatial pattern of sales and purchasing behaviour.

In terms of both sales and purchases organic farms are not significantly more connected to the local economy. For example, on organic farms 29% of the total value of purchases and 19% of sales are made within ten miles of the farm compared to 27% and 27% respectively for non-organic farms. The definition of 'local' is clearly open to interpretation and if it is widened to encompass the county within which a farm business is located then a total of 72% of purchases and 57% of sales on organic farms were made 'locally' compared to 65% and 56% for non-organic farms. On the basis of this measure of economic impact and connectivity there is little difference between organic and non-organic farms.

The results of this research largely confirm the results of previous studies in identifying a significant employment dividend associated with organic production. Organic farms accounted for 46% of the sample but 57% of all people employed in the sample. Standardising labour in terms of Full Time Equivalents (FTES) confirmed that, despite being smaller on average, organic farms employ more FTEs per hectare and per farm than non-organic farms. Moreover, they employ more non-family FTEs compared to their non-organic counterparts and it is only on organic farms that non-family FTEs exceeded family labour inputs. However, while employment is higher on organic farms a much greater proportion is accounted for by casual staff (50% compared to 33% for non-organic farms). This may be a reflection of the farm type structure of the two sub-samples as horticultural businesses account for a greater proportion of the organic sample (see the short and full reports for full details). Casual employment may

offer flexibility to multiple job holding rural workers but by definition does not offer stability and may be associated with lower levels of pay.

While the economic impacts and local economic connectivity of the two farming systems are broadly similar, the operators of the businesses and the way in which individual businesses are configured are significantly different. The people who operate organic farms are typically younger and more highly educated than their non-organic counterparts. On average, organic farmers are 6 years younger than their non-organic counterparts and 51% have a higher education qualification compared to 30% of non-organic farmers. In addition, a significant proportion have entered agriculture as an entirely new 'career' and did not come from a farming family. Many had never farmed in any other way but organically and had no intention of leaving organic farming in the foreseeable future.

It is reasonable to assume that this distinctive group of organic farmers bring with them different skills and aptitudes and possibly also a different attitude to operating a farm business. They are more likely to run diversified enterprises than their non-organic counterparts and those enterprises are much more likely to be orientated away from providing services to the agricultural industry and instead are focused on processing and/or retailing.

Further analysis revealed that farms operating direct sales enterprises have the most distinctive impact in terms of their contribution to rural development. Compared to other organic farmers they were younger, more highly educated and more likely to have diversified. All farms with direct sales recorded a higher value of sales per ha than farms where direct sales were absent but this was even more marked for organic farms. On average organic farms with direct sales generated sales of £4,983/ha compared to £3,249/ha for non-organic farms with direct sales, whilst all farms without direct sales generated sales of £1,654/ha. These farms also support a larger number of jobs as well as providing a more diverse range of employment opportunities.

In addition to the readily quantifiable impacts noted above, the combination of organic production, in particular, with direct sales is associated with less easily quantifiable impacts that nevertheless represent a bonus to rural development and suggest the possibility of having a re-generative role in the community. Key here is the direct relationship with the consumer which often transforms the operation of the farm business in that it requires there to be trust between farmers and their customers. As well as connecting farmers and consumers in a more direct manner, direct sales are frequently associated with improved connections and collaboration between farmers as consumer demand almost always requires farms to act collectively.

These networks of trust can help build broader feelings of reciprocity and solidarity. Consumers can feel that they are supporting and building a form of food production that they find to be superior from an environmental and or health perspective, or just convenient, or a combination of all of these. As a result, they can enter a new set of relationships with those who produce their food. In turn the producers, who are often already acutely aware of their dependency on consumers, can negotiate that relationship face-to-face with their customers. Organic status again acts as a bridge, a social shorthand, that helps customers and producers share a feeling of solidarity before entering into a relationship of relative interdependence. These feelings can be established outside the framework of organic agriculture, but the costs in terms of time and effort will be more considerable. Fellow feeling and mutual dependence strengthen the sense of community. Although the selling of food directly to the customer is not a complete answer to community development, it can make an important contribution.

Implications

The beneficial impacts identified in this research were associated with organic farms which operated a very different business model. Therefore it is recommended that a *business reconfiguration package* is developed to help farmers reconfigure their businesses to supply customers directly. In addition, given the shortage of external private capital in farming it is recommended that possibility of private co-financing to lever in funds from outside the farm sector is explored. A *venture grant scheme* could be facilitated with Defra acting as the broker introducing those willing to share both risk and reward with farmers wanting to reconfigure their businesses. Action should also be taken to recruit dynamic and pioneering farmers into a *network of demonstration farms* where the emphasis is on understanding the process of changing and sustaining the farm business rather than just the farm system. Finally, it is recommended that the concept of developing *organic hubs* is explored through an experimental pilot project. An organic hub would be a single site where organic infrastructure, including advice workers, is located. The hub could provide an organically certified small-scale abattoir, cold-storage unit and warehouse/pack-house facilities. The principle would be to establish a point where infrastructure was available to facilitate the building up of networks of smaller producers selling directly to the customer.

A longer summary and the full report are available from the Centre for Rural Research website: www.centres.ex.ac.uk/crr/

Results of the 2005 Organic Studies Centre Spring Cereal Variety Trials

For the second year in succession, the Organic Studies Centre have teamed up with The Arable Group (TAG), with part-funding from Organic South West, to run spring cereal variety trials at Waylands Farm, Looe courtesy of Geoffrey and Giles Maddever. The trials were an expansion of those run during 2004, with the inclusion of spring oats as well as spring wheat, barley and triticale. Following discussion with local producers, disease and weed monitoring were also included in the 2005 programme. Crude protein analyses were also conducted although these results were not available in time for publication. They will be published in the next (9th) edition of the Technical Bulletin. A full report of the trials can be obtained from the Organic Studies Centre.

The trial site and design

The trial included thirteen varieties of spring barley, six varieties of spring wheat, five varieties of spring oats and four varieties of spring triticale. All of the varieties were grown in triplicate in random plots of 2m x 12m. The trial crops were drilled on 1st April 2005. The spring oats and barley variety trials were drilled at 400 seeds/m^2, the spring wheat was drilled at a rate of 500 seeds/m^2 and all of the spring triticale plots were drilled at 400, 500 and 600 seeds/m^2

A second trial was conducted at the same site in order to evaluate the impact of seed rate on yield and other key parameters. The spring barley variety Static was grown in replicated plots at seed rates of 200, 300, 400 and 500 seeds/m^2. The spring barley variety Paragon was grown at seed rates of 300, 400, 500 and 600 seeds/m^2. All four of the trialled spring triticale varieties were grown at seed rates of 400, 500 and 600 seeds/m^2.

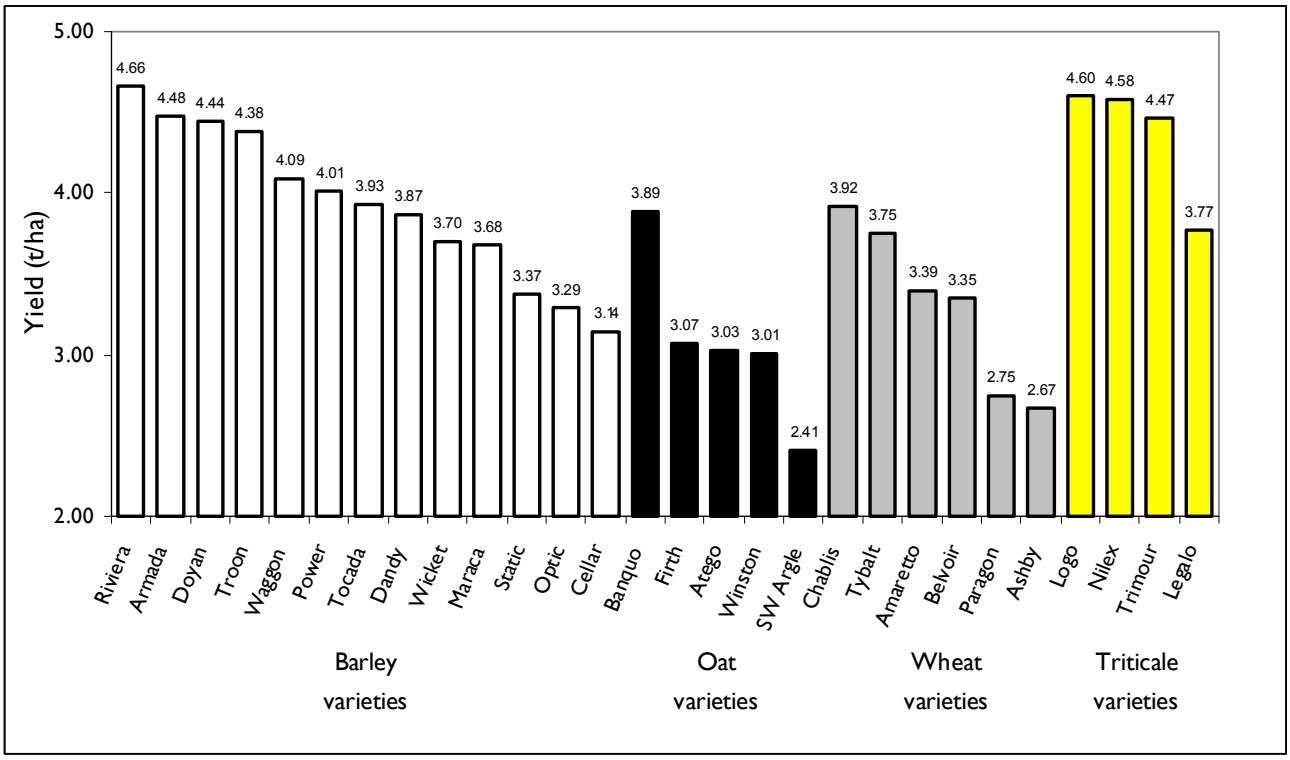
A soil analysis was completed by the Organic Advisory Service, Elm Farm Research Centre which showed the trial site as being of a light soil type of pH 5.6, a clay content of 17% ww and an organic matter of 4.2% ww. Phosphorus and potash levels were considered to be low for arable production. The trial crop was preceded by a crop of spring wheat, which in turn followed a rygrass/white clover sward. The trial plots were not weeded during the trial as this was considered unnecessary. The site did not receive any pre or post-drilling inputs.

Summary of yield estimates for all varieties

Figure 1 summarises the average yields for all of the varieties grown in the trial. More detailed information is presented below in separate sections for each crop species.

In summary, it is interesting to note that in general the spring triticale varieties out-performed spring wheat varieties. The poor performance of the spring oat variety SW Argyle was largely a consequence of badger damage. There was a wide-range of yields across the spring barley varieties. Closer analysis of the trial data also revealed that there was variation between plots of the same variety, highlighting the variation in yield potential across a single field.

Figure 1 The mean yield estimates of all spring cereal varieties



Spring barley varieties

The spring barley varieties were assessed for crop height, maturity and disease score on the 22 July 2005 (Table 1). The main results of this assessment are as follows:

- There were statistically significant differences in *Rynchosporium* incidence between the varieties. The *Rynchosporium* incidence in both Cellar (2.2%) and Optic (5.0%), although low, was significantly greater than that seen in the other varieties.
- Net blotch incidence and the percentage of abiotic spotting were low in all varieties.
- There was a statistically significant difference in the height of the varieties, with Dandy standing at a height significantly higher than the other varieties. There were also large differences in the height between plots of the same variety e.g. plots of Armada (average 64 cm) ranged between 54 cm and 71cm.
- Although there were differences in crop maturity between varieties, these were not statistically significant.

Table 1 The mean height (cm), maturity score (1-5) and disease incidence (%) in spring barley varieties (22 July 2005)

	Height (cm)	Maturity Score 1-5 (5 = most)	Abiotic spotting %	Rynchosporium %	Net Blotch %
Cellar	56	3.7	0.1	2.2	0.2
Dandy	74	3.3	0.5	0.2	0.0
Doyan	61	2.0	0.3	0.2	0.1
Optic	56	2.0	0.4	5.0	0.1
Power	53	3.0	0.4	0.7	0.0
Riviera	63	3.3	0.2	0.5	0.0
Static	58	2.7	0.3	0.4	0.5
Tocada	61	3.0	0.1	1.0	0.3
Troon	62	2.0	0.4	0.6	0.1
Waggon	58	2.7	0.2	0.5	0.1
Wicket	56	1.7	0.1	0.1	0.1
Maraca	54	2.7	0.5	0.0	0.0
Armada	64	2.3	0.1	1.5	0.1
LSD(P=.05)	6.13	1.49	0.25	1.73	0.18
D	3.64	0.88	0.15	1.02	0.11
CV	6.09	33.39	54.40	103.20	86.53

The yield, brackling percentage and specific weights of the barley varieties were estimated at harvest on 2 September (Table 2).

Table 2 The mean estimated yield (t/ha), brackling (%) and specific weight (hl/kg) of spring barley varieties at harvest

	Yield (t/ha at 85% DM)	Brackling (%)	Specific weight (kg/hl)
Cellar	3.14	99	57.06
Dandy	3.87	96	60.89
Doyan	4.44	98	58.21
Optic	3.29	98	57.39
Power	4.01	99	58.76
Riviera	4.66	93	60.04
Static	3.37	98	58.03
Tocada	3.93	98	56.15
Troon	4.38	96	58.75
Waggon	4.09	88	57.56
Wicket	3.70	99	58.02
Maraca	3.68	99	58.74
Armada	4.48	91	60.70
LSD (P=.05)	0.66	7.72	1.61
SD	0.39	4.58	0.96
CV	10.04	4.76	1.64

- The overall mean yield was 3.93 t/ha. The differences in mean yield between the varieties were statistically significant. The varieties Doyan, Power, Riviera, Troon, Waggon and Armada all produced more than 4 t/ha.
- There were also significant differences between plots of the same variety. For example, the individual plot yields for Armada were 2.89 t/ha, 5.2 t/ha and 5.36 t/ha.
- The percentage of brackling was very high across all varieties, and is probably a reflection of the late harvest.
- The average specific weight was 58.48 kg/hl with significant variations between varieties and between plots.
- Interestingly, there were no real differences in the yields obtained from seed rates of 200, 300, 400 and 500 seeds/m^2.

Spring oat varieties

Assessments of crop height, maturity and the percentage rust and septoria were conducted for each oat variety at growth stage 71 on 22 July 2005 (Table 3).

Table 3 The mean height (cm), maturity score (1-5) and disease incidence (%) in spring oat varieties (22 July 2005)

	Height (cm)	Maturity Score 1-5 (5 = most)	Rust (%)	Septoria (%)
Atego	99	3.0	11.0	0.2
Banquo	100	2.3	6.7	0.1
Firth	99	4.0	13.3	0.5
SW Argyle	92	1.0	0.5	0.0
Winston	99	2.7	15.7	0.4
LSD (P=.05)	10.65	0.64	8.86	0.31
SD	5.66	0.34	4.71	0.17
CV	5.79	13.14	49.87	73.38

- At growth stage 73, although there were no real differences in the height of the five spring oats varieties trialled, there were significant differences in the stage of maturity. On a scale of 1-5, Firth was the most mature of the varieties (score 4) whilst SW Argyle (score 1) was considered as the least mature.
- There were large variations between the varieties in the percentage of rust attack. Whilst all of the other varieties were visibly affected, SW Argyle had only very low levels.
- Although the differences in septoria attack assessed on 22 July were significant, the levels were low across all varieties.

The varieties were harvested on 2 September. Estimates of yield, specific weight and the percentage of brackling and lodging are given in Table 4.

Table 4 The mean estimated yield, brackling % and specific weight of spring oat varieties at harvest

	Yield (t/ha @ 85% DM)	Brackling (%)	Lodging (%)	Specific weight (kg/hl)
Atego	3.03	99	0	44.56
Banquo	3.89	90	8	46.85
Firth	3.07	99	0	44.72
SW Argyle	2.41	23	76	48.24
Winston	3.01	99	0	44.81
LSD (P=.05)	0.77	20.01	20.66	.
SD	0.41	10.63	10.97	.
CV	13.21	12.95	64.80	.

- Although overall yields were relatively low, at an average of 3.08 t/ha, Banquo yielded significantly more grain than the other varieties.
- The yield of SW Argyle was severely affected by badger damage. All three of the replicates of this variety had measurable damage (70%, 15% and 10% damage to plots). As a consequence, this variety produced significantly lower yields than the other varieties although the least affected plot produced a comparable yield. Other varieties were not affected, suggesting that SW Argyle, being less mature, was more palatable to badgers.
- SW Argyle also stood out as being heavily lodged (as a result of badger damage) whilst the other varieties, at harvest, suffered comprehensive brackling probably as a consequence of late harvest date rather than for any varietal reasons.

Spring wheat varieties

Assessments of septoria infection were made on spring wheat varieties on the 22 July, 2005, along with crop height and maturity (Table 5).

Table 5 The mean height (cm), maturity score (1-5) and disease incidence (%) in spring wheat varieties (22 July 2005)

	Height (cm)	Maturity Score 1-5 (5 = most)	Septoria (%)
Crop Stage	73	37	73
Ashby	88	1.7	0.4
Chablis	78	2.3	1.2
Paragon	89	2.3	1.3
Belvoir	88	2.7	2.2
Tybalt	79	3.7	1.2
Amaretto	93	2.3	1.2
LSD (P=.05)	6.40	6.40	1.59
SD	3.52	3.52	0.88
CV	4.11	35.02	89.78

- At growth stage 37 (15th June), Paragon showed a significantly higher level of septoria at 2.2%. However, a second assessment at growth stage 73, on the 22 July, revealed low level infection with no differences between the varieties.
- Also at growth stage 73, the differences in plant height were significant, with Tybalt and Chablis being the shortest.
- Tybalt (mean score of 3.7 from 5) was significantly more mature than Ashby (mean maturity score of 1.7). Again on the 9th August Tybalt was significantly more mature than Ashby (scores of 4 and 2 respectively). The other varieties were at a similar stage of maturity on both occasions.

Estimates of yield and lodging and measures of specific weight were conducted at harvest on 2 September (Table 6).

Table 6 The mean estimated yield, brackling % and specific weight of spring wheat varieties at harvest

	Yield (t/ha @ 85% DM)	Lodging (%)	Specific weight (kg/hl)
Ashby	2.67	43	63.88
Chablis	3.92	2	65.52
Paragon	2.75	53	64.55
Belvoir	3.35	0	64.73
Tybalt	3.75	2	65.90
Amaretto	3.39	2	71.10
LSD (P=.05)	0.88	41.80	
SD	0.48	22.98	
CV	14.62	135.62	

- At harvest, there were significant differences in the mean percentage lodging, with approximately half of the Ashby and Chablis crops exhibiting lodging whilst the other varieties had not lodged. However, the greatest effect was between replicates of the same variety rather than between varieties i.e. some plots of the same variety had not lodged whilst others had.
- The average yield across all varieties was 3.31 t/ha.
- There were significant yield effects between varieties and between replicates. Paragon and Ashby yielded significantly less than others. Both yielded on average less than 3t/ha.
- Grain from Amaretto had a noticeably higher specific weight (71.10 kg/hl) than the other varieties.

Spring triticale varieties

The height and weed biomass of the triticale varieties were measured on 22 July (growth stage 73) and crop maturity on 9 August (crop stage 75). The data in Table 7 shows the average results from plots sown at 500 seeds/m^2.

- Weed biomass on 22 July showed Nilex to have the lowest score, although most of the variation between the plots was found between replicates of the same variety. Overall, weed biomass did not appear to be heavily influenced by seed rate, although in the case of Nilex, the greatest weed burden was observed at the lowest seed rate.
- At the same growth stage, ears per m^2 were influenced by variety and seed rate although again there were field effects as well, with differences recorded between plots of the same variety grown at the same seed rate.
- Nilex appeared to be the earliest maturing variety and Trimour the latest maturing.

Table 7 Mean height (cm) and weed biomass at growth stage 73 and maturity score at growth stage 75 of spring triticale varieties

	Height (cm)	Weed Biomass 0-9 (9=high)	Maturity Score 1-5 (5 = most)
Nilex	118	1.3	3.3
Legalo	117	3.3	3.7
Logo	114	2.7	2.7
Trimour	115	4.0	1.3
LSD (P=.05)	5.51	2.25	1.33
SD	3.26	1.33	0.79
CV	43.94	25.74	89.78

- There was no difference in yield between the three seed rates for any of the varieties (Table 8).
- However, there was a significant difference in the yield of varieties at all three seed rates, with the variety Legalo producing the lowest yield.
- Seed rate and variety appeared to have no effect on the specific weight of the trial crop.

Table 8 The mean yield and specific weight of spring triticale varieties at three seed rates (400, 500 and 600 seeds/m^2)

	Yield (t/ha)			Specific weight (hl/kg)		
	400	500 seeds/m^2	600	400	500 seeds/m^2	600
Nilex	4.4	4.6	4.4	67.7	69.1	68.0
Legalo	3.8	3.8	3.8	66.8	66.3	65.9
Logo	4.4	4.6	4.5	65.1	64.3	64.0
Trimou	4.5	4.5	4.7	64.4	65.3	66.3

We are grateful to Geoffrey and Giles Maddever for their co-operation and for hosting the trials and to Richard Overthrow and Ron Stobart at The Arable Group for conducting the trials, providing the data analysis and for editorial comments.

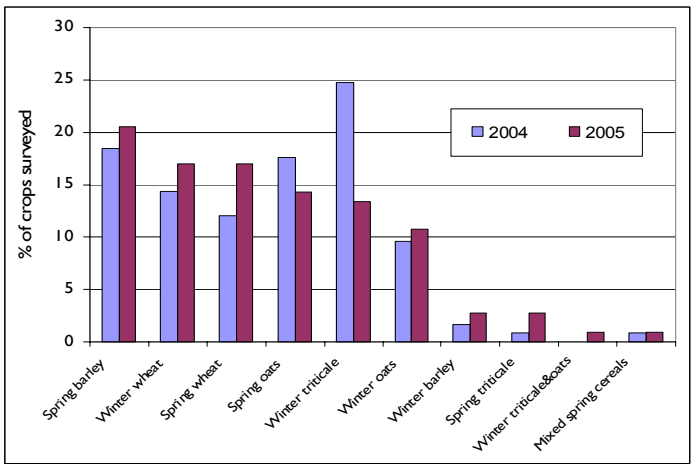
Organic Combinable Cereal Survey: comparing 2004 and 2005

The 2004 Organic Studies Centre survey of organic farms in the south west revealed interesting results concerning the types of crops being grown, and the variable quality achieved. The survey was repeated in 2005, allowing an opportunity to examine the results over two seasons, and to give an indication of any changes that may be occurring in trends of production and marketing. The results of the 2005 survey are discussed in detail below, with some comparison with those obtained the previous year.

An initial telephone survey of those who participated in the 2004 organic cereal survey was conducted pre-harvest 2005 in order to gather information on the extent of production of the various organic cereal crops being grown in the south-west. The main focus of the survey was on combinable cereals. A total of 58 organic cereal farmers in Cornwall, Devon and Somerset provided details of 119 combinable cereal crops including information on varieties and whether crops were intended for home-use as livestock feed or for sale.

Comparing this information with that obtained from a survey of 73 farms and 124 crops in 2004 (reported in Bulletin 6, December 2004), the most striking result is the decline in the proportion of combined winter triticale crops being grown (see Figure 1). In 2004, 25% of crops were winter triticale. In 2005, this crop represented just 13% of the crops surveyed. It is unclear from the survey whether this is a consequence of a decline in the acreage or triticale *per se*, or a shift towards triticale being grown more as a whole crop silage and as crimped grain crop. Although crimped grains were not included in the survey criteria, it is known that at least some of the crops were eventually harvested for both crimping and whole crop silage as a consequence of poor harvest-time weather conditions.

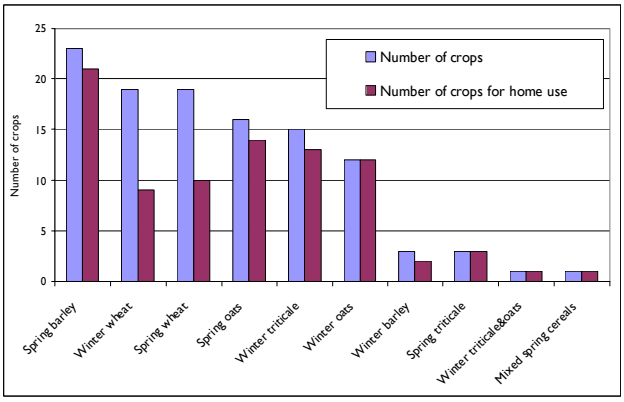
Figure 1 A comparison of the proportion of crops grown on farms surveyed in 2004 and 2005



Of those initially contacted, 41 farmers sent 78 samples of organic grain for laboratory analysis, with each sample being accompanied by a completed questionnaire with crop and marketing details and management information. This response was lower than that achieved during 2004, when 73 responses and 124 samples were received. There was a regional bias in the response compared with 2004. Whilst the number of samples received from farmers in Cornwall was similar to that received in 2004, there was a large reduction in the number of samples received from Devon (31 samples compared with 68). This difference in the response rate between 2004 and 2005 should not be read as being indicative of any changes in the area of cereals grown, although this may be a possible explanation.

Figure 2 shows the number of samples obtained as well as an indication of their intended use. This shows triticale, oats and barley being grown largely for feeding on farm and wheat being grown predominantly for sale.

Figure 2 Number of winter and spring grain samples analysed and their intended usage



Grain quality

As a consequence of the lower return rate in 2005, some of the comparisons of production and grain quality with 2004 are not well suited to statistical analyses i.e there were too few samples of some categories of cereals for the comparison to have statistical relevance. However, comparisons are made in the following sections which reveal some interesting trends in production.

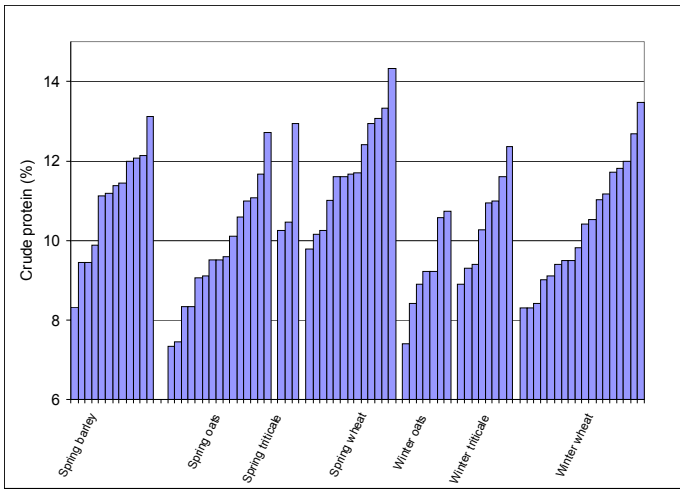
The average moisture content across all crops was 16.2%, with a range between 11.0% and 22.1%. The average moisture content was similar to that measured in crops during 2004. Although there was no real difference between values for spring and winter crops, the differences between crop types were statistically significant (Table 1)

Table 1 The average, minimum and maximum moisture content of sampled cereals (2005)

	Spring barley	Spring oats	Spring wheat	Winter oats	Winter triticale	Winter wheat
Samples	12	15	13	7	8	18
Average (%)	16.9	14.9	17.4	14.8	15.9	16.5
Minimum (%)	14.7	12.0	14.9	11.0	13.9	13.8
Maximum (%)	18.8	18.2	22.1	21.7	18.1	18.1

The laboratory analyses include measures of crude protein content. The trends in these measures are graphically presented in Figure 3. This shows a wide range in values for all of the crop types. Whilst this trend was also observed in 2004, the dominant result in that year was the significantly higher average protein value in the spring drilled cereals.

Figure 3 Individual crude protein values (%) of surveyed crops grouped by cereal type (2005 harvest)



Comparisons with results from 2004 are given in Figure 4. Other comparisons between years and crops can be summarised as:

- In 2005, although the differences in the crude protein content of spring wheat (mean 9.7%) and winter wheat (10.6%) were evident this difference was not significant. This was a different result to the previous year's study, which showed spring wheat to be superior to winter wheat.
- There were no differences between the protein content of winter wheat and winter triticale in 2005; a similar result to 2004.
- There was a significant annual difference in the crude protein content of spring oats, with the 2005 samples being significantly lower (9.7%) than those measured in the 2004 samples (11.4%). This effect was not noted in the winter oat samples.
- The difference between the crude protein of the spring wheat samples was also significant ($p<0.05$), with the mean value of the 2004 samples being 13.6% and the 2005 sample averaging 11.8%.
- There were no differences in the protein content of the 2004 and 2005 samples of spring barley.
- Unlike the spring cereals, the difference between the 2004 (mean 9.3%) and 2005 (mean 10.5%) winter triticale samples were in favour of the 2005 crop. However, some caution in interpretation should be applied here, as there were only 8 samples analysed in 2005 compared with 31 in 2004. The 2005 samples did not contain as wide a range of values (8.9% to 12.4%) as the 2004 samples (6.2% to 11.9%).
- The difference in the crude protein content of the winter wheat crop over the two seasons was not significant (mean 10.1% and 10.6% respectively).

There was no difference in the specific weight between comparable crops sampled in 2004 and 2005. Data reflecting the weights of the 2005 samples are shown in Table 2

Figure 4 A comparison of mean crude protein values (%) between 2004 and 2005 surveyed cereal crops

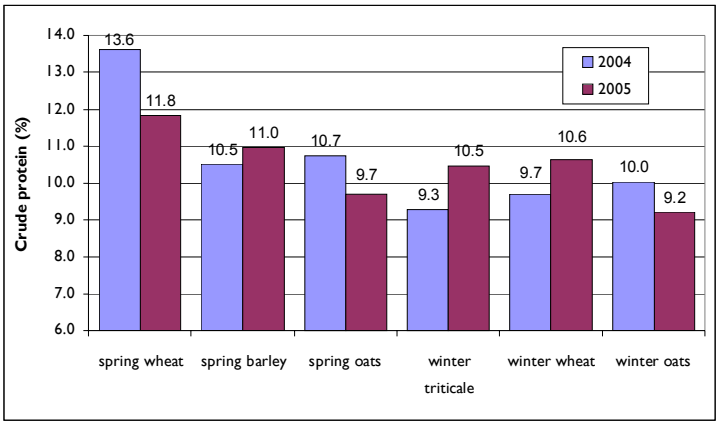


Table 2 The average, minimum and maximum specific weight (kg/hl) of sampled cereals (2005)

	Spring barley	Spring oats	Spring wheat	Winter oats	Winter triticale	Winter wheat
No. Samples	13	16	14	8	9	19
Average	56.3	47.2	68.0	45.6	61.2	68.9
Minimum	12.0	15.0	13.0	7.0	8.0	18.0
Maximum	67.0	55.2	78.7	56.1	71.1	81.5

Varieties and seeds

Ninety six (96) respondents gave detail of the cereal varieties grown in 2005. In general, the same varieties recorded in the 2004 survey were used with similar frequency (Table 3). Atego was a new and popular choice of spring oat variety and Logo was the only named variety of spring triticale. Forty-one percent (41%) of the 74 samples sent for analysis were grown from home-saved seed. This ranged from 57% of winter oat crops to 21% of winter wheat crops.

Table 3 List of varieties grown by survey respondents (2005)

Barley		Oats		Triticale		Wheat	
Spring varieties							
Dandy	12	Banquo	6	Logo	2	Paragon	11
Static	5	Atego	4			Ashby	3
Optic	2	Firth	2			Tybalt	2
Riviera	1	Drummer	1				
Doyen	1	Markant	1				
		Sailor	1				
Winter varieties							
Pearl	2	Millenium	4	Trinadad	4	Claire	5
		Dunkeld	2	Ego	2	Deben	2
		Imagine	1	Partout	2	Except Maris	2
		Jalnar	1	Purdy	2	Widgeon	2
				Tricolour	1	Robigus	2
						Istabraq	1

Hereward, Solstice and X19 winter wheat varieties grown at Coswinsawsin Farm as part of a variety trial

Crop rotation

Details concerning crop rotation were available for the 74 analysed samples. Forty two percent (42%) of these were grown as a second cereal in a crop rotation whilst 41% of crops followed grass-clover leys or in a small number of cases, a green manure crop. Whilst winter triticale and winter oats were most frequently grown as second cereals, both winter and spring wheat followed grass-clover leys or leguminous crops such as peas, beans and lupins (Table 4).

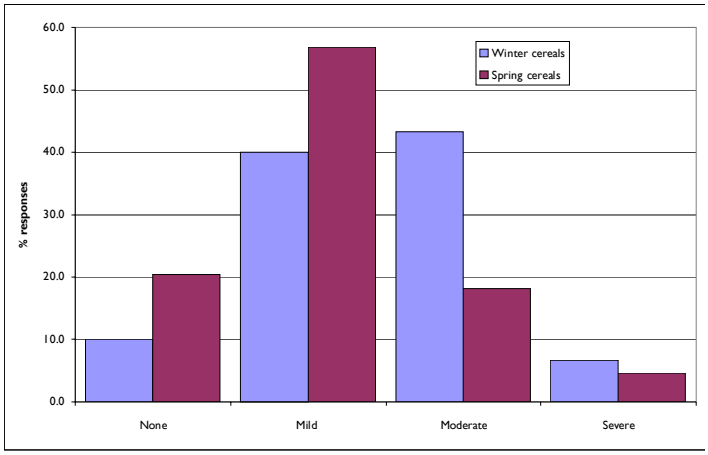
Table 4 The percentage of cereals following cereals in crop rotations on surveyed farms

	% of crops following cereals in a rotation
All samples	42%
Winter oats	71%
Winter triticale	67%
Spring oats	53%
Spring barley	50%
Spring triticale	33%
Winter wheat	25%
Spring wheat	15%

Weeds, pests and diseases

In a similar manner to the 2004 survey, responding farmers were asked their perception of what the weed, pests and disease pressures were on the submitted crops from which samples had been submitted.

Figure 5 A comparison of surveyed farmers' perception of weed problems in winter and spring organic cereal crops



The results expressed in Figures 5, 6 and 7 compare the results obtained for spring and winter crops. From this comparison, it appears that winter cereals are perceived to have a greater (expressed as moderate) weed challenge than spring crops. Overall, weeds are viewed as being more problematic than pests or crop disease. As with the results from 2004, there were very few cases of severe weed, pest and disease problems on organic crops, with the majority of crops considered as being under mild pressure.

Figure 6 A comparison of farmers' perception of disease problems in winter and spring organic cereal crops

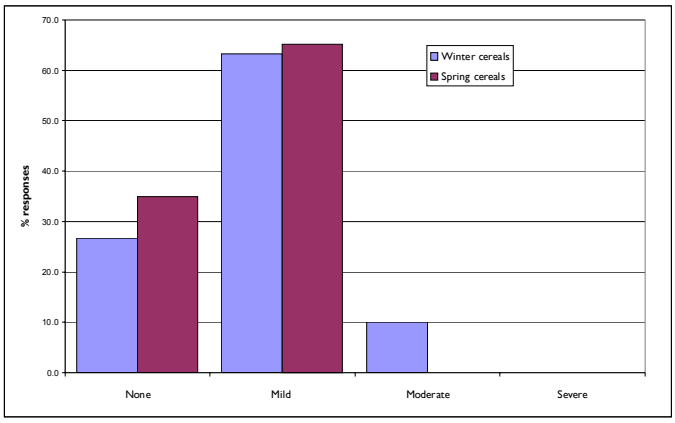
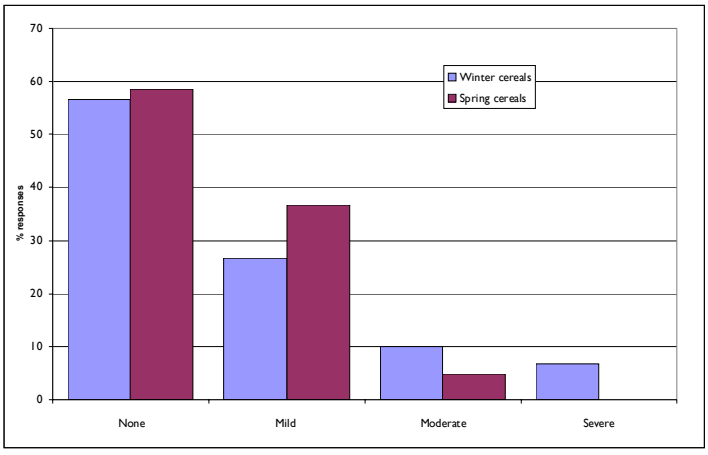


Figure 7 A comparison of farmers' perception of pest problems in winter and spring organic cereal crops on surveyed farms



We would like to thank the farmers who contributed to this study, and in particular those that took the time and effort to send grain samples. We are also grateful to Devon Grain Stores Ltd, West Country Grain Marketing Ltd and Grainfarmers plc for funding this work. For further details of the survey, please contact the Organic Studies Centre.

Feed self sufficiency in organic dairy farming – the challenges

Research studies at IGER Trawsgoed have been examining a key question facing many organic dairy farmers i.e. that of choosing between feeding all-purchased concentrate feeds or the provision of 100% home-grown diets. In the following summary of this work, Richard Weller from IGER describes the study, its results and the conclusion from this Defra-funded project.

Introduction

A key decision for many organic dairy farmers is choosing between purchasing all the concentrate feeds or growing combinable crops on the farm to provide 100% home-grown diets. The decision can have a significant affect on both the stocking density and milk output per hectare. Purchasing concentrate feeds reduces the sustainability of the system but allows more flexibility in balancing the diets to overcome any adverse changes that occur in the energy to protein ratio of either the herbage or silage-based diets. Key challenges for many dairy farms are a lack of energy in the diet during the early lactation period and an erratic supply of feed protein throughout the year. Balancing the diets is more challenging in a self-sufficient system compared with a system based on purchased concentrates where the type of ingredients and feed ratios in a concentrate mix can be more readily adjusted.

Two contrasting systems of organic milk production are currently being evaluated at IGER Ty Gwyn to compare an extensive self-sufficient system with a more intensive system based on purchased concentrates. The main objective of the self-sufficient system is to increase the sustainability of organic milk production by establishing a crop rotation to provide both concentrate and forage feeds, with the main aims in the purchased concentrate system being the maintenance of a higher stocking density, increased milk output per hectare and maximising milk income.

The 'farm gate' nutrient balance at Ty Gwyn

Growing all the feed on the farm in the self-sufficient system leads to changes in the 'farm-gate' nutrient balance for N, P & K. The annual N-surplus ranges from +70 to 99 kg/ha with both the P and K balances declining annually by -3 or -4 kg/ha. This compares with the annual nutrient balance for N, P and K ranging from +145 to178, 0 to +10 and + 9 to 58 kg/ha in the system where concentrates and straw are purchased. However, despite the declining P and K in the self-sufficient system during the last six years to date there have not been any differences between the two systems in either the dry matter (DM yield or mineral content of the grass + clover forage leys.

To maintain a system that is reliant on 100% home-grown diets relies on the production of sufficient feed for both grazing and conservation. Three cuts of silage per annum at Ty Gwyn ensures good yields are achieved from the short-term red clover and red clover + grass leys, with the perennial ryegrass + white clover leys either cut for silage in May and then grazed or grazed throughout the growing season. Rotationally grazing the fields and maintaining a minimum sward height of 6 cm ensures the swards are not overgrazed and a good grass to white clover ratio is maintained.

Cropping strategy

Table 1 shows the crop rotation that has been established in the self-sufficient system at Ty Gwyn to provide forage from 82-85% of the land area for both grazing and ensiling, with cereals grown on 15-18% of the land to produce both grain and straw. A key objective for the long-term viability of the rotation is the balance between the N-contributing legumes (red clover, white clover) and the N-demanding cereal and grass plants. Another objective is to building up the soil fertility during the duration of the leys to provide sufficient nutrients for the succeeding cereal crops as the only other source of nutrients is from one application of either farmyard manure or slurry.

The option of increasing the land area used for growing cereal crops would increase the quantity of grain for the dairy herd. However, unless combinable N-fixing legumes were also sown to provide part of the concentrate feed requirements there would be an adverse affect on the quantity of total nitrogen that is available within the system as increasing the area for cereal production would also reduce the land available for growing clover-based leys and improving soil fertility. Pure red clover leys currently provide an additional high-protein crop (16-20%) for ensiling and balance the low protein of the cereal grains (10-11%).

A recent change in the cropping policy has led to winter cereals now being grown as the grain yields are markedly higher than those from spring-sown cereals (Table 2). These higher yields provide 700 kg of grain/cow compared with the 400 kg/cow that have been produced from the spring-sown cereals in previous years. In the next year the extra grain from the winter cereals will increase the energy density of the ration and reduce the risk of a negative energy balance in early lactation.

Table 1 The current crop rotation in the self-sufficient system at Ty Gwyn

Year	Crops grown in the rotation
1-3	• Short-term ley of either (a) Italian ryegrass/hybrid ryegrass/red clover or (b) pure red clover
4	• Year 4 Winter triticale for grain and straw production
5	• Year 5 Winter barley for grain and straw production
6-10	• Years 6-10 Perennial ryegrass/white clover/herbs

Table 2 The grain yields from the cereal crops grown at Ty Gwyn

Cereal crops (sown at a seed rate of 200 kg/ha)	Range of grain yields @ 14% moisture
Spring barley	2.33 – 3.07
Winter barley	3.78 – 4.45
Spring triticale	2.82 – 4.09
Winter triticale	4.27 – 5.49

Herd performance

As shown in Table 3 growing the concentrate feeds (e.g. cereal grains) on the farm leads to a lower stocking density in a self-sufficient system compared with a higher stocking density that can be maintained when the concentrates are purchased. The self-sufficient system is also more influenced by seasonal changes in the weather patterns that lead to variations in the annual yields produced from the crops within the rotation. In the self-sufficient system 84% of the milk is produced from forage, compared with 49% when 1.4 tonnes of purchased concentrates is fed. The efficiency of converting feed into milk is lower in the self-sufficient system with cows producing lower yields from the very high-forage diets and utilising a higher proportion of their total feed intake for maintenance rather than production.

The average milk quality is similar in both systems and reflects the current spread of calving dates throughout the year. However, the feeding of <0.5 tonnes of concentrates (e.g. cereal grain) in the self-sufficient system leads to a higher proportion of cows producing milk with a low protein content during the early lactation period.

A major problem in some organic dairy herds is producing enough high quality forage to ensure the diets are not energy deficient during early lactation. Experience in Denmark suggests that aiming to provide energy-rich diets and produce 8,000 litres per cow will lead to the stocking density falling to <1.0 cow/ha when fodder beet is grown to provide a high energy forage, all the feed (both forage and concentrates) is grown on the farm and the diet has >35% concentrate in the total ration.

Breeds and the cost of replacements

In the Ty Gwyn system based on purchased concentrates and the feeding of >1.0 tonne of concentrates per cow, the Holstein breed are suited to the system. The cows maintain the appropriate body condition during the different stages of lactation and achieve pregnancy rates of 88-91%. In contrast, while some of the Holstein cows perform well in the self-sufficient system others produce low milk proteins in early lactation, fail to maintain milk persistency during lactation and either fail to conceive during early lactation or remain barren after several inseminations/natural services, leading to a pregnancy rate for the herd of 79-83%. Current results suggest a Holstein cow needs >1.0 t of concentrates unless forage quality is very high in early lactation, including for example the feeding of fodder beet or forage maize. While during the last few years the cows have been inseminated to predominantly Friesian bulls, the option of changing to other breeds or crossing the cows is currently being considered to improve the compatibility between the genetic potential of the cow, high-forage diets and the need to produce quality milk while maintaining good body condition, health and fertility.

In both systems the average lactation number in the herds was relatively low, with the main reasons for culling cows being infertility, lameness and high cell counts. Calculation of the costs of replacements for both herds showed an increase from 1.05 to 1.75 and 2.45 pence/litre of milk when the culling rate increases from 15% to 25% and 35% respectively. These costs include the cost of rearing the heifer and the prices received for both a culled cow and calf. The costs do not include the lower milk production from the first lactation heifer compared with a mature cow that is culled during her prime.

Table 3 The performance of self-sufficient and purchased concentrate systems of organic milk production at IGER Ty Gwyn

Type of system	Self sufficient	Purchased concentrates
Key system driver	Sustainability	Maximising milk output
Forage source:	Home grown	Home grown
Concentrate source	Home grown	Purchased
Concentrate feeds: Energy	Barley & triticale grain.	Barley & wheat grain.
Protein	None	Field beans, soya beans
Main forage for grazing and ensiling	Grass/clover leys.	Grass/clover leys + whole-crop cereals for ensiling.
High protein forage	Red clover	None
Average performance (4-year period):		
Stocking density (cows/ha)	1.28	1.69
Concentrate inputs (t/cow)	0.4	1.4
Milk yields (litres):		
Yield per cow	5,629	6,849
Yield/ha	7,205	11,575
% of total milk produced from forage	84	49
Milk fat %	4.15	4.03
Milk protein %	3.30	3.33
Efficiency of feed utilisation (MJ of milk per MJ of feed energy)	0.36	0.40

The role of 100% forage diets in a self-sufficient system

In wetter areas of the UK the feed energy production from many forage crops is often higher than the yields obtained from combinable crops and for some dairy farmers this raises the question of whether 100% forage diets are an option in a self-sufficient system. While growing only forage crops, rather than having to establish and harvest both forage and combinable crops, simplifies the management of the system there are four potential disadvantages that need to be considered:

- Compared with concentrate feeds the consistency of forages is more variable in energy, protein and dry matter.
- Is the dairy cow able to consume sufficient forage particularly in the latter part of the grazing season and when silage-based diets are fed?
- Are the genetics of the cow compatible with the energy and protein quality of the diet, especially during the early-lactation period?
- Although forage is generally cheaper per tonne of DM than concentrates the yield per cow is likely to be lower on 100% forage diets and overhead costs per kg of milk may increase.

The implications on the management and costs of a self-sufficient system

While deciding to grow all the feed on the farm increases the sustainability of the system there are factors to consider in relation to both the management and financial performance of the farm. As the level of self-sufficiency increases both the stocking density and milk income per hectare decline leading to both higher fixed costs and reduced milk income per hectare. A farm with a self-sufficient system also requires a more complicated crop rotation to provide both concentrate feeds and forage crops for grazing and conservation.

While a crop rotation is essential in a self-sufficient system, an alternative option for a system based on purchased concentrates is to grow only grass and white clover leys that can be used for both grazing and ensiling. While the total yield from these leys will be lower than the yields from short-term red clover leys and other forage crops in the rotation, the forage costs per tonne of DM may also be lower. This is due to reduced establishment costs and the lack of a 'non-productive period' between the last harvest/grazing of the previous crop and the first cut/grazing of the succeeding crop that occurs in rotations when new crops are established, often at frequent intervals.

The option of growing either fodder beet or forage maize in the rotation to provide additional energy to the cereal grain crops needs to be balanced against other factors. These include the extra costs associated with a requirement for effective weed control via a number of inter-row cultivations in both the crops. Other factors to be considered include the requirement on many farms for specialist machinery to harvest the crop and the implications on the total available nutrients from the on-farm slurry and FYM as both fodder beet and forage maize crops remove significant quantities of nutrients, particularly potassium, from the soil. The duration of the crop rotation will also be extended.

Acknowledgement

The author acknowledges the financial support from Defra for the organic study at IGER Ty Gwyn on organic dairy systems.

Organic Lettuce and Cabbage Varieties Open Day

An open day was held on the 22nd July, 2005 to give Cornish growers a chance to observe, taste and discuss the merits of the different lettuce and cabbage varieties grown as part of NIAB/HDRA trials. Twenty people attended, including staff from the Organic Studies Centre, HDRA, organic farmers from the county and representatives from seed companies. The open day was kindly hosted by Francis Sampson on his mixed farm, which is located over two separate sites, starting at Plain-an-gwarry and then at the main holding at Cargease Farm, Cockwells, near Penzance. The farm has been organic for six years.

Phil Sumption from HDRA introduced the vegetable varieties project being carried out by HDRA, NIAB and the Soil Association and funded by Defra. The Cornish group consists of four growers and is one of five grower groups based around the country (Devon, Herefordshire, Cambridge and Wales) that are involved in the project. There were 16 varieties of lettuce to choose from and 14 varieties of summer/autumn cabbage. The performance and marketable yield of the varieties is recorded by each grower in what is one of an increasing number of farmer participatory research initiatives. HDRA are working one year behind the NIAB formal trials and hope to compare the results with these trials once all the data has been gathered from the participating farmers. All the results will be made available at the organic seeds website www.cosi.org.uk and will be published in the next edition of the Organic Studies Centre Technical Bulletin.

Estelle Skinner, Phil Sumption, HDRA 16/08/2005

Controlling internal parasites in organic livestock without the use of pharmaceutical anthelmintics

Organic systems seek to reduce reliance on external inputs, and develop sustainable methods of production which balance output with high standards of animal welfare. The standards for organic production emphasise preventive control strategies based on grazing management, appropriate breeding and good nutrition. The ultimate goal is to eliminate dependence on anti-parasitic drugs although this is rarely achieved in practice. Defra-funded research project OF0185 examined alternative approaches to the control of internal parasites in organic livestock. The project was led by Ray Keatinge of ADAS Redesdale and was a collaborative effort involving ADAS, the Institute of Rural Science (IRS), Moredun Research Institute (MRI) and Scottish Agriculture Colleges (SAC). The following report summarises the major findings of the study.

The overall objective of this research was to develop organic farming systems which do not rely on pharmaceutical control of roundworm parasites. Focussing on management and nutrition, the approach was to combine on-farm epidemiological studies with replicated experiments in order to develop and demonstrate better systems of control applicable to UK organic farms.

Parasite epidemiology

Five commercial organic farms, reflecting a range of production systems (specialist hill sheep, upland beef and sheep, lowland specialist sheep, specialist dairying, and lowland mixed arable/livestock) were selected for detailed epidemiological study. The aim was to assess the level and pattern of parasite challenge, critical points for disease control, and the degree of success achieved with current management practices. The study combined the use of standard epidemiological techniques, with close collaboration of the researchers, participating farmers and their veterinary advisers. Comprehensive epidemiological data were collected over two contrasting seasons (2002 and 2003).

Without recourse to routine anthelmintic, control was generally underpinned by grazing management within the constraints of land/crop resources and the diversity of enterprises available on each farm. Generally, ewes were not drenched. The exception was the specialist sheep flock, where anthelmintic was given on veterinary advice to reduce pasture contamination at lambing. Nematodirus was a particular problem early in the season on two (specialist sheep and upland beef and sheep) of the four sheep farms studied. Apart from the extensively managed flock, specific groups of animals in the other three flocks were drenched in both years. Nevertheless, the overall amount of anthelmintic used was substantially less than levels typically used in conventionally managed flocks. In young dairy-stock, stomach worms appeared to be well controlled - the result of frequent movement and integration of grazing and conservation.

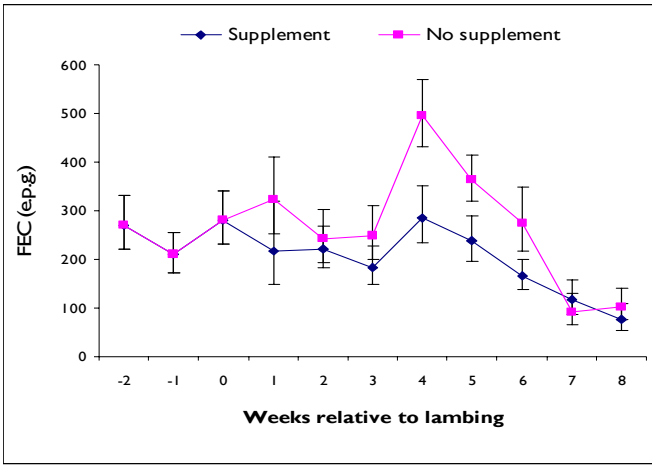
A separate study comparing growth rate, faecal egg output and blood pepsinogen levels taken in paired drenched and undrenched cattle, across four herds, did not indicate a high risk of winter parasitism in organically managed animals. Potentially, the most significant parasite problem found in cattle was lungworm (*Dictyocaulus viviparous*).

The role of nutrition

The emphasis on a preventive nutritional approach to health management in the organic standards is based on sound scientific reasoning. Under-nutrition in energy, protein and mineral/trace elements have all been implicated, directly or indirectly, in pre-disposing animals to parasitic infection. The "spring" or "peri-parturient rise" in ewe faecal egg output which occurs close to lambing and during early lactation features strongly in the epidemiology of roundworm parasites in sheep. At a time of high demand or nutrient scarcity, proteins required for lactation are prioritised over the requirements for immune response.

Previous studies, using controlled nutritional conditions and a known parasite challenge, developed a hypothesis for understanding nutritional influences on the host response to parasites. A replicated experiment was set up to test whether this framework could be extended to organically managed ewes carrying a mixed naturally-acquired infection. After lambing, ewes were allocated to one of two treatments - grazing a ryegrass/white clover sward with or without a concentrate supplement (0.6 kg/day GMO-free soyabean meal).

The total daily energy and metabolisable protein intake in supplemented animals was calculated to be 128% and 188% respectively, relative to a group of control animals. Up until lambing, the mean parasite faecal egg count (FEC) varied between 200 and 300 eggs per gram (epg). After lambing, this level was maintained for the control ewes, until weeks 4-6 of lactation, when a clear rise in FEC was evident. In contrast, supplemented ewes did not show any increase in FEC ($P<0.01$). The effect is shown in Figure 1.



In a further experiment ewes were managed so as to achieve two target body condition scores (High - CS 3; or Low - CS 2) at lambing. After lambing, ewes from both treatments were supplemented with 0.9 kg per day fresh weight of home-mixed organic concentrate, until the grass sward they were grazing reached a height of 5 cm.

Significant treatment differences in ewe live weight and body condition score, established by lambing, were maintained during early lactation. Faecal egg output followed a typical pattern, increasing during peak lactation, but there was no significant effect of treatment. The results suggest that maternal body reserves are less critical to the loss of host immunity during early lactation than current nutritional status. Conversely, good nutrition in early lactation can at least to some degree ameliorate the potential impact of reduced body condition on faecal egg output.

Using novel crops

A series of experiments were undertaken to determine the potential of several novel crops for parasite control. Two experiments were undertaken at IRS to investigate the effect of novel cropping on parasite burdens in weaned lambs. Of the four sward types studied (chicory; chicory with Lotus; perennial ryegrass and Lotus; perennial ryegrass and white clover), chicory showed the greatest potential in terms of agronomic performance, improved trace element status, and ability to reduce FEC in lambs. However, there was no significant effect on total worm burden determined post mortem. A further study at SAC compared the effect of chicory or ryegrass/white clover swards on parasite burden in suckling lambs. Lambs grew more quickly on chicory, and tended to have lower FEC, but total worm burden was not reduced. A major limitation of many novel crops is their tendency for poor establishment and persistency, and it is difficult to see how the specific use of these crops for parasite control could be widely recommended to UK organic farmers at the present time.

Parasite pasture ecology

Nematode larvae populations have also been shown to differ between herbage species, potentially due to differences in crop morphology or microclimate beneath the sward (which may affect larval development and survival, or the number of coprophagous or nematophagous organisms at soil level). Several small plot and pot experiments were undertaken to assess the effect of crop type on larval survival, rates of faecal degradation, and soil dwelling invertebrates. The work identified several interacting factors, but insufficient information is currently available to make specific recommendations on the effect of pasture ecology for parasite control.

Breeding for resistance

Although studies on breeding for resistance to roundworms were not included in this study, the approach is viewed as a potential contributor to integrated parasite control in both organic and conventional systems. The heritability of resistance to roundworms is thought to be 0.2-0.4. The value of this to the farmer is twofold. Firstly, progress can be made in selecting more resistant individuals. Secondly, it has been estimated that in lambs 50% of pasture contamination arises from 10% of individuals in a flock, so by removing the most susceptible individuals overall challenge can be reduced.

More precise genetic selection methods are now commercially available, based on faecal egg counts. An index which includes resistance to roundworms is available through Signet for Suffolk, Charolais and Texel breeds, which could be readily applied for selecting terminal sires on lowland organic sheep farms. Some organic farmers select against dagginess, but dirty animals may in fact be mounting an aggressive immune response. There is a debate as to whether selection should be for animals which are genetically resistant i.e. shed fewer eggs, or for animals which are more resilient i.e. may continue to shed significant numbers of eggs, whilst being tolerant of the effects of infection. Some evidence exists for a negative correlation between resistance/resilience to parasites and productive traits, possibly because a higher proportion of total nutrient resources are being deployed to meet immune responses. Furthermore, resilient stock will continue to contaminate the environment with potentially detrimental effects on the less resilient faction within the flock. The ideal animal for selection may well be one which performs well physically, but in a parasitized environment. Within the next 10-15 years, continuing advances in DNA technology hold the promise of more accurate, marker-assisted selection techniques.

Monitoring

The value of monitoring is to provide regular information. Assessments done at single points in time are difficult to interpret, and are of limited value. Faecal egg counts are the most common tool used - through a veterinarian, laboratory or, with appropriate training, using on-farm systems such as FECPAK. However, FECs are an indirect measure, an overall consequence of the total burden, physiological state and relative fecundity of the parasite species present. To arrive at a more robust conclusion, information should be drawn from a range of sources (current FEC, status of current and future grazing, weather conditions, age and animal performance) to provide a more rounded disease picture. Another useful concept is 'contamination mapping' - a risk assessment based on likely previous contamination of the pasture by monitored animals. Over time, data and experience will support some of the subjective judgements which have to be made. Following any treatment of organic sheep, a faecal egg reduction test is recommended to check the drug for continuing efficacy.

In conclusion

Overall, the results from this study indicate that with sufficient diversity of cropping and stocking, it is possible to virtually eliminate anthelmintic usage. However, many farms still face significant difficulties, particularly those systems dominated by sheep. The extent to which control can be achieved by management alone, depends on the farming system, with the greatest opportunity for control in the more mixed, or very extensive production systems. Many of the issues faced by the organic sector are increasingly relevant to conventional farmers where anthelmintic resistance is becoming increasingly prevalent. More integrated strategies are required, not only for organic producers, but also to prolong the life of drenches currently used in conventional farming. Practical recommendations have been derived from this research, and promoted to organic and conventional farmers, based around key messages of system planning, parasite monitoring and maintaining biosecurity.

A full report of the study can be obtained from the Defra website http://www.defra.gov.uk/science/. Further information pertaining to this study can be obtained by contacting Ray Keatinge at ray.keatinge@adas.co.uk.

Potato variety testing for organic production 2005

Supported by Bioselect UK and Agrico UK, the Organic Studies Centre trials to identify potato varieties suitable for organic production in Cornwall were continued for a third year, into 2005. This year the study was designed and managed as part of the Agrico/Bioselect national potato trial work. The trial plots were established on organic land at Tresawson Farm, near Looe in east Cornwall, with the co-operation and assistance of organic farmer Richard Tolputt. Results of the trials are summarised in the article below.

Trial site information

The previous crops had been a barley and peas mixture grown for whole-crop forage, followed by rape and stubble turnips which had been strip-grazed during the winter, firstly by cattle then by sheep. Applications of approximately 4 tonnes/ha FYM were made in autumn 2004 prior to drilling the rape/turnip mixture and again in February 2005. The land was ploughed, deep cultivated, ridged and de-stoned towards the end of March in preparation for the potato crop.

Soil Analysis revealed soil organic matter of 4.9%, adequate for soils of medium texture and with a clay content of 29% w/w. Although a pH of 6.2 was satisfactory, phosphorous and potash levels of 37.7mg/kg and 77.4mg/kg respectively, were below optimum levels for the intended potato crop. However, as this information was received after the crop was planted, no amendments were applied.

Varieties and planting

Two replicated blocks each containing 16 tuber plots of 18 potato varieties were hand planted in four rows within a commercial potato crop in good weather conditions on 5th May 2005. All varieties, with the exception of Virgo, were planted at 30cm tuber spacings. In addition, plots of varieties Milva and Nicola were planted at 20cm spacings and varieties Cosmos and Virgo at 35cm spacings. Each potato variety was separated from adjacent varieties by a one metre gap in planting and clearly labelled using white plastic bed markers. All seed potatoes supplied by Agrico Research, NL through Bioselect UK, including three numbered varieties, were from non-organic sources. Their use in this study was therefore subject to derogation from Soil Association Certification Ltd. The varieties Mira and Axona supplied by the Sarvari Research Trust were produced from organic seed.

The trial plan, showing the potato varieties tested and tuber spacings at which they were planted are presented in Table 1.

Monitoring of foliar blight (*Phytopthora infestans*)

The trial plots were monitored using a scale adapted from James, C. 1971 (Table 2) from 8th July when the first signs of onset of disease were noted.

Table 2 Observation scale for progression of foliar blight infection

Severity %	Description
0.001	1 lesion per 16 tuber plot
0.01	2-5 leaves affected per plot
0.1	5-10 infected leaflets/plant or 2 affected leaves per plant
1.0	General light infection. About 20 lesions/plant or 10 leaves affected/plant
5.0	About 100 lesions/plant; 1 in 10 leaflets affected (up to 50 leaves affected)
25	Nearly every leaflet infected but plants retain normal form; plants may smell of blight. Field looks green although every plant is affected
50	Every plant is affected and about 50% of leaf area is destroyed. Field appears green flecked with brown

Table 1 Plan of potato trial plots, varieties grown and tuber spacings for organic potato variety testing 2005.

8 tubers per variety per row		8 tubers per variety per row		
Row 1	Row 2	Row 3	Row 4	tuber
variety		variety		spacing(cm)
Mira*	Mira*	Axona*	Axona*	30
Nicola	Nicola	Milva	Milva	30
Sante	Sante	Madelaine	Madelaine	30
Novello	Novello	Romano	Romano	30
Amorosa	Amorosa	Red Baron	Red Baron	30
Toluca	Toluca	Junior	Junior	30
Ditta	Ditta	Cosmos	Cosmos	30
AR97-1479	AR97-1479	AR98-1009	AR98-1009	30
Milva	Milva	0597-77	0597-77	30
Virgo	Virgo	Cosmos	Cosmos	35
Mira*	Mira*	Axona*	Axona*	30
Milva	Milva	Nicola	Nicola	20
Toluca	Toluca	Ditta	Ditta	30
Madelaine	Madelaine	Novello	Novello	30
Romano	Romano	Red Baron	Red Baron	30
Junior	Junior	Sante	Sante	30
AR98-1009	AR98-1009	Amorosa	Amorosa	30
0597-77	0597-77	Cosmos	Cosmos	30
AR97-1479	AR97-1479	Milva	Milva	30
Cosmos	Cosmos	Virgo	Virgo	35

Varieties supplied by Sarvari Research Trust denoted by *;
20cm = 8in spacing; 30cm = 12in spacing; 35cm = 14in spacing

The progression of foliar blight in the trial plots is illustrated in Figure 1. The haulm of the varieties most susceptible to blight was cut and removed from the field when disease levels on the plants were considered to exert increased pressure on remaining varieties in the study and on the surrounding commercial crop. The variety Junior was first to be defoliated on 26th July followed on 1st August by Milva, Novello, Red Baron, Virgo and the numbered variety AR98-1009. Tuber spacing had no effect on the progression of blight in varieties Milva, Nilcola and Cosmos. The varieties Mira and Axona were largely unaffected by blight whilst varieties AR97-1479 and Toluca had no more than 4% and 17.5% of foliage affected by the disease by 16th August, respectively. After this date all remaining potato haulm was topped and the field treated with a green burner to reduce the risk of tuber blight. The potatoes were then left in the ground to allow skins to set prior to harvest. The overall pattern and timing of foliar blight infestation was remarkably similar to that observed in 2004 trials. However, there were striking differences in the progression of the disease in potato varieties Junior, Novello, Milva, Sante and Cosmos that had been included in both studies (Figure 2).

Figure 1 Progression of foliar blight in potato variety trial plots at Tresawson Farm, Looe 2005

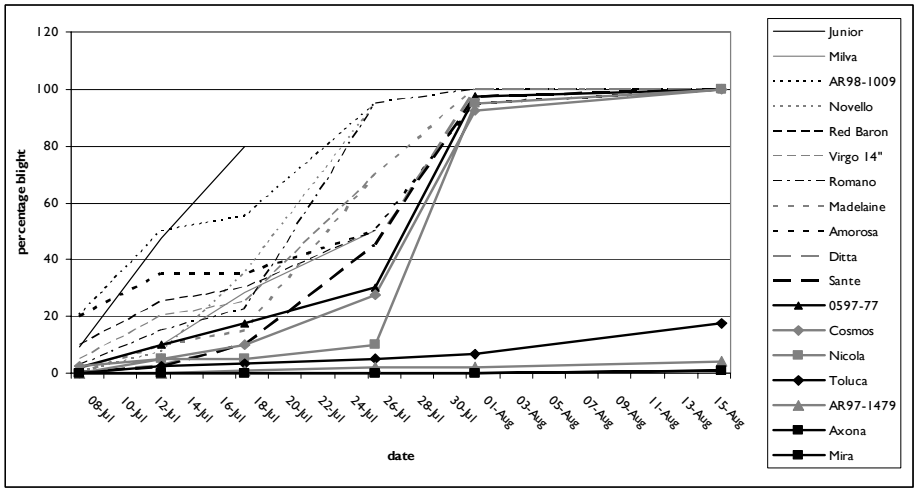
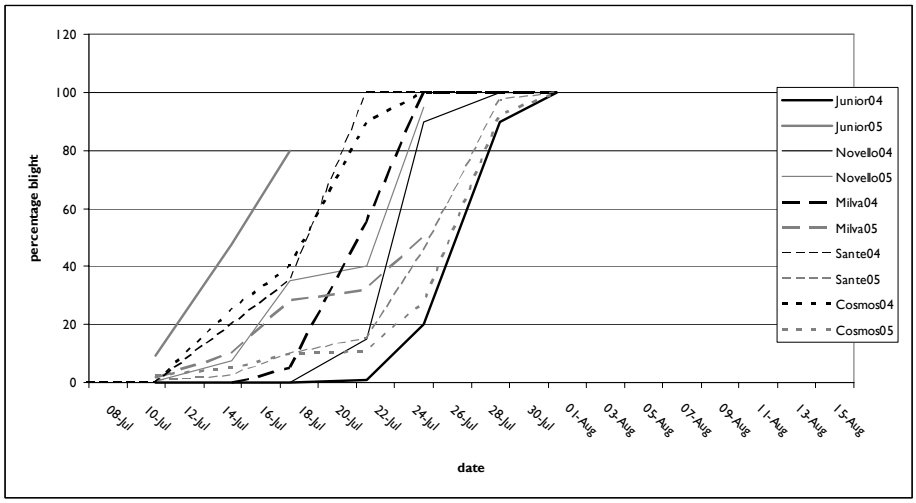


Figure 2 Differences in progression of foliar blight in five potato varieties during growing seasons 2004 and 2005



Harvest and yield assessment

The potato trial plots were harvested by hand on 1st September. Tubers were assessed for shape and appearance then passed through grading sieves and separated into size fractions. The weight of each size fraction was determined and the yield parameters from 16 tuber plots of each variety calculated (Table 3). Apart from Agrico Research NL varieties AR97-1479 and Toluca and Sarpo varieties Mira and Axona, yields were disappointingly low. Although low soil fertility following two successive years in cereals may have played a part, it is considered that the poor crop performance was due to a growing season shortened by unseasonally cold weather conditions following planting.

Table 3 Total yield, size fractions and outgrades as % of total yield and % yield over 25mm (excluding outgrades) of potato varieties from 16 tuber trial plots grown under organic management in Cornwall 2005.

		Size fraction as % total yield				outgrades	% yield
Variety	Total yield (kg)	25-35 mm	35-45 mm	45 – 65 mm	>65 mm	as % of yield	>25 mm
Mira	14.8	3.2	12.2	69.9	11.5	2.2	97.8
Axona	14.5	4.5	19.6	70.5	2.1	2.4	97.6
Nicola 8"	4.2	49.6	32.8	4.5	0.0	6.6	93.0
Milva	2.8	55.0	29.7	10.8	0.0	12.6	85.4
Milva 8"	3.5	65.7	22.9	0.0	0.0	1.4	98.4
Toluca	16.0	2.5	12.2	70.9	3.2	10.6	89.3
Ditta	5.7	36.2	41.9	4.4	0.0	14.4	85.1
Novella	7.6	39.4	45.4	9.6	0.0	1.3	98.6
Madeleine	5.8	19.0	45.5	26.0	0.0	8.7	91.3
Romano	4.9	34.0	46.2	11.7	0.0	3.6	96.3
Red Baron	5.9	35.3	37.9	11.5	0.0	11.1	88.4
Sante	6.9	20.4	43.4	20.8	0.0	14.2	85.6
Junior	9.5	27.1	38.9	27.9	0.0	1.8	98.1
AR98-1009	6.3	36.8	37.6	8.6	0.0	3.4	96.1
Amorosa	3.8	38.2	40.8	6.6	0.0	5.9	93.5
Cosmos	5.4	20.3	46.2	28.6	0.0	3.0	96.9
Cosmos 14"	6.2	21.8	35.9	28.2	0.0	11.7	88.0
O596-77	8.0	20.1	48.1	21.1	0.0	6.0	93.7
AR97-1479	19.7	2.3	10.3	80.5	4.8	1.7	98.3
Virgo 14"	5.1	38.6	28.2	22.3	0.0	9.9	90.0

References

James, C. 1971. A manual of assessment keys for plant diseases. Canada Department of Agriculture. Publication No. 1458.

Coswinsawsin Update: farm manager's report

Coswinsawsin Farm is Duchy College's organic demonstration farm. The farm was converted to full organic production in January 2001 and since then has been producing a range of commercial organic crops as well as providing a useful resource for the Organic Studies Centre research and demonstration projects. Paul Harris, the college's commercial farm manager, has provided his regular summary of activities on the farm for the summer and autumn period.

The summer weather of 2005 was a real contrast with the wet summer of 2004 with crops planted, harvested, rotational hedge trimming and stewardship maintenance having been conducting in good conditions. We have recently completed our annual Soil Association Inspection which takes an amazing 7 hrs with the inspector leaving no stone unturned with regard to detail. At the end of this process, I consider the inspection to be positive and helpful as the inspector puts forward constructive ideas and provides useful updates on organic practice.

Wheat
The variety Istabraq produced a yield of 5.8 tons/ha of grain at 15% moisture with an average bushel weight of 72.65kg/hl. As a comparison, with Soil Association permission, a conventional crop of Istabraq was drilled at the same time yielding 8.4tons/ha with a bushel weight 73kg/hc.lt. The dramatic difference between the two crops is the £340/ha projected gross margin in favour of the organic crop. The organic crop is at present in store awaiting sale on a long pool marketing arrangement.

I am in no hurry to drill the 2006 crop with the mild weather conditions at the time of writing (November 2nd) which favours the aphid transmitted disease barley yellow dwarf virus, which in turn results in light yellow concentric circles appearing in the crop during May with shrivelled grain in the ears of wheat. A high seed rate of 260kg/ha will be used to establish the 2006 crop. From experience this will give a dense crop canopy to compete with the weeds and compensate the lack of tillering when no artificial nitrogen fertiliser is used.

Brassicas
The cauliflower and cabbage have been established in good conditions with the crops benefiting from fertility building crops. The good growing conditions have helped the cauliflower to produce a large leafy framed plant which helped to combat a relatively high level of caterpillar damage. The cabbage has experienced a high level of mildew infection which originated in the early stages of plant raising. The mild weather has helped both crops to recover and re-grow damaged green leaf. Harvesting of the cauliflower is due to start in mid November with the cabbage being later to harvest than the normal late November start. The anticipated start is likely to be late December. The challenge with a late start is keeping the cabbage green. It will be interesting to find out if the use of Epsom Salts is permitted by the certification bodies, as it has a dramatic greening effect on the cabbage.

Potatoes
The buyers of our potatoes encouraged us to grow the variety Triplo rather than Orla as it has, in theory, better blight control and better skin finish. In reality this proved not to be the case as the skin finish was not of the standard required for packing and the crop suffered from a late attack of blight. The blight pressure was very severe in West Cornwall from late June until late July with a virtually full time Smith Period. The crop has been processed to be used in organic baby food production. The end result was a disappointing yield of 21.6tons/ha after grading, with skin finish still an issue (even for a processing crop) resulting in a 20% drop in price. The variety Orla has been ordered for 2006 with seed being source from Ireland with an anticipated delivery date of early December.

Fertility building
A mixture of winter rye and vetch has been established in late August using minimal cultivations ahead of a potato crop. In the near future the land will receive an application of farm yard manure when conditions allow and will be disc harrowed in late January 2006 in order to allow the green material to be fully incorporated prior to potato cultivations. A mixture of vetch and white sweet clover has been used in fixing nitrogen for the cauliflower. The reason for this mixture being used is that in recent years we have had considerable amount of vetch die during winter and it is hoped that the white sweet clover will act as an insurance policy. The Cotswold Pochon grass seed mixture which was established in September 2004 has been very successful with the grazing being rented out. Prior to seeding out docks were a major problem with a combination of grazing and topping. I have been amazed at the level of control that has been achieved.

To further enhance our fertility building, and in an attempt to gain a financial reward, we will be planting the spring bean variety Clipper, which will be under sown with trefoil. The plan is to establish the beans as soon as soil conditions allow in early 2006, with trefoil under sown during late March/early April.

Onions
Nothing ventured nothing gained is how I could sum up organic onions. A combination of weeds and neck rot ended up with an unsuccessful crop. Despite regular mechanical hoeing the weeds became very competitive as onions do not produce a competitive crop canopy to help smother weeds. Hand weeding was tried but proved to be uneconomical.

DEFRA-funded organic farming research projects

Defra funds a large number of research projects every year. Details of all these projects are available through the Defra web-site at http://www.defra.gov.uk/science/default.htm. A recent search of the site revealed that there were 216 completed or current projects listed under the policy subject area "Organic Farming". In an endeavour to ensure that the information generated from these studies is made available to farmers and growers, it has been a policy of the Organic Studies Centre to summarise the results of some of these studies within our Technical Bulletins. This edition of the bulletin contains three such reports summarising the results of Defra-funded research. The following list is just a selection of completed projects that have full scientific reports available for access from the web-site. We intend to continue this feature in future editions.

Optimisation of phosphorus and potassium management within organic farming systems (OF0114) This study aimed to produce guidelines to enable organic farmers to manage P and K effectively, sustainably and economically, using both permitted fertilisers and on-farm sources of P and K. The results of this study were summarised in OSC Technical Bulletin 4. *Contractors: Elm Farm Research Centre, Rothamsted Research (BBSRC), Royal Agricultural College, Scottish Agricultural College*

A study of the advantages and disadvantages of break crops for organic rotations (OF0143) This study aimed to identify agronomically, environmentally and economically suitable break crops for organic grass/arable rotations. *Contractor: Aberdeen University, Scottish Agricultural College*

Overwinter transplant production for extended season organic cropping (OF0144) The aim was to develop and evaluate protocols for organic transplant production during the autumn, winter and early spring, with particular focus on nutrient supply, cell size and disease control for brassica, allium and lettuce crops. *Contractor: Elm Farm Research Centre*

Testing the sustainability of stockless arable organic farming on a fertile soil (OF0145) The objective was to test the sustainability of a stockless arable rotation on a fertile soil at ADAS Terrington and compare the performance of ten commercial, largely arable, organic farms. *Contractor: ADAS Consulting Ltd*

Organic milk production (OF0146) The aim of this work was to evaluate the factors determining the physical and financial performance of different organic dairy farming systems with particular emphasis on feed imports and degree of self-sufficiency. Results of this work are summarised in this edition of the OSC Technical Bulletin *Contractor: Institute of Grassland and Environmental Research* (IGER)

The environmental implications of manure use in organic farming systems (OF0161) The main aim was to review the environmental impact of manure use in organic farming systems, particularly in relation to nitrate, ammonia, nitrous oxide and methane. *Contractor: ADAS Consulting Ltd*

Understanding soil fertility in organically farmed systems (OF0164) The main objective was to provide a better understanding of the nutrient cycling aspects of soil fertility targeting the processes and their controlling factors (including the role of biological diversity). *Contractors: ADAS Consulting Ltd; Henry Doubleday Research Association; Institute of Grassland and Environmental Research* (IGER)

Effect of breed suitability, system design and management on welfare & performance in traditional & organic poultrymeat (OF0153) This study aimed to identify breeds, first crosses and/or hybrids suited for use in extensive poultrymeat production and to establish aspects of system design and management that are important in optimising bird welfare, range usage and economic performance. *Contractor: ADAS Consulting Ltd*

Conversion to Organic Production software (COP) (OF0159) The aim was to develop software that can assist farmers and advisors in assessing the feasibility of a conversion to organic farming for use in connection with OCIS (Organic Conversion Information Service) and in carrying out more detailed conversion planning. *Contractor: Welsh Institute of Rural Studies*

Optimising the synergism between organic poultry production and whole farm rotations, including home grown protein (OF0163) Some of the objectives were to review literature on home grown protein sources so as to identify their maximum inclusion rate in organic rations, to identify the optimum position for poultry in a whole farm rotation and to promote management techniques to producers. *Contractor: ADAS Consulting Ltd*

Factors influencing biodiversity within organic and conventional systems of arable farming (OF0165) The objectives were to quantify biodiversity differences between organic and conventional, determine the extent that these arise from non-crop habitats, examine the importance of duration under organic management and make recommendations concerning biodiversity on both organic and non-organic farms. *Contractor: British Trust For Ornithology*

Economic and agronomic feasibility of organic vegetable seed production in the UK, and subsequent seed quality (OF0166) The risks, costs, seed quality, disease and treatment issues associated with organic vegetable seed production were examined. *Contractor: Horticulture Research International*

Development of disease control strategies for organically grown field vegetables (DOVE) (OF0168). The aim was to review the significance of diseases in organically grown field vegetables and the potential effectiveness of control strategies, evaluate novel control techniques, monitor disease development in relation to rotation and enterprise size and to update advisory literature. *Contractor: ADAS Consulting Ltd*

Optimising production systems for organic pig production (OF0169) The project examined the effects of breed, nutritional value of feeds, housing (paddock and straw yards), sensory properties of pig meat, ranging

behaviour and implications for sward utilisation, animal welfare, manure deposition and parasites. The project also aimed to establish best practice and economics of organic pig production. *Contractors: ADAS Consulting Ltd, University of Newcastle*

Milk yield & lactation characteristics & development of herd simulation model for organic milk production (OF0170) The project used data from 13 dairy herds to examine lactation curves, milk yield characteristics and the genetic potential of organic dairy cows. *Contractor: The University of Reading*

Animal health and welfare in organic livestock systems: Identification of constraints and priorities (OF0172) The study examined animal health and welfare practices on organic farms and identified key constraints and critical points in the application of animal health care and welfare in relation to organic farming standards. *Contractor: The University of Reading*

Clover:cereal bi-cropping for organic farms (OF0173) The project evaluated the agronomic viability and sustainability of bi-cropping in organic farming systems for both silage and grain production. *Contractor: Institute of Grassland and Environmental Research* (IGER)

Influence of level of self-sufficiency on the nutrient budgets of an organic dairy farm (OF0180) The project examined whole-farm budgets and internal flows of N, P and K for self-sufficent and purchased concentrate organic dairy systems at the IGER Ty Gwyn Farm. *Contractor: Institute of Grassland and Environmental Research* (IGER)

Companion cropping for organic field vegetables (OF0181) The aim was to determine the effects of fertility-building companion crops, grown in permanent strips on a bed system, on the nutrient accumulation and incidence of damage from pests and diseases in three major field-scale vegetable crops. *Contractor: ADAS Consulting Ltd*

Economics of organic farming (OF0189) The project aimed to provide information on the financial performance of organic farms of seven farm types, compared with carefully selected conventional farms, and to build up data on costs of production and comparable enterprise performance to enable benchmarking within the organic sector. *Contractor: Welsh Institute of Rural Studies*

Workshop and desk study to appraise technical difficulties associated with organic pullet rearing (OF0192) The objectives were to identify potential technical problems associated with organic pullet rearing and to assess the extent to which conventional pullet rearing may or may not be applied. *Contractor: ADAS Consulting Ltd*

Establishment of, and running, a comprehensive organic seed information database and communication network (OF0195) The research collated information from seed companies and organic seed producers on the availability of organic cereal, field vegetable and potato seed in order to produce an up-to-date list of varieties. *Contractor: National Institute of Agricultural Botany*

Organic farming: technology transfer (OF0405) This project addressed two separate issues: (a) production of a booklet for farmers/advisers on managing soil fertility in organic farming and (b) production of a report summarising the environmental impacts of organic farming. *Contractor: ADAS Consulting Ltd*

Study of the market for organic vegetables (OF0307) The overall aim was to provide detailed market information and quantification of the demand and supply of individual UK organic vegetable crops throughout the UK growing season. *Contractor: Henry Doubleday Research Association*

Alternative, non-animal based nutrient sources, for organic plant raising (OF0308) The aim was to identify suitable alternative, non-animal based nutrient sources for organic plant raising and to assess these under UK organic plant raising conditions. *Contractor: Elm Farm Research Centre*

Vaccine use in organic cattle and sheep systems: Development of a decision support tool based on risk assessment (OF0310) The objectives included a risk assessment of the use and non-use of available vaccines to control the most common diseases, to develop a decision support system for organic farmers and advisors. *Contractor: The University of Reading*

Optimising the production and utilisation of forage for organic livestock (CTE0202) (OF0328) The overall objective was to review information on forage production and utilisation in order to deliver more efficient, sustainable, and environmentally-friendly output from organically managed livestock. *Contractor: ADAS Consulting Ltd*

Incorporation of conventional animal welfare assessment techniques into organic certification and farming (CTE0202) (OF0314) Part of the project objectives were to formulate welfare assessment protocols for use in organic dairy & beef cattle, pig and laying hen systems and to develop a web-based database system that will produce a welfare benchmarking report for organic farmers based on information from on-farm visits by inspectors, advisors or researchers. *Contractors: The University of Bristol*

Further details of Defra-funded projects, including current research, will be published in the next edition of the OSC Technical Bulletin