MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

Research and Development

Final Project Report

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Executive summary (maximum 2 sides A4)

At present the UK supply of organic vegetables is insufficient to meet the growing consumer demand, consequently approximately 80% of organic vegetables are imported (Soil Association, 1999). Despite the strong demand fuelled by the intense interest from the supermarkets and by premium prices, farmers and growers have been reluctant to convert their land to organic production. A major barrier for individual farmers is the present lack of information and knowledge about organic farming systems and in particular the lack of data and advice relating to the period of transition from conventional to organic systems. To address this situation, the overall aim of this project was to provide information on the agronomic and economic performance during conversion to organic systems with field vegetable production.

Within the study the conversions on eleven farms are being monitored, one main site and ten reference farms. The main site is a 12 ha unit, Hunts Mill at HRI Wellesbourne. One of the reference farms is at HRI Kirton and the other nine are on commercial farms. The reference farms were chosen to reflect differing scenarios of conversion, varying size of farm, location in the country and use of differing market outlets. On all of the farms the monitoring programme involves assessment of crop yields, soils, occurrence of weeds, pests, diseases and economic performance of individual crops and whole farm units. The monitoring programme is carried out in greatest detail at Hunts Mill, and at this site the effect of different fertility building regimes is also being evaluated. During this project (1996-2000) Hunts Mill has been monitored for a full four year period from the conversion date (the two in-conversion years and two years of organic vegetable production). Due to the staggered inclusion of the reference farms to the project, these are all at slightly different stages of conversion. By the end of the project (August 2000) all of the farms had started their staged conversions, six of them had completed one season of organic vegetable production and on average the farmers had converted 46% of the target organic area on the farms. On all of the farms the performance during the in-conversion years and the year of organic production have been monitored. Assessments of financial performance have also been carried out for the year prior to conversion. The monitoring programme is now being continued in a second

phase of the project. During this phase the first full cycle of the target rotations at Hunts Mill will be completed and a minimum period of four years will be monitored on each of the reference farms (two in-conversion years and two years of organic vegetable production). For most of the farms, the second phase of the project will in fact cover more than two years of organic vegetable production.

The work has been carried out as a collaborative project between HDRA, HRI Wellesbourne, the Organic Advisory Service (OAS) at Elm Farm Research Centre, and the Welsh Institute of Rural Studies (WIRS) at Aberystwyth. Dissemination is an important part of the project and this has been carried out in close collaboration with the OAS and the Soil Association using a range of approaches. The OAS advisers use the results, as appropriate, in the advice they provide to farmers. Regular open days, farm walks and seminars have been held at Hunts Mill and at the reference farms to demonstrate conversion in practice. Furthermore, the results are gradually being incorporated into the Organic Farm Management Handbook (Lampkin & Measures, 2001).

On all of the farms, the conversion began with a fertility building period (usually a grass clover ley), the length of which varied from 7-29 months on the various farms. Initially, difficulties with establishing leys were experienced on many of the farms, though it was found that in subsequent years these difficulties had often been overcome. At this stage in the project it is not possible to evaluate how the different lengths of fertility building during conversion have affected the physical and economic performance of the crops, as the first course of the target rotation has not yet been completed on any of the farms.

Taking land out of cash crop production for fertility building led to a decline in overall net farm income during the in-conversion period; in general this decline was greater the more intensive the systems were prior to conversion and in systems without livestock. On farms where land was registered for arable area payments, the loss in income has partly been offset by the ability to claim set-aside payments on grass clover leys, though some intensive vegetable farmers without arable land have not been to claim this. Organic aid, which was increased to a payment of £450/ha over 5 years in 1999, also helped. Many farmers have also been able to take advantage of other environmental schemes (e.g. Countryside Stewardship) to help develop habitats favourable to organic production during the conversion period.

In-conversion crops were grown at Hunts Mill (barley) and on one of the reference farms (potatoes and cabbages). At Hunts Mill this was done to evaluate the option of growing in-conversion barley (for which there is a good market) with an understorey crop of clover and thus use the land for both fertility building and cash cropping. On the other site it was done partly to give farmer some practical experience with organic growing techniques and also to evaluate the option and the effects of reducing the initial fertility building phase on a soil with an inherent high level of fertility. Yields and financial returns of the in-conversion crops were generally low, especially from the vegetables since there is only a limited demand for in-conversion vegetables.

At the end of the project period organic vegetables had been grown and marketed successfully for two seasons at Hunts Mill and for one season on six of the reference farms. On all farms, the growers were noted to have managed their crops well and were found to have adapted relatively easily to organic production, with problems only arising where farmers had less experience of vegetable growing or tried to grow too many crops for which they had no previous experience. Vegetable yields have on average been 40-50% below conventional averages and 28% below typical yields from established organic farms. However, as expected, there were considerable variations between farms and between crops. For a number of reasons, it is often expected that yields are likely to be lower during the initial years following conversion than in established organic systems. One reason can be that the farmer is inexperienced with organic production methods, but often there are also reasons related to the planning of the conversion eg planting/sowing dates for the first organic crops are governed by the original date of conversion. There may also be agronomic factors at play eg the ability of the soil to deliver nutrients from its organic sources (it is thought that the microbial communities in the soil gradually become more active and effective as the organic system are established).

Problems related to difficulties with soil management were highlighted on several of the farms, including at Hunts Mill. At present, best practice regimes for soil management are poorly defined and all the effects and implications on the soil of different cultivation activities are not well understood (e.g. cultivation for ground preparation, for weed control, for breaking up the soil surface, for stimulating microbial activity and nitrogen mineralization). As a result, farmers have to rely on the approach of trial and error to find the best practice regimes for their situations. On a number of farms soil compaction (occurring for example as a result of using inappropriate cultivation regimes or as a residual effect of repeated mowing of fertility building leys) was identified to be the cause of poor plant growth and yields. It is clear that the compaction may not necessarily have arisen as a result of converting to organic production, but in the organic system the consequences of compaction and poor soil structure manifested themselves more clearly eg symptoms of nitrogen deficiency.

On all of the farms, assessments have been made for a range of soil parameters. At this stage it is of course, impossible to draw any conclusions regarding how the change to an organic management regime have affected the nutrient status of the soils. Even at Hunts Mill (where four years data has been collected) the first full cycle of the rotations have not yet been completed. At this site, levels of available phosphorus and potassium have been noted to have declined, but assessment needs to be carried out over a longer period in order to take into account the effects of the inputs made at the different stages of the rotation (i.e. green waste compost at Hunts Mill) and the effects of the different crops themselves.

In most of the crops on the farms weeds have been managed and kept to satisfactory levels using a combination of accepted organic techniques; stale seedbeds, thermal and inter-row cultivations and by hand weeding. Growers have had to adapt to new techniques and to new machinery for weed control, but they were found to do this relatively easily. Most crops apart from potatoes have required at least one hand weeding, and this has proved to be expensive, although it was mainly used in high value crops where the cost has been recouped through high sales values. Annual weeds caused more problems than perennial weeds in the first season, although there are indications that perennial weeds are becoming more of a problem in the second year of production. In the different areas at Hunts Mill detailed assessment have been carried out to monitor the weed seed bank in the soil. The weed seed numbers were found to have declined during the grass clover leys and then to risen again during the vegetable cropping. The composition has changed with decreasing proportions of pansy and increasing levels of fat hen, knotgrass, chickweed, mayweed and poppy. As for the assessment of the characteristics of the soil, it is still too early to draw any firm conclusions with regard to the effect on the weed seedbank. Trends in seed numbers over complete cycles of the rotations needs to be evaluated.

Pests, diseases and weeds have in general been less of a problem during conversion than what was anticipated by the farmers. Growers have used a variety of techniques; rotations, time of sowing, crop covers, use of resistant varieties and of permitted sprays to minimise the impact of pests. For most of the crops grown on the reference farms during the 1999/2000 season, damage by pests and diseases were not considered to have been significant in terms of affecting marketable yields. Diseases were generally more of a problem than pests, with potato blight being the most significant.

Recruiting, motivating and retaining labour has caused a problem on some of the reference farms due to shortages of people with practical experience and knowledge of organic production. Lack of familiarity with organic specifications has resulted, in some cases, in a proportion of the marketable crop being left unharvested. Planned marketing has been an important factor in ensuring good returns from organic vegetable production.

At Hunts Mill all crops have been graded and packed on farm and sold mainly to wholesale markets and a proportion to box schemes. Financial returns have been good with average gross margins from the vegetables of £3921/ha. From the whole unit, with a target rotation which included 40% fertility building and 20% cereals, the farm gross margin averaged £1984/ha, which is higher than conventional averages for the region. On the reference farms gross margins achieved have been equivalent to conventional standards and much higher than actual conventional returns for the season, although they have been below organic standards. It will, however, be important to assess average gross margins over the whole rotation, which will include a period of fertility building.

Average gross margins have varied by a factor of two; the most significant variable was marketable yield, costs of production being fairly similar between farms. Organic vegetable production is expensive with high costs of casual labour, especially hand weeding which averaged £720/ha (152hrs/ha). Hand and mechanical weeding averaged £870/ha. High prices for organic crops enabled farmers to obtain good returns and all farmers expressed satisfaction with the level of returns received. One had budgeted to break-even in his first year of organic vegetable production and had been pleasantly surprised to achieve better than this.

Data from the conversion at Hunts Mill, HRI Wellesbourne has been used to construct a model of an arable cropping system converting to an organic arable/vegetable cash cropping system in order to assess the economic trends during and following conversion. The conversion was from a conventional arable and root crops system to an organic arable/vegetable rotation consisting of 40% fertility building, 40% vegetables and 20% cereals. Levels of farm income halved during the in-conversion period but rose to higher than conventional levels following conversion. The costs of conversion in terms of reduction in income during the in-conversion phase and costs of new investments were estimated to be £560/ha, of which 80% would have been recouped by organic aid at £450/ha.

The current high organic vegetable gross margins are largely due to the current price premiums available for organic vegetables (average 350%, 1999). The model described above has been used to simulate the likely effects of a 25% and a 50% reduction in organic vegetable prices on the farm net margin. A 25% reduction in prices would lead to a halving in overall farm margin, and a 50% reduction would have a very serious implication leading to levels of income lower than conventional. The implication is that overall returns from organic vegetable production are very sensitive to a lowering of prices.

In order to encourage growers to convert they need positive messages from government in terms of continued conversion aid, stable premium prices from buyers and the market and sufficient information and advice on the conversion process.

Scientific report (maximum 20 sides A4)

BACKGROUND

At present the UK supply of organic vegetables is insufficient to meet consumer demand, consequently 82% of organic vegetables are imported. Whilst the demand for fresh organic produce is increasing at 40% per annum, the area of land undergoing conversion to organic vegetables production is still small. The land in organic vegetable production increased by 12% per annum from 2400 ha in 1997 to 3000 ha in 1999 (Soil Association,1999).

Despite the strong demand, fuelled by an intense interest from the supermarkets and by premium prices, farmers and growers have been reluctant to convert their land to organic production. The present poor financial state of much of UK farming is, however, causing many farmers to reassess their production systems and more are currently considering conversion to organic systems.

A major barrier for individual farmers is the present lack of information and knowledge about organic farming systems and in particular the lack of data and advice relating to the period of transition from a conventional to an organic system.

INTRODUCTION

What is reported on here are the findings from the first phase (4 years) of a project which is being carried out in two phases over a total of 7 ¾ years. It is therefore important to note that any conclusions that have been made are regarded as interim.

1. SCIENTIFIC OBJECTIVES

The overall aim of this study is to provide information on the physical and economic performance during conversion to organic systems of field vegetable production. The specific objectives are as follows:

1. To convert 13 ha (Hunts Mill) of the farm at Horticultural Research International (HRI) Wellesbourne to an organic system with a rotation including field vegetables and arable crops.
2. To assess physical and economic performance during conversion of Hunts Mill. To achieve this, individual fields and crops grown within the unit will be quantitatively and qualitatively monitored by:
    - 2.1 assessing yields of cash crops and fertility building crops
    - 2.2 assessing the soil nutrients status, nutrients removed and replaced within the cropping programmes
    - 2.3 assessing weeds and weed seed bank
    - 2.4 assess pest and disease problems
    - 2.5 assessing economic performance of individual crops and of the unit as a whole, considering crop gross margins, fixed costs and costs of new investments.
3. To assess the overall physical and economic performance during conversion of Hunts Mill, comparing scenarios where the initial fertility-building phase is 29, 17 or 7 months, or a mixture of the three.
4. To monitor physical and economic performance during conversion at three (amended to 4, 1997 then 10, 1998) commercial farms, representing contrasting scenarios of organic vegetable production. This will be achieved by collecting and assessing basic data of yields, soil nutrient status, weed, pest and disease problems, crop gross margins, fixed costs and capital investments, with particular emphasis on the vegetable crops in the rotation.
5. To interpret and evaluate the data to produce information appropriate to aid farmers who are undergoing, or who are considering, conversion to organic systems, and to aid future policy making on related farming issues.

2. EXTENT TO WHICH THE OBJECTIVES WERE MET

Generally the objectives have been fully met.

Objectives 1 and 2. The Hunts Mill farm at HRI Wellesbourne has been successfully converted. All crops including potatoes, cabbage, onions, carrots, leeks, cereals have been successfully grown, harvested and marketed. All planned quantitative and qualitative assessments have been performed.

Objective 3. At Hunts Mill contrasting fertility building regimes have been used during the conversion of the different plots. However, at this stage the first full cycle of the target rotations has not yet been completed on any of the plots and it is therefore too early to draw conclusions on how the fertility building regimes have influence the performance of the different scenarios.

Objective 4. Due to the staggered inclusion of the reference farms (the project was enlarged in 1997 and 1998), the conversions at the reference farms are at different stages. On all of the farms the staged conversions have now begun and conversion plans have been completed. Six of the reference farms have completed the in-conversion period plus one season of organic vegetable production. By the end of the first phase of the project (August 2000) farmers had on average converted 46% of the target organic area on the farms. Important information has been obtained on the planning, fertility building and first year of organic vegetable production. All the results obtained so far have been discussed with relevant advisory bodies and disseminated, as appropriate, via their advisors and through regular workshops, seminars and farm walks.

Objective 5. So far the results from the reference farms have primarily been evaluated on an individual basis (as individual case studies), making some comparisons between the farms and with typical organic values from the Organic Farm Management Handbook (Lampkin & Measures, 1999). Eventually, as more results are collected, the aim is to also draw more general conclusions based on pooled findings from farms representing similar conversion scenarios. The lapse in time taken in obtaining whole farm financial data, has resulted in difficulties in drawing any meaningful conclusions on whole farm financial trends during and after conversion. Instead, data from Hunts Mill has been used to construct a model to illustrate the likely whole farm effects of conversion.

3. MANAGEMENT OF THE PROJECT

The work has been carried out as a collaborative project between HDRA, HRI Wellesbourne, the Organic Advisory Service (OAS) at Elm Farm Research Centre (EFRC), and the Welsh Institute of Rural Studies (WIRS) at Aberystwyth. HDRA led the project and other institutes were involved as subcontractors or on a consultancy basis. HRI Wellesbourne provided the land for the main site. Researchers at HRI assisted with defining appropriate methods of assessment as well as with the analysis and interpretation of the results. OAS aided with the preparation of conversion plans for all the farms and provided ongoing advice through two half-day visits to each farm per year for the duration of the project. OAS advisors have also been involved in the interpretation of the results. WIRS provided advice on the economic monitoring and assisted with the analysis and interpretation of the results.

A steering committee for the project contained representatives from MAFF, Soil Association Producer Services, OAS, Horticultural Development Council (HDC), ELGRO, British Organic Farmers (BOF) and three of the reference farmers. The committee met twice a year to discuss the progress of the project, to check outputs and to provide guidance on its future direction.

4. METHODS AND APPROACHES

The basic experimental approach has been to use eleven farms as case studies for monitoring and documenting the performance of systems undergoing conversion to organic field vegetable production. Agronomic and economic information was collected and evaluated for individual crops as well as for each organic unit as a whole. The main site, Hunts Mill, has been monitored in greatest detail. The ten reference farms were chosen to reflect different scenarios of conversion; varying size of farm, location in the country and use of differing market outlets. The strength of the information collected from these farms is that it is actual performance data from commercial units.

4.1 Hunts Mill

Because this site is located on an experimental station it is possible to have a degree of control over the long-term management of the site and to include some additional aspect for investigation. However, even at this site the strategy is to manage the crops as closely as possible according to commercial practice for field scale vegetable production. Best practice management regimes were devised through consultation with OAS and HDRA/HRI researchers, incorporating current knowledge from organic as well as conventional farming practice and research findings.

Hunts Mill is a 13 ha field, which forms part of the 200 ha farm on the HRI Wellesbourne site. Prior to conversion this site had been cropped in an arable rotation (3 years cereals, 1 year of experimental field vegetables) since it was purchased by HRI in 1977. The soil is a sandy loam, with low organic matter levels and marginal nutrient reserves for arable/horticultural production. The average rainfall is 598 mm per annum.

The site has been divided into 6 equal areas (1-6) (Appendix 1), each measuring 0.8 ha; Area 7 is a presently used for a set-aside ley. Each of the six areas is divided into six strips (A-F) for monitoring purposes. A further division is made for weed seed sampling; each strip being divided into quarters (labelled w-z). Hunts Mill was converted in two stages; Areas 1-3 were registered for conversion in August 1995 and Areas 4-6 in August 1996.

The basic stockless rotation used as this site is as follows:

Year 1 Grass/clover ley	cut and mulched
Year 2 Grass/clover ley	cut and mulched; addition of green waste compost
Year 3 Vegetables 1	potatoes and brassica, vegetables with a higher nitrogen demand
Year 4 Vegetables 2	onions, carrots and leeks, vegetables with a lower nitrogen demand
Year 5 Spring cereal	barley or wheat undersown with grass/clover ley

Where possible winter cover crops, such as rye and vetch, have been grown to prevent nitrate leaching and to improve soil fertility.

Different approaches to fertility building (species composition and length of growth period) have been used in the different areas. Areas 1 and 4 were converted following the basic rotation as described above. In Areas 2 and 5 the rotation was adjusted to include a shorter fertility-building period (17 months instead of 29) which was then followed by a similar sequence of cash crops starting with an in-conversion cereal. In Area 6 the initial fertility-building period was further reduced to 7 months, using an over wintered vetch as the fertility-building crop. Three main rotations with contrasting fertility building regimes have thus been established at the site (Appendix 2). The full sequences of cropping on each area and strip are shown in Appendix 3.

4.2 Reference Farms

Initially only 3 reference farms were included in this project; in 1996 very few farmers were actually converting to organic field vegetable production and it was thus difficult to find a greater number of sites suitable for monitoring. One additional reference farm was included in 1997 and the project was expanded in 1998 to include a further six farms raising the total to ten. The main reason for increasing the number of reference farms in the project was to produce more robust results, increasing the number of farms representing each of the three scenarios and broadening the geographical representation of sites to include farms in the main vegetable producing regions of the country.

The farms were selected to represent three scenarios of conversion; all of which were expected to be important for organic vegetable production in future:

- Scenario A Conventional arable farms converting to organic systems and introducing vegetables in the rotation (farms 2, 3, 5 and 8).
- Scenario B Conventional intensive vegetable farms converting to intensive organic vegetable production (farms 1, 9 and 10).
- Scenario C Conventional mixed farms with livestock converting to mixed organic systems with vegetables (farms 4, 6 and 7).

More details concerning the reference farms are given in Appendix 3

All the farms took advantage of the 1½ days free on-farm advice available through the MAFF funded Organic Conversion Information Service (OCIS). They have also had two half days per year of advice from OAS who also prepared a conversion plan for each farm. This has ensured that farmers were guided to follow current best organic practice. Commonly, although not in all cases, this involved 2 years grass clover ley prior to establishing organic cash cropping.

4.3 Evaluation and dissemination of results

All data was evaluated in light of findings from other studies. Yields and financial results have firstly been compared with organic values (in this report refered to as 'organic standards') from the Organic Farm Management Handbook (Lampkin & Measures, 1999). It should be noted that figures in the handbook are *best* *possible estimates* of what a typical established organic farm with average management might expect to achieve. These comparisons must therefore be made with caution, but they are considered valuable as they provide a basis against which to compare the performance.

The output from the project has been used to provide information for farmers undergoing conversion and for potential organic farmers, assisting them in their decision making process. The dissemination of the results is an important aspect of this project. This is carried out in close collaboration with OAS using a range of approaches; the OAS advisors use the results, as appropriate, in the advice they provide to farmers, and they are also incorporated into the Organic Farm Management Handbook which is updated biennially. The information is disseminated via the OAS farmer groups and the Soil Association, who bring together organic and conventional farmers, advisors and scientists to open days/workshops and seminars which demonstrate conversion in progress. A list of dissemination activities is listed in Appendix 5.

5. SCIENTIFIC MONITORING METHODS

These have been discussed within each section

6. RELIABILITY OF THE RESULTS

These have been discussed within each section

7. MAIN RESULTS, CONCLUSIONS AND FINDINGS

7.1 Management of the in-conversion period

A good fertility building period is thought by many to be the cornerstone of the conversion process and essential to its success. At Hunts Mill a grass clover was used for this purpose in most of the plots (contrasting strategies of fertility building have been used at this site see Section 4.1 above). Once established the leys were mown 3-4 times each year and incorporated 1-2 months before cropping began. The date of incorporation is know to be crucial - if the ley is incorporated too early in advance of the next crop there can be loss of nutrients, particularly nitrogen), but if incorporation is carried out to close to the sowing/planting of the next crop then there may not be enough time for the organic matter to break down sufficiently in order for the desired tilth to be created or for nitrogen to become mineralised.

Most reference farms have practised staged conversions lasting from 2 to 5 years. They have managed their fertility building in different ways, according to their farm type, soils and scenario of conversion. Establishment of leys was something in which the staff on the stockless farms usually had only very limited experience, as they were not used to growing grass. In the first year, patchy and uneven establishment of the grass/clover leys was common on many of these farms. However, the farmers clearly gained the required experience very quickly, and the leys sown in later years were often found to have established well. The length of the initial fertility building period varied from a minimal 7 months red clover sward over winter to 29 months and more. At this stage of the project it is, however, not yet possible to evaluate how these different fertility building regimes have affected the yields.

7.2 Crop yields

For all vegetable crops grown at Hunts Mill the marketable and unmarketable yields in each of the entire strips have been recorded. All cash crop and green manures were also sampled by destructive assessments (quadrat sampling) at harvest/incorporation for more detailed assessments of the produce. Dried samples were milled and analysed for their N, P and K contents. This information was used to construct nutrient budgets for the rotations (section 7.32). On the reference farms yield data (marketable and unmarketable fractions) was obtained from farmer's records and accounts and by direct sampling in some of the crops.
It is important to note that the yield results that are reported here are from only two years of production at Hunts Mill, from one year at the reference farms and they are from a limited number of the reference farms (6). The results must therefore be viewed with caution. Yields of vegetables are notoriously variable from farm to farm and, from season to season. This can be explained by the quality of soils and the management of the site, to the variety of the crop, to access to resources such as irrigation and not least to the weather conditions.

Organic vegetables have been traditionally generally grown on a wide range of soils, with a wide range of access to resources (irrigation, manure) and less specialised skills, although the newer growers now converting are generally more specialised and experienced in vegetable production. Yields in organic systems are also known to be affected by the position of the crop within the rotation.

7.2.1 In-conversion crops

According to organic standards crops grown 12 months after the start of the conversion date may be sold as *in-conversion crops*. There is a good market for in-conversion cereals, the price per tonne being half way between current organic and conventional prices. In-conversion vegetables are being bought by some wholesalers for sale into vegetable box schemes.

In-conversion crops were grown at Hunts Mill (barley) and on one of the reference farms (potatoes and cabbages). At Hunts Mill this was done to evaluate the option of growing in-conversion barley with an understorey crop of clover and thus use the land for both fertility building and cash cropping. On the other site the in-conversion vegetables were grown partly to give the farmer some practical experience with organic growing techniques and also to evaluate the option and the effects of reducing the initial fertility building phase on a soil with an inherent high level of fertility. Total yields were high from both the potatoes and the cabbages, but due to pest (caterpillars) and diseases (potato blight) problems affecting the marketable yield and to difficulties in securing a market for the in-conversion produce, the financial returns were low. The yields of the barley averaged 4 t/ha, some 40% lower than conventional yields normally achieved HRI Wellesbourne.

7.2.2 Organic vegetables yields- Hunts Mill

Vegetables (potatoes, cabbage, onions, carrots, leeks) were first grown at Hunts Mill in 1998. Despite a wet and cold spring the yields (Table 1) of the first years cropping were satisfactory. Vegetable yields were on average 26% below organic standards. During 1999 the same crops were grown again with average yields being 24% below organic standards. Carrots and potatoes have performed well on this site. Comparison of the results obtained in 1998 with those obtained in 1999, show that for some crops (cabbages and potatoes) increases were achieved in the second year. These increases were thought to be related to the improved structure of the soil (due to changes made to the cultivation regimes for the site) resulting in improved establishment of the crops (particularly the cabbages). However, the yields of onions and leeks declined in 1999. This was thought to be the effect of having increased the density of the plants (changing from planting 3 crop rows per bed to 4 rows per bed) to a level at which the supply of nutrients in the soil was insufficient to meet the demand of the crop. When grown in the 4-row system a greater proportion of the produce did not reach marketable size. Consequently this system was considered to be unsuitable for the soil at this stage at this site.

Gradeouts from the vegetables averaged 23%, which is higher than organic standards for wholesale markets (15%). Gradeouts were above average for cabbage and carrots. Cabbages (44% gradeout) suffered from pest attack, cabbage root fly, aphids and caterpillars. Carrot total yields were very high and gradeouts (32%) were mainly due to oversized and split roots.

Table 1: Hunts Mill marketable yields[3] 1998 and 1999 (t/ha)

Crop	1998	1999	Organic Standards[1]
Potatoes	23	36	34
Cabbage (doz/ha)	1360 doz.	1808 doz.	2750 doz.
Onions	17	10	28
Carrots	35	37	34
Leeks	12	10	15
Spring barley[2]	2.5	2	2.9
Spring wheat[2]	2.6	-	3.1

[1] *Lampkin & Measures, 1999 wholesale figures*
[2] *Cereals were undersown with clover*
[3] *Fuller details of yields and varieties grown are shown in Appendix 6*

7.2.3 Yields from varying fertility building periods at Hunts Mill

At this stage it is not really possible to draw any conclusions on how the different fertility building regimes have influenced the performance of the vegetables. The yield differences that have been noted have been thought to have been due to a variety of factors, and could not be solely attributed to the initial fertility building regime. As can be seen (Table 2) with potatoes and cabbage, which have by now been grown twice after a 29 month fertility building period, the yields were higher in area 4 than in area 1, and this was thought to be due primarily to differences in the management practices, e.g. earlier sowing, more appropriate crop spacing for the site, and differences in the weather conditions. Carrots produced the highest yields (18% higher than average) on area 6 after the 7 month vetch but this could be more directly related to the season, better establishment, the suitability of the varieties grown in this area.

Table 2: Hunts Mill marketable yields for each area (t/ha)

Crop	1	2	3	4	5	6	Average
Fertility building period (months)	29	17	29	29	17	7	
Potatoes	23			36			30
Cabbage (heads/ha)	16323			20160			18241
Onions	11	18			9	17	14
Carrots	35	26			40	44	36
Leeks	9	15			11	9	11

7.2.4 Organic vegetables yields - Reference Farms

During the 1999/2000 season six of the reference farms grew their first organic vegetables. On average crops yielded (Table 3) 30% below organic standards. There was, however, considerable variation between farms and between crops. Two of the smaller intensive vegetable producer’s yields were 8% and 38% above organic standards, whereas the larger arable farmer’s yields, both with late start dates, yielded 63% and 27% below the organic standard. Different crops performed variably, ranging from 66% below (early potatoes on farm 7) to 99% above with carrots on farm 1. All carrots yielded above the standard (average 30% more), attributable to fertile soils, good establishment and low grade-outs due to low levels of carrot root fly.

For a number of reasons, it is often expected that yields are likely to be lower during the initial years following conversion than in established organic systems. One reason can be that the farmer is lacking the experience with organic production methods, eg techniques for weed control, but in many cases they are also having to get used to growing new crops (crops for which they have no previous experience even in conventional production) For many farmers the conversion thus become a steep learning curve. The performances of the crops are also often affected by factors related to the planning of the conversion eg planting/sowing dates for the first organic crops are governed by the original date of conversion. Two of the reference farms had a late start date for entry to conversion, meaning they were eligible to sow/plant their first organic crops from June onwards. Therefore a number of the crops were planted much later than what would have been normal practice, which in turn led to problems. The potatoes, for example, had only a very short growing season before the onset of blight. The pressure on weed control with very narrow windows for weeding during times of high labour demand also contributed to lower yields in some of the crops. There may also be different agronomic factors at play eg the ability of the soil to deliver nutrients from its organic sources (it is thought that the microbial communities in the soil gradually become more active and effective as the organic system are established).

The larger size of farm and the marketing outlet for the produce is a major factor influencing the lower marketable yields from the reference farms in comparison to the organic standards, with high specifications for produce going to supermarkets and under-developed markets for produce outside this specification. Where we have information the average gradeout is 20%.

Table 3: Reference farms marketable yields – 1999/2000 season (t/ha except where stated)

Crop	Farm 1	Farm 2	Farm 3	Farm 5	Farm 7	Farm 9	Hunt Mill[4]	Standard[1]
Potatoes (early)					4 & 14			15
Potatoes (main)	28.3	21.5		12.3			30	28
Cabbage - Savoy						30000[3]	12446[3]	30000[3]
Cabbage - white	17.5							35.0
Cauliflower				0	46%[5]			nd
Calabrese		4.8	2.5	4.9				6.0 [2]
Carrots	59.7			37		50	36	30
Onions	12.6						14	26
Leeks				10.9			11	15
Beetroot			7.4	18.6				20.0
Celeriac				17.1				nd
Celery			20500[3]					nd
Chicory				12.5				nd
Lettuce					30%[5]	74%		70%

[1] *Lampkin & Measures, 1999* [2] *EFRC, personal communication, 1999*
[3] *Heads per ha* [4]*Data from 1998/99 and 1999/00 Hunts Mill, HRI Wellesbourne*
[5] % cut nd no data available

7.3 Soils and nutrients

On all of the farms soil samples were taken annually in late February/early March and analysed according to the methods of EFRC (these have been designed specifically to assess the status of organically managed soil and are those normally interpreted by OAS). At Hunts Mill samples were collected from each of the strips in all of the areas and on the reference farms they were collected from either all or selected fields of the organic unit. The soils samples were routinely analysed for organic matter content, pH, calcium, available phosphorus, available potassium, available magnesium, and trace elements. At Hunts Mill, additional samples were taken at the time of sowing and at harvest of each crop and these were analysed for mineral nitrogen to aid in the budgeting of nitrogen.

7.3.1 Hunts Mill

The soil at Hunts Mill is on the borderline between a sandy loam and a loamy sand. The soil was very compacted, (making sampling to below 60cm depth virtually impossible). An application of lime restored pH values to their initial levels (6.4 to 6.8). Total organic matter levels in all the areas were low (around 1.5%) and have been unaffected by any of the cropping regimes so far. The soil was sampled to depth at strategic dates and computer modelling (the N_ABLE model) used to estimate leaching losses and to identify any crops where nitrogen shortage was a particular problem.

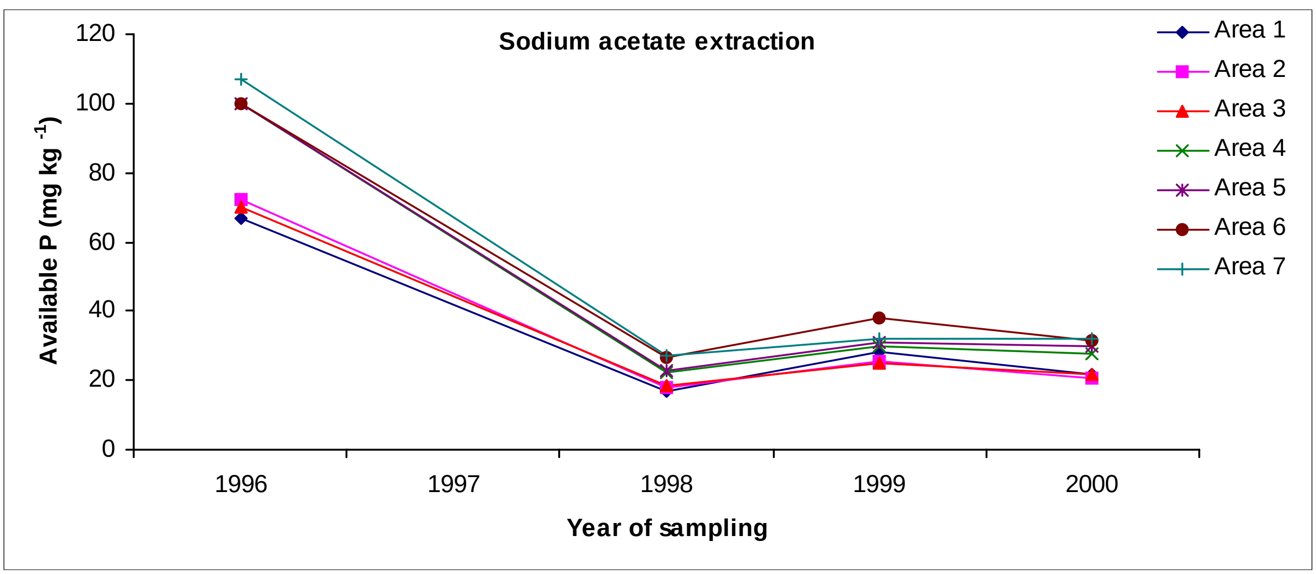
Phosphorus was determined using four different extractants (Fig 1). The standard ADAS method (Olsen's) suggests that available P in the soil initially increased but the other three methods, each measuring pools of P with differing availability, indicate a considerable decline. This has interesting implications regarding the interpretation of such soil analysis results. Applications of green waste compost have now been made, at various dates, to Areas 1-6; approximately 15% of the P in this would be expected to become available in the first season (HDRA Consultants, 1999). However, biological activity appears to have been low over this period as the compost is still observable in distinct layers.

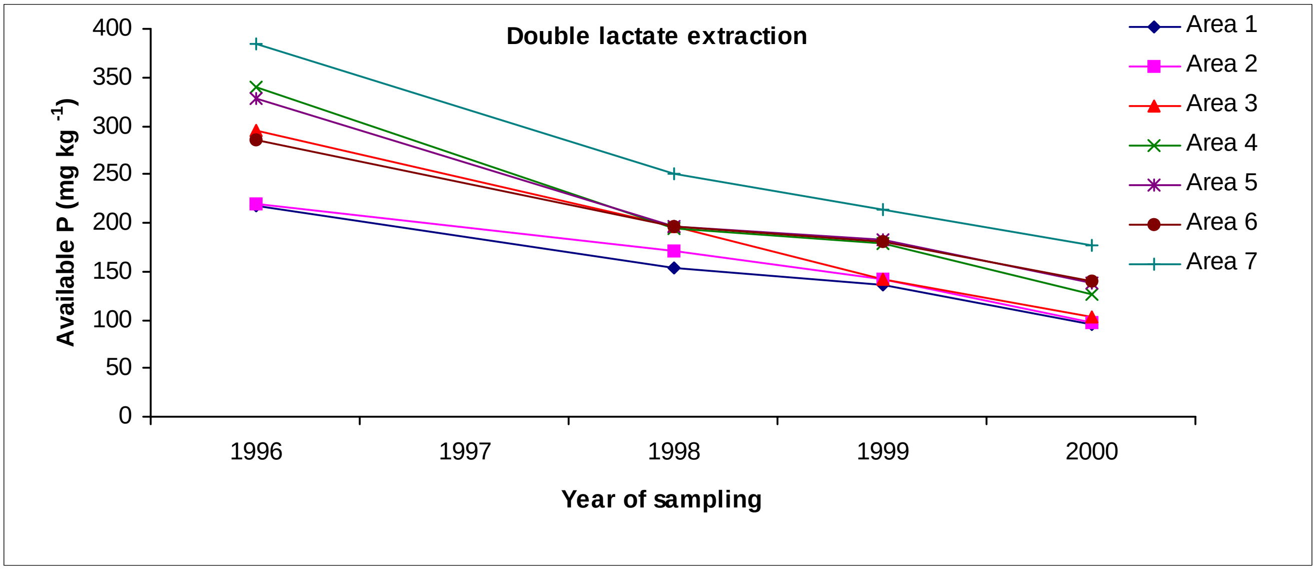
During the four year period, the potassium levels have been noted to have declined since conversion began; by EFRC recommendations they are now borderline for being adequate for horticultural production. Approximately 50% of the K in the green waste compost applied to each area would be expected to be made available in the first season (HDRA Consultants, 1999). Magnesium levels were adequate. Calcium levels were low. Levels of iron were high this is often associated with waterlogging: concentrations did reduce somewhat between 1996 and 2000. Most manganese levels were normal but occasional strips were high. This may be linked to soil compaction. Zinc was low (but zinc deficiency is rarely a problem) and copper levels normal.

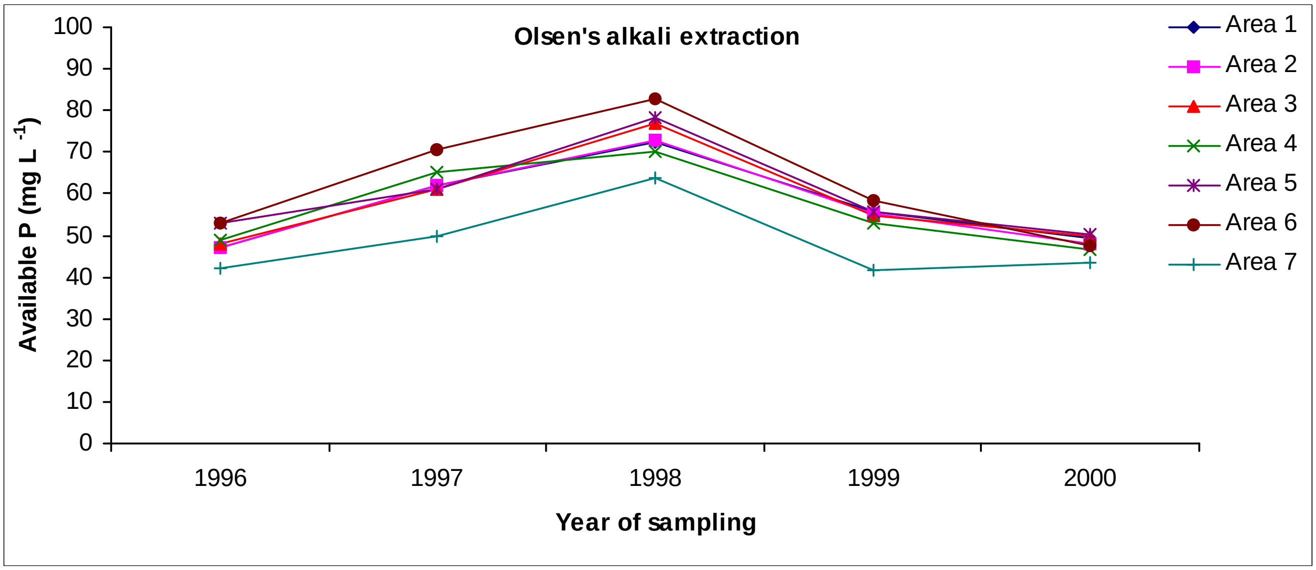
Even with results from four years at this site it is still too early to draw any firm conclusions with regard to how the nutrient status of the soil has been affected by the conversion or by the different crops sequences. So far the first full cycle of the rotations have not yet been completed in any of the plots. Assessments need to be carried out over a longer period in order to take into account the effects of the inputs made at the different stages of the rotation (i.e. green waste compost at this site) and the effects of the different crops themselves.

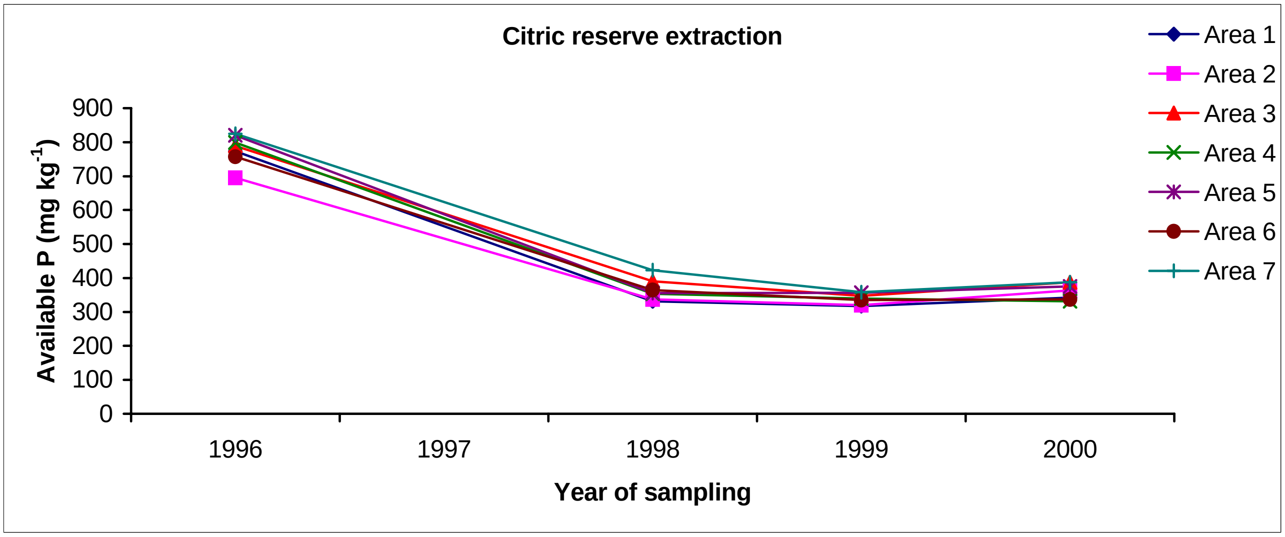
In practice a number of problems have been experienced with the soil at this site and the cultivations regimes for soil have had to be carefully considered. In the first years, severe compaction of the soil was evident in a number of the plots, for example, in the in-conversion barley where it was thought to have depressed yields. There were problems also in some of the vegetables where the hard ground resulted in the carrots being unfit for supermarket specifications (Class I). The soil has been found to be prone to capping in dry conditions following wet weather. This has made mechanical and hand weeding difficult. Cultivation regimes including shallow subsoiling, the use of bed forming machines, regular inter row cultivation to avoid capping etc have been implemented to try to alleviate these problems. Since conversion the structure of the soil appears to have improved, the soil has become more workable and the biological life in the soil (activity of worms) appears to have increased. With the regular additions of organic matter (fertility building crops and green waste compost) the structure of the soil is expected to improve further over the years to come

Figure. 1. The phosphorus levels using four different methods. Content of the top 30 cm of soil at Hunts Mill. *NB only Olsen's alkali measurements were made in 1997.* Values for the six strips within each area have been averaged.




Double lactate extraction
Available P (mg kg -1)
400
350
300
250
200
150
100
50
0
1996
1997
1998
1999
2000
Year of sampling
Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7


Olsen's alkali extraction
Available P (mg L -1)
100
90
80
70
60
50
40
30
20
10
0
1996
1997
1998
1999
2000
Year of sampling
Area 1
Area 2
Area 3
Area 4
Area 5
Area 6
Area 7



7.3.2 Reference farms

Comprehensive soil analysis has been made on samples from fields on farms 1 to 4 since 1998 and farms 5 to 10 in 1999 and 2000 only. It is therefore still too early to be able to assess any changes in nutrient levels as a result of the conversion. For farms 1 to 4 that have three years data there do not appear to have been any significant changes in organic matter, pH or nutrient levels as yet.

As for the site at Hunts Mill, problems related to difficulties with soil management were highlighted on several of the reference farms. EFRC interpretation of the soil analyses suggest that many farms show indications of poor soil structure, compaction and waterlogging. At present, best practice regimes for soil management are poorly defined and the effect and implications on the soil of different cultivation activities not well understood (eg cultivation for ground preparation, for weed control, for breaking up the soil surface, for stimulating microbial activity and nitrogen mineralization). As a result, farmers have to rely on the approach of trial and error to find the best practice regimes for their situations. On a number of farms soil compaction (occurring for example as a result of using inappropriate cultivation regimes or as a residual effect of repeated mowing of fertility building leys) was identified to be the cause of poor plant growth and yields. Clearly, compaction may also have been a problem on these soils when they were used for conventional production and it did not arise as a result of converting to organic production, but in the organic system the consequences of compaction and poor soil structure appeared to manifest themselves more clearly e.g. symptoms of nitrogen deficiency, and they were more difficult to deal with.

Many of the farms have soils which are said by EFRC to have an imbalance between the different phosphorus fractions which indicates that the biological activity of the soil is poor and that attention is needed to improve soil structure and pH. This enhances the biological activity, enables micronutrients to be made available and helps improve soil aeration and drainage. So far, there have been a few instances where over winter cover crops have been used on the farms once organic cropping has started which may well impact on nutrient levels for following crops, (e.g. by not minimising the leaching of nitrogen released from the incorporated grass/clover leys).

7.3.3 Nutrient budgets

For various plots at Hunts Mill nutrient budgets have been constructed. This is a useful exercise to determine the flux of nutrients in crop rotations, to demonstrate if nutrient levels in the soil are being built up or depleted and to demonstrate the effect of individual crops within the rotation. Nutrients are removed from the system with the removal of the harvested produce, and returned to the systems with addition of inputs such as compost (on this site) and through nitrogen fixation by the leguminous crops. There is also a return of nutrients via the crop residues left in the field. A small amount of nitrogen though wet and dry deposition is added to the soil, and some is lost to the air or through leaching with soil water.

Initially, the nutrient budgets were constructed using standard figures, but these are gradually being replaced by actual data collected from the field. The nutrient budgets for areas 4, 5 and 6 (Hunts Mill) representing the 3 different initial fertility building periods are shown in Table 4, which indicate all inputs, off takes and the balances for the different major nutrients. These show that the yield has a great impact on the off take of nutrients. This can be clearly seen in cropping sequence 14, Area 5 (strips 5B and E; Appendix 3). The carrot yield in these two strips was very high in the 1999/2000 cropping season, removing high levels of nitrogen, phosphorus and potassium from the soil. At this stage of the rotation the calculated balance is still mainly positive, with the exception of potassium. The only other negative figure can be found in cropping sequence 11, representing strips 4 A, B and C, where the off take of potassium is higher than the input. This is caused by high potato yields in 1999, especially in strip 4C. High surpluses of nutrients can be found in cropping sequence 18 because of high inputs of nutrients – it has had two applications of compost, one in 1997 and one in 2000, whereas cropping sequences 11 and 14 only have so far received one.

Table 4: Nutrient budgets for the first 4 years for 3 cropping sequences at Hunts Mill (kg/ha).

Length of fertility building		29 months (area 4)	17 months[2] (area 5)	7 months (area 6)
Cropping sequence[1]		Sequence 11	Sequence 14	Sequence 18
Nitrogen	From compost	+165	+165	+557
	From g/c ley	+208	+251	+166
	From crop	6	44	71
	Off take by crop[3]	-82	-180	-140
	Balance	+291	+236	+583
Phosphorus	From compost	+34	+34	+85
	Off take by crop[3]	-26	-33[2]	-17
	Balance	+8	+1	+68
Potassium	From compost	+118	+118	+356
	Off take by crop[3]	-176	-262*	-93
	Balance	-58	-144	+263

[1] Full Cropping sequences-Appendix 3 [2] not including spring barley. [3] Not including crop residues

This data needs to be interpreted with caution, as the effects that added nutrients have on the levels of available nutrients in the soil are difficult to determine. They will be influenced not only by the amount of material and its chemical composition, but also by the soil and climatic conditions at the time of incorporation. Depending on the length of time between incorporation and establishment of the following crop, nutrients can be taken up by plants, immobilised in the soil, lost to the atmosphere through ammonia volatilisation or denitrification or leached from the soil. Table 4 shows the nutrient flux four years into the rotation, the final result, which will be obtained after the completion of the target rotation, will be more complete as more crops are grown and more compost added.

An attempt has been made to estimate some of the uncertain inputs and off takes (Table 5), and also to model the effects of the future crops. Strip 4B is used for this example. The potato crop in 1999 was followed by carrots in 2000, followed by spring barley in 2001, and a second compost application will be applied in spring 2001. The modelled results for the carrots and the spring barley are shown in italics. The yield data and nitrogen content for the two crops are taken from data obtained from areas 1, 5 and 6, where they have been grown previously. The results show a positive balance of nitrogen, an equal off take/input of phosphorus and a deficiency in potassium. Again, these figures are uncertain as many of them have to be estimated, especially the amount of nitrogen fixed by the leys, the deposition of nitrogen and the leaching of all three nutrients.

Table 5: Example of projected nutrient budget for the target rotation: strip 4B, Hunts Mill

Crop	Yield (t/ha)	Nutrient input (kg/ha)			Nutrient removal (kg/ha)		
		N	P	K	N	P	K
Grass/clover (30 months)	25	210					
Potatoes	36				87	25	175
Carrots	*58*				*79*	*28*	*219*
Spring barley	*2*				*28*	*8*	*28*
Compost (25+40 t/ha)		500	89	334			
Leaching (kg/ha)[1]					150	15	5
Deposition[2]		100					
Total		810	89	334	344	76	427
Nutrient balance					**+466**	**+13**	**-93**

[1] *EFRC personal communication*
[2] *Mitchell et al, 1998*

7.4 Weeds

On all of the farms composition of the emerged weed flora and the severity of the weed problems was monitored to see if practices and rotations used in the conversion process had any effect. Weed assessments on all farms were made twice in each season in every crop. At Hunts Mill the first assessment was made at the peak weed pressure (just prior to the first weeding in the vegetables) and the second before the second weeding or at the end of the season before harvest of the crop. Any changes and trends in species composition during conversion and in the subsequent cropping were identified and documented. In addition at Hunts Mill, the soil weed seed bank was monitored to establish if any of the practices or rotations used in conversion affected its composition. Samples were taken at sowing and harvest of each crop to monitor the effect of each crop on weed seed levels. Variation in weed seed levels between the crop sequences and across time would then be compared.

7.4.1 Hunts Mill

In comparison with many of the reference farms on more fertile soils, Hunts Mill had a low weed pressure. Weeds have been effectively controlled in all years by using established techniques such as undersowing cereals with grass/clover and using stale seedbeds; additionally mechanical operations such as steerage hoeing, brush weeding, flame weeding and hand weeding have been implemented. More weeding was required in the relatively wet growing season 1998/99 than in 1999/2000, where any secondary weed flushes were delayed due to the dry weather resulting in only one main hand weed being required in the vegetable crops. The relative time and costs of weeding (Table 6) has varied between crops. Potatoes have required little weeding but higher levels have been required for carrots and onions.

Table 6: Weeding inputs Hunts Mill, average for 1998 and 1999 seasons

Crop	Hand weeding time (hrs/ha)	Mechanical costs[1] (£/ha)
Potatoes	13	36
Cabbage	51	40
Onions	310	75
Carrots	171	136
Leeks	99	60

[1] *Included use of ridging, steerage and brush hoes.*

So far annual weeds have caused more problems than perennial weeds, but we are now beginning to see an increase in presence of perennial grasses such as couch (*Elitrigia repens*) and black bent (*Agrostis tenuis*). These are increasing in all areas, visible this season (2000) in areas 3 and 6 where controlling them in the potato crop has been difficult. Further control measures will have to be taken next season to prevent then getting out of control. There are also patches of horsetail (*Equisetum* spp.) in some areas, but levels in the 1999/2000 season are very similar to those in 1998/99 and the problem does not appear to becoming too serious.

The weed cover in the three different fertility building periods are depicted by three sample rotations; 29 months-cropping sequence 2 (Figure 2), 17 months- cropping sequence 8 (Fig. 3) and 7 months- cropping sequence 17 (Fig. 4). In all rotations grass clover leys have been effective for suppressing the weeds (Figs 2 & 3). Weed cover has risen but remained fairly low (5% cover) in potatoes and cabbage although it reached higher levels during the growing of other vegetables to a peak of 20% where carrots were grown under fleece in 1998. (Figs 3 & 4). Weed cover has been highest amongst the spring sown cereals (30% cover 1999, Fig 3) The only weed controlling technique used here has been undersowing with white clover. Where the undersow clover did not establish well the barley crop became very weedy. The most important weed in spring barley crops was mayweed (*Matricaria* spp.) which emerges quickly in spring and establishes before the clover.

At this stage of the conversion process the length of the initial fertility-building periods does not seem to effect the total weed cover, and the rotations with only seven months fertility building are no weedier than those with 17 or 29 months.

Figure. 2: Weed cover (%) Hunts Mill, cropping sequence 2 (29 months initial fertility building)

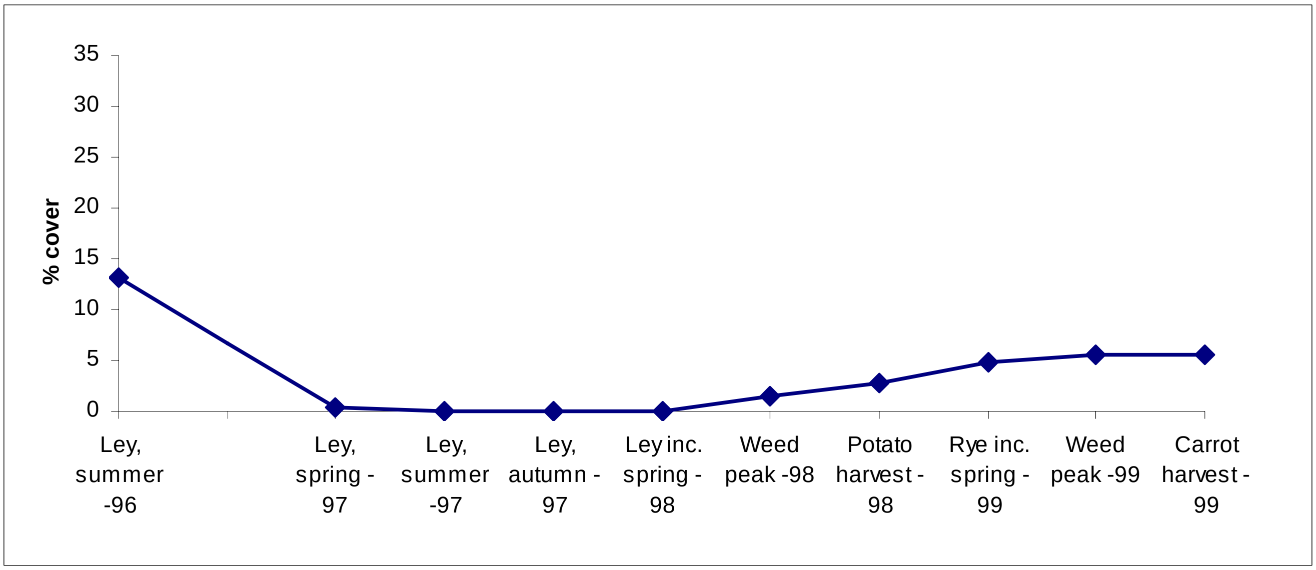


Fig. 3: Weed cover (%) Hunts Mill, cropping sequence 8 (17 months initial fertility building)

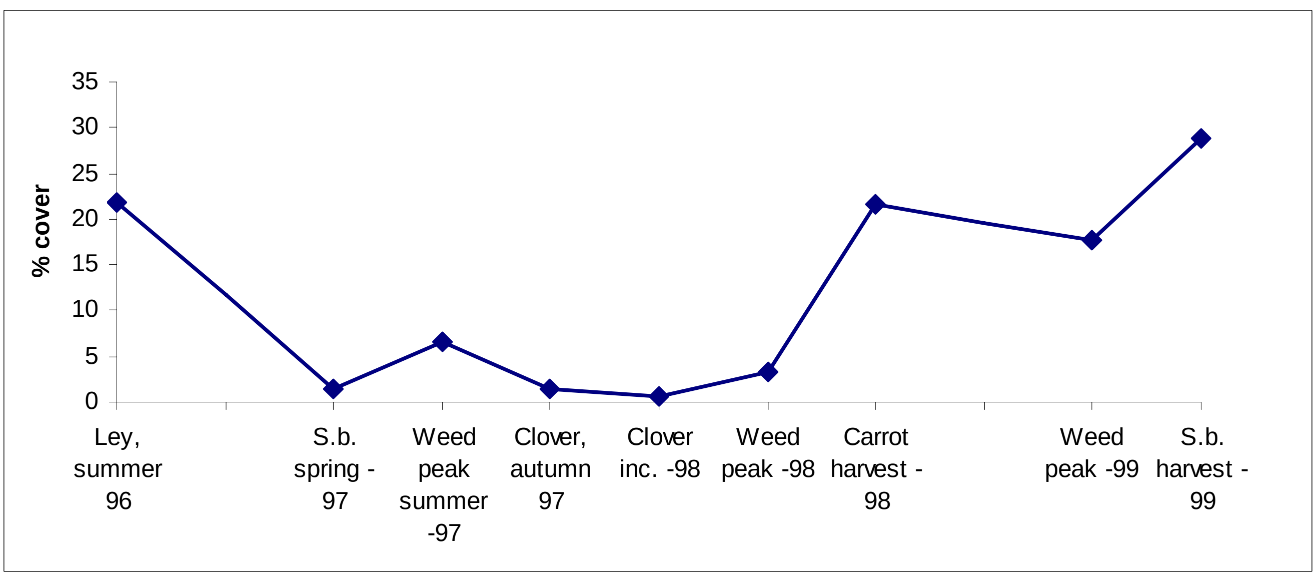
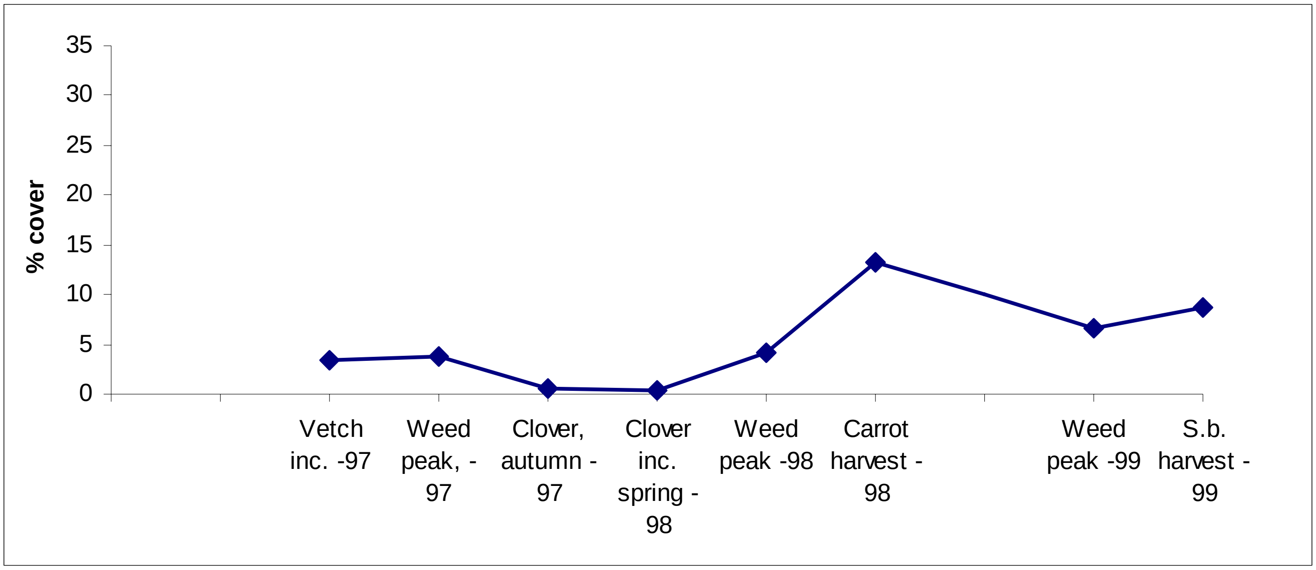


Fig 4: Weed cover (%) Hunts Mill, cropping sequence 17 (7 months initial fertility building)



At Hunts Mill, areas 4, 5 and 6 were analysed for weed seed numbers using the wet sieving, filtering and flotation method (Ricketts, 1979) area 4 had 29-month fertility building grass/clover ley, area 5 - 17 months and area 6 a 7-month vetch. The trends in weed seed numbers can be followed in Figure 5.

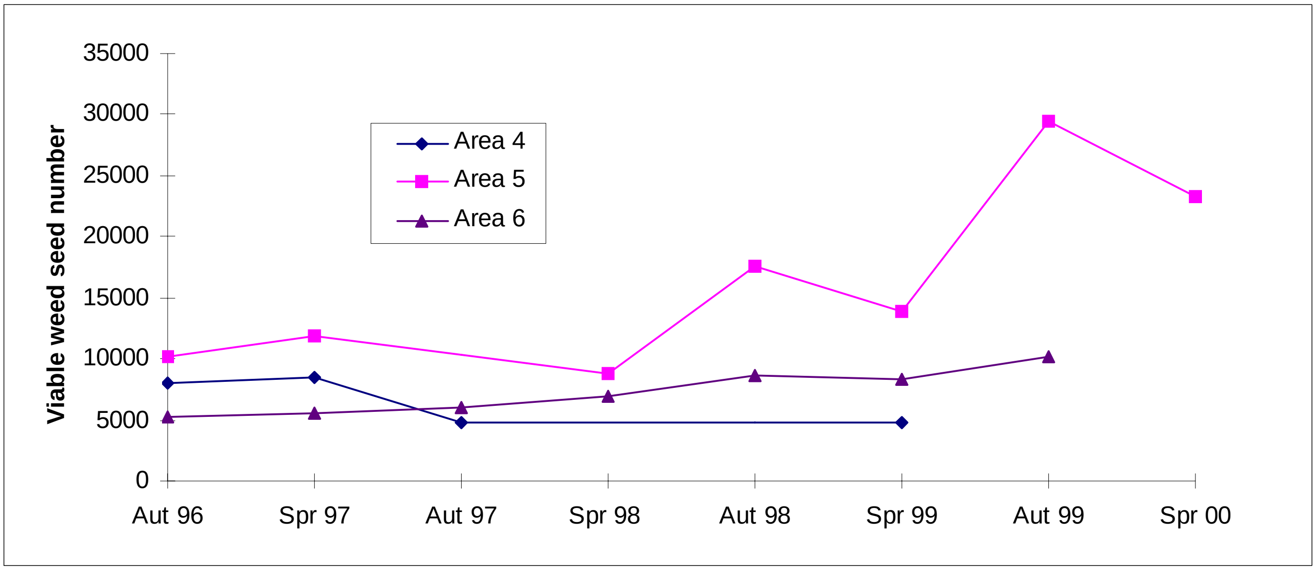
Area 4 has been under grass/clover ley and the first season of high nutrient demanding crops. It can be seen that the baseline weed seed numbers in this area are the lowest seen in the field at around 5000/m^2 of viable seeds at the onset of conversion in autumn 1996. It can be typically expected to find around 10000/m^2 of viable seeds in the upper 15 cm of intensive vegetable production areas, although values have been found ranging from 2000-86000, using the open pan method of analysis (Roberts, 1966). This method which relies on weed germination over a 2-year period, can potentially under estimate numbers. The wet sieving, filtering and flotation method will overestimate viable seed numbers, relying on pressure applied to seed coats to determine apparent viability. Therefore the soil in this area had a relatively low viable weed seed bank. Analysis of samples across the strips in this area and across time has shown no significant change in weed seed numbers. A small range of weed seeds dominates the area. At the start of conversion in autumn 1996, predominantly pansy (76%) some fat hen and a few knotgrass were the major species. By spring 1999 the proportions of knotgrass and fat hen had increased at the expense of pansy numbers. There has been no change, however, in these three species and viable numbers have declined throughout the ley period.

Area 5 contained the highest level of weed seeds at the start of the project. Again a decline in viable weed seeds was seen over the ley period, numbers of viable seeds rising in the autumn of 1998 after the first barley crop (Figure 5). Numbers then declined again over the winter period with natural mortality. At the end of the lower nutrient demanding vegetable sequence viable numbers had once again risen, and this shows significantly when performing analysis of variance. Again a decline in numbers can be seen over the winter months, but levels did not fall back to the original baseline. The central strips B and C consistently have the highest numbers of viable seeds over time. A wider range of seeds dominated the bank in his area in autumn 1996, pansy most prolific but also fat hen, poppy, shepherd purse, and chickweed occurred in number. As seen in area 4 pansy levels have decreased with fat hen and poppy becoming more dominant in the samples taken in autumn 1999.

Area 6 has shown a gradual increase in weed seed numbers over time although this is not a significant trend (Fig. 5). There was no initial long-term fertility-building period so weed seed levels were not seen to drop initially. Again pansy was the dominant viable species found in samples from this area at the start, again dominance of this weed decreasing considerably by autumn 1999. The proportion of fat hen seeds relative to other species found has remained similar over time. By autumn 1999 chickweed had become more dominant and most noticeably the presence of mayweed, the dominant weed in the seedbank in this area, by the last sample date.

At this stage it is still too early to draw any firm conclusions with regard to the effect on the weed seedbank of the different cropping strategies. Trends in seed numbers over complete cycles of the rotations needs to be evaluated before this can be done.

Fig 5: Viable weed seeds per m^2 to a depth of 10cm



7.4.2 Reference farms

In most cases weeds have been managed and kept to satisfactory levels using a combination of accepted organic techniques, including stale seed beds, flaming, inter-row cultivations and hand weeding where necessary (Appendix 5). Annual weeds caused more problems than perennial weeds in the first season after conversion, although early signs are that perennial weeds are becoming more of a problem in the second year of production.

For two farms a late start date and ambitious cropping plans in the first year lead to a high weed pressure at peak times and narrow windows for weeding operations. Many farms have highly fertile soils with high weed pressures and timings of operations have been critical. In two instances topping was resorted to in order to minimise weeds seeding (in carrots and beetroot).

Growers have had to adapt to new techniques and new machinery for weed control. Early indications are that already in the second season the mechanical weed control strategies have been improved and the requirement for hand weeding has been reduced. Farms have been able to invest in the latest available weed control equipment and are continuing to invest as they expand their organic areas and as they have more idea of what is best suited to their systems.

Reference farmers thought that weeds would be their most difficult problem during and following conversion. After one year's cropping the farmers agree that weeds were less of a problem than they had initially thought they would be. Weeds have been more of a difficulty on fertile soils. It has paid to have a variety of machinery and techniques available to control weeds. Perennial weeds are likely to become more serious as conversion progresses.

7.5 Pests and Diseases

At Hunts Mill crop walking was performed on a weekly basis throughout each growing season. General agronomic comments are noted for each strip. Pest and disease assessments were made on several occasions, targeted when the crops are at peak pest or disease pressure. On the reference farms crop walks were carried out at least twice for each crop during each season scoring for pests and diseases presence and leaf area affected and where possible outgrades and damage in store were assessed.

7.5.1 Hunts Mill

In the 1998/1999 season the cabbage crop was the most affected by insect pests. These included mealy aphid (*Brevicoryne brassicae*), cabbage root fly (*Delia radicum*) and caterpillars (large and small white (*Pieris* spp.), cabbage moth (*Mamestra brassicae*) and diamond backed moth (*Plutella xylostella*) all of which contributed to the high grade-out obtained (50%). Other vegetable crops were largely unaffected by either pests or diseases. In the 1999/2000 season pest and disease problems were not serious enough to drastically affect yield or marketability of any of the vegetable crops grown with the possible exception of downy mildew (*Peronospora parasitica*) in leeks and onions.

On the whole pests and diseases did not cause greater losses than other factors (e.g. mechanical damage or late weeding).

7.5.2 Reference Farms

There were no major losses from pests and diseases during the first year of vegetable production on the reference farms. Most pests and diseases recorded were present at low levels and did not affect either marketability or yield. Diseases were generally more of a problem than pests. Potato blight (*Phytophthora infestans*) being the most significant disease problem encountered. The problem was worse on farm 5 which had a late planting date due to late start date after receiving full certification and the use of a susceptible variety which was chosen for crisping. Common scab (*Streptomyces scabies*) also affected marketability of potatoes on two farms. Most other diseases were site specific e.g. white rot (*Sclerotium cepivorum*) in onions and clubroot (*Plasmodiophora brassicae*) in cauliflower.

Farmers primarily used cultural control methods (e.g. timings of sowings, rotations, crop covers, resistant varieties) for pest and disease control. Rotations were probably the most important tool available for pest and disease management and all the farmers have target or planned rotations which have been subject to change where there were persistent pest and disease problems. Rotations, choice of crop and variety are, however, subject to change under the influence of various factors and in this respect pest or disease management decisions can be subordinate to market demands. Avoidance of difficult crops is a strategy used by farmers where a known problem exists, for example white rot in onions, club root in brassicas and potato cyst nematode (*Globodera* spp.) in potatoes. One farm used satellite-mapping techniques for potato cyst nematode and avoided growing potatoes in fields where incidence was high. Many crops were grown without the use of any direct treatments of organic pesticides. Where these were employed they were used quite intensively, especially on brassicas and potatoes.

Pests and diseases are notoriously variable from season to season, therefore the conclusions drawn from two season at Hunts Mill and one on the reference farms should be treated with caution.

7.6 Economics

All produce from the Hunts Mill unit was marketed commercially. Hunts Mill was treated as a separate commercial unit with its own set of accounts. Since the unit was a relatively small part of the overall HRI research farm, it was difficult to allocate realistic overhead costs to the unit. Therefore it was decided to concentrate on close monitoring of individual crop costs, in order to calculate gross (MAFF, 1980) and net margins considering variable costs, labour and machinery costs of all cultivation operations. Net margin is the gross margin minus the labour and machinery costs of cultivations incurred in growing a crop. Data collected has enabled us to model the economics of the various approaches to conversion, the whole farm economics and the economic effects of adopting differing fertility building regimes.

For each of the reference farms data was collected from the farmers' records and accounts, which made possible the production a set of whole farm accounts prepared to Farm Business Survey (FBS) standards for the pre-conversion year, for the two in-conversion years and the first year's organic cropping. This enabled the monitoring of changes in the level of output, costs and of net farm income, and to make comparison with other reference and with conventional farms. The comparisons will be done using cluster analysis with the assistance of WIRS. In addition gross margins for all organic vegetable crops have been calculated and fixed costs recorded. Where possible these have been allocated to crops to calculate net margins per crop. Costs of management time devoted to conversion planning, information gathering and managing organic crops has also been identified. Capital investments in new machinery, equipment and buildings for organic conversion have been recorded.

7.6.1 Gross and net margins

At Hunts Mill potatoes, carrots, leeks, onions, cabbage, spring barley and spring wheat have successfully been grown and marketed. All crops have been graded and packed on farm and sold mainly to wholesale markets and a proportion to box scheme operators. This has enabled us to maximise the returns from the holding. All yields and financial returns (Table 5- fuller details Appendix 8) have been compared with organic standards (Lampkin & Measures, 1999). Results from the first two years organic vegetables show that on average yields have been 25% below organic standards. Financial output from the vegetables has averaged £8197 with average gross margins of £3921. From the whole unit, which has included 40% vegetables, 40% fertility building leys and 20% cereals, farm output has averaged £3848 and farm gross margin averaged £1984.

Six of the reference farms grew organic vegetables (areas from 2-20 hectares per crop) for the first time during the 1999/2000 cropping season after completion of their 24-month conversion period. Financial returns produced from the first year's organic vegetable cropping have been good. Gross margins (Table 5- fuller details Appendix 9) ranged from £13,470 to -£980. Apart from a few more specialist crops (e.g. chicory) the highest gross margins were from potatoes and carrots. Gross margins were on average higher than conventional standard margins; however, they were on average 32% less than organic standards from established organic farms (Table 5). The averages do conceal quite a lot of variation, with the highest returns being double those from the lowest for many crops, this is by a factor of two. The most significant variable was marketable yield, costs of production being fairly similar from farm to farm, variations that did occur were due to differing production methods, for example some growers used fleece as crop protection, there was also increased amounts of hand weeding on some farms.

Knowledge and access to markets has been a very important factor in ensuring good financial returns. Most successful growers carefully planned the growing of each crop with a vegetable packhouse to fit in with their planned programme of sales to multiple retailers.

Table 5: Average gross margins, compared with organic and conventional standards

Crop	Hunts Mill[1]	Reference farms[2]	Organic standards[3]	Conventional standards[4]
Potatoes	5769	4060	3781	2071
Beetroot	-	2498	5992	-
Cabbage	5571	-	5253	2939
Calabrese	-	1733	2037	3524
Onions	949	-	3119	-
Carrots	8620	4521	9505	4013
Leeks	4418	-	5506	4345
S. barley	493	-	684	357
S. Wheat	569	-	792	381

[1] Average of 1998 and 1999 cropping years, all marketed through wholesale markets and box schemes
[2] 1999 cropping year, all marketed through multiple retailers –full details Appendix 9.
[3] Lampkin & Measures, 1999 less mechanical harvest costs
[4] SAC Farm Management Handbook 1999/2000

Although yields from the organic vegetable crops were on average 40-50% less than conventional ones, much higher prices (Table 6) currently available made organic production comparable or in many cases more profitable than conventional systems. From the 4 crops listed below current organic price premiums range from 75-640%. It should be noted that many conventional vegetable prices are currently extremely low, making profitability from these crops hard to achieve.

Table 6: Reference farms net organic vegetable prices[1] (£/t) 1999/2000

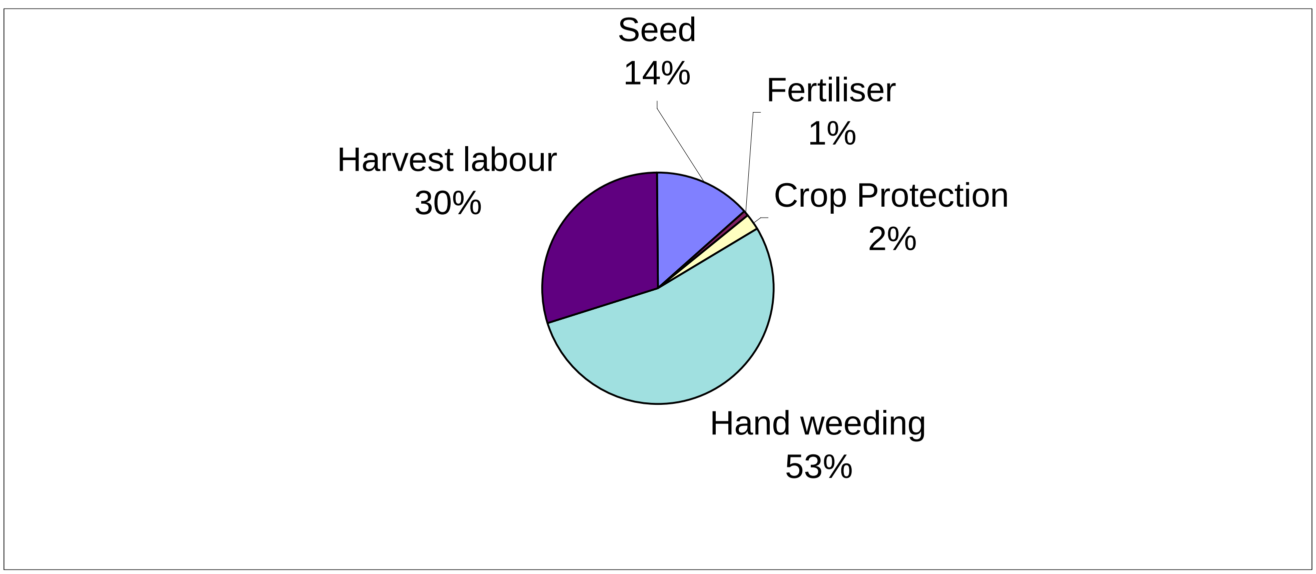
Crop	Reference farms	Conventional[2]
Beetroot	250	47
Calabrese	919	374
Carrots	200	27
Potatoes	227	130

[1] Prices are net of all marketing charges (grading, packing, transport and commission)
[2] Data from two of the reference farms which grew these crops

Variable costs when expressed per hectare for the reference farms were generally lower than conventional standards with the exception of carrots; this is partly due to the fact that some inputs such as hand harvesting of crops are related to yields, which are lower on the organic farms. However, variable costs per tonne of crop marketed for organic crops are in the case of carrots 213% higher and for potatoes 58% higher than conventional standards. This indicates some of the higher costs of production of organic crops relative to conventional.

From the 4 crops analysed casual labour accounted for an average 41% of variable costs (not including market charges). The largest element of this was hand weeding, accounting for 25% of variable costs; however, this was as high as 53% for carrots (Fig 6). Organic vegetable growers commonly spend 100-300 hours/ha hand weeding but the time may reach as much as 500 hrs/ha (Melander, 2000). In this sample the average hours for the four vegetables was 151 hours, which included potatoes, which required little if any hand weeding. The highest was 462 hours (£2196/ha) for weeding carrots on fertile soils on one of the farms in the sample. It should be noted that all the farms also extensively used mechanical weeding methods as well (methods detailed in Appendix 7 and costs detailed in Appendix 9). There is scope for improved management and technology to reduce overall weeding costs.

Fig 5: Percentage breakdown of variable costs of carrot production on reference farms 1999



7.6.2 Economics of the various fertility building periods

At this stage (covering the period 0-48 months from the date of conversion), the rotation with the shortest initial fertility building period (7 months) has the highest overall financial return (annual average net margin £2073), although only marginally (£87) higher than the 29 month fertility building period (Table 7; see Appendix 10 for details). The area with the shorter fertility-building period was able to grow continuous crops during the period under study and to take advantage of in-conversion cereal crops (1997) grown following the first overwintered green manure (vetch). The areas with the longest fertility building period was able to claim set aside for two years (£338/ha in 1996 and £308/ha in 1997), this has allowed it to nearly equal the income levels from the areas continually cropped. Since the target rotation has not been completed on any of the areas the financial results have been determined by what crops have been grown, for example the areas with the 29 month fertility building period have grown 2 crops of vegetables, whereas the other areas have only grown one. Therefore it is difficult to draw any firm conclusions from the results to date.

Table 7: Net margins from the different fertility building strategies (£/ha)

	1996	1997	1998	1999	Average
29 month	238	265	5086	2411	1986
17 month	219	394	3570	80	1190
7 month	-	312	5614	158	2073

7.6.3 Whole farm economics

Data from the conversion at Hunts Mill, HRI Wellesbourne has been used to construct a model of an arable cash cropping system converting to an organic arable/vegetable cash cropping system in order to assess the economic trends during and following conversion. The conversion was from a conventional arable roots system to an arable organic vegetable rotation consisting of 40% fertility building, 40% vegetables and 20% cereals.

During the conversion financial output fell by 42% during the two in-conversion years. After conversion output rose by more than double of the conventional equivalents (Figure 7), this is mainly due to the increased prices which are currently available for organic vegetables and is also due the fact that the farm has converted to a more intensive level of production. Both variable and fixed costs reduced during the in-conversion phase, largely because a considerable proportion of the farm was in fertility building grass clover leys. Following conversion variable costs rose five fold largely due to the increased use of casual labour which is required in more intensive vegetable cropping systems and especially so in organic ones. Casual labour accounted for 32% of variable costs in the organic system. Net margins also reduced by 30% during the in-conversion period but rose three fold following conversion.

The costs of conversion were estimated by subtracting net margins of the model from net margins of comparable conventional Farm Business Survey data for the region during conversion (Figure 8). In addition average recorded investments from the reference farms of new equipment and machinery necessary for organic vegetable production were added (£150/ha). Total costs of conversion were estimated at a total of £560/ha. At the time of conversion of Hunts Mill organic aid was available at £250/ha spread over 5 years. This would not have recouped this cost. However, the new rate of £450/ha introduced in 1999 would have met 80% of the costs. Levels of income following conversion have increased considerably and are higher than the conventional equivalents. This higher level of income is largely attributable to the current premium prices available for organic vegetables. At current prices the increased level of income will enable a relatively quick recoupment of the farms costs of conversion to organic production.

The model shows the likely effects of trends during and immediately following conversion from arable roots rotations. If, however, a farm with an intensive vegetable rotation converts its income prior to conversion will be higher and therefore costs of converting will be higher. More data to calculate these exact costs will be forthcoming in the second phase of the project.

Initial actual data from the reference farms is confirming that generally farm output, gross and net margins are falling during conversion, however, there are exceptions and some farms are converting a relatively small area of their farm, therefore the costs of conversion on these farms in relation to the whole farm are quite small.

Fig 6: Arable conversion model of financial output, gross and net margins during and following conversion (£/ha)

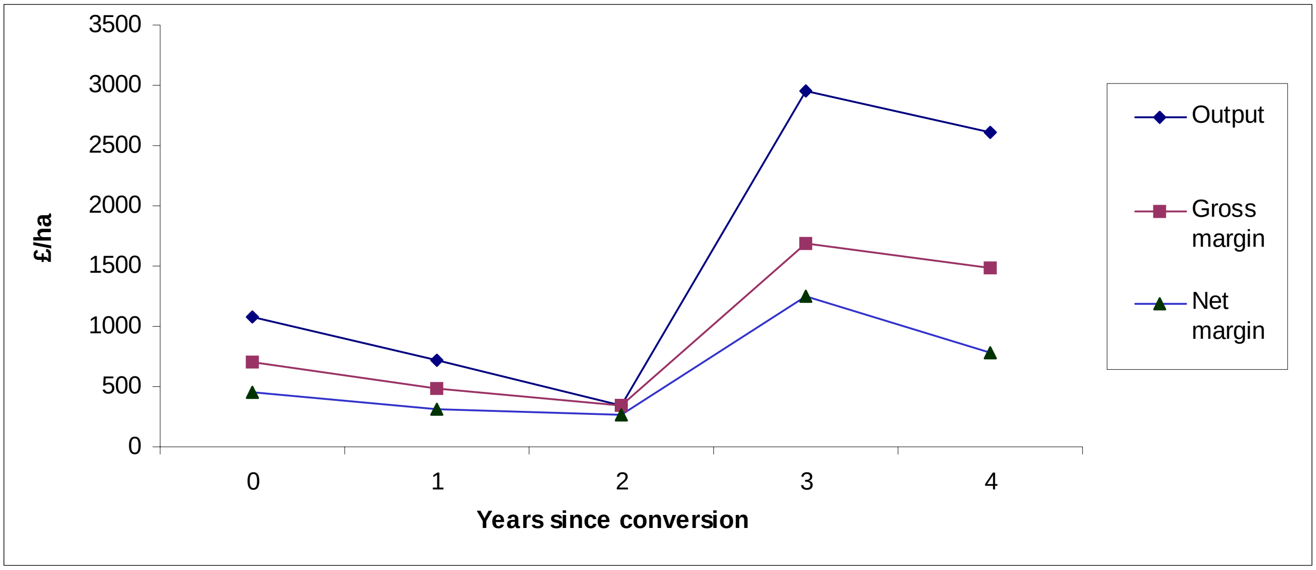
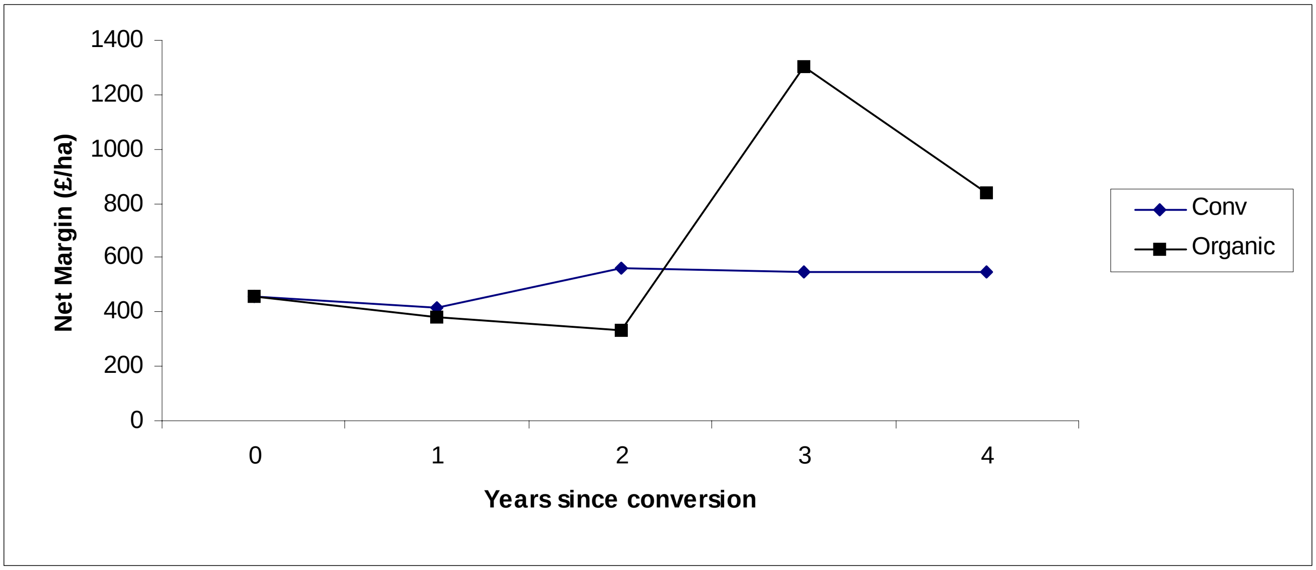


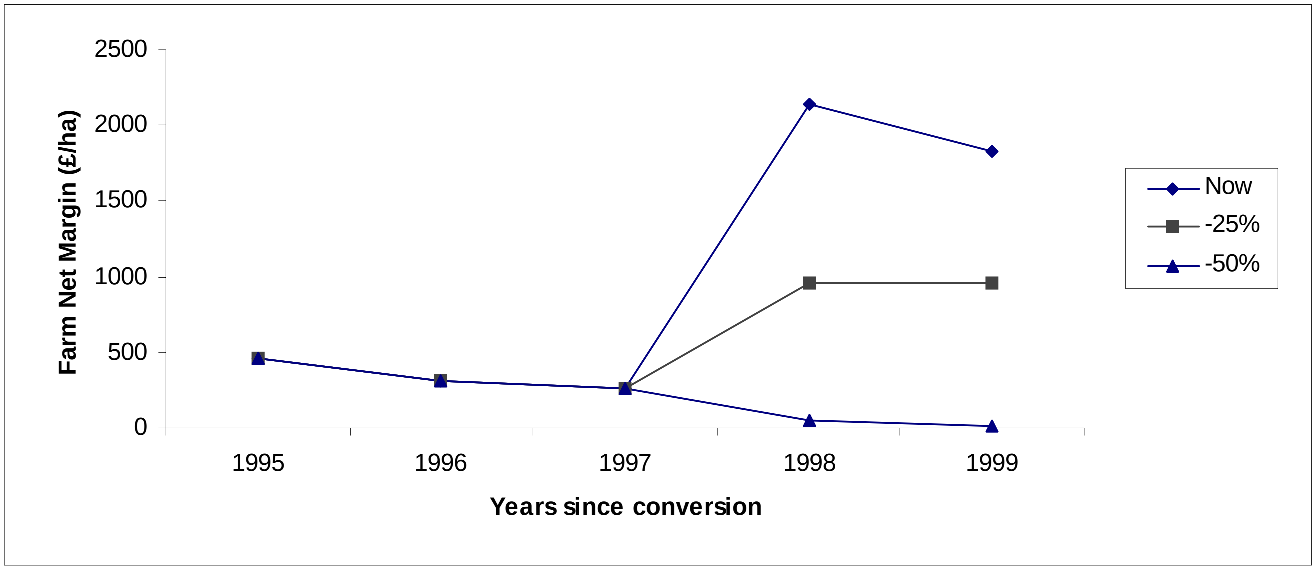
Figure 7: Arable conversion model; comparison of net margin with conventional data[1] (£/ha)



[1] *Conventional figures (Vaughan, 1995-98) University of Reading Farm Business Data for farms with arable cash cropping (more than 5% area under cash crops).*

The current high gross margins are largely due to the current price premiums available for organic vegetables. The model described above has also been used to stimulate the likely effects of a 25% and 50% reduction in organic vegetable prices on the farm net margin/ha (Figure 8). A 25% reduction in prices would lead to a halving in overall farm margin/ha, although the net farm margin would still be above conventional levels. A 50% reduction would have very serious implications leading to levels of income lower than conventional levels. The implication is that overall returns from organic vegetable production are very sensitive to a lowering of current premiums.

Figure 8: Arable conversion model showing likely effects of price reductions on net farm margin following conversion[1] (£/ha)



[1] 1995 is the pre conversion year and 1996 and 1997 the in-conversion years. Organic vegetables were first grown in 1998 and again in 1999

In order to encourage growers to convert to organic production with vegetables, they require positive signals from government and the market. Continued organic aid at least at the current rates (to October 1999) is required to give growers the confidence to make the change in the farming system and also stable premium prices are required from the market.

The length of time for which data has been collected is relatively short, the sample of farms and number of crops per farm is also relatively small meaning the data on crop margins should be interpreted with caution. Whole farm financial data is usually only available some 12-18 months after the cropping season, therefore at present there is insufficient data to draw conclusions on the actual whole farm financial performance during and following conversion from the reference farms.

References

Farm Business Survey in England and Wales (1998/99). Instructions for Collecting the Data and Completing the Farm Return. Ministry of Agriculture, Fisheries and Food, Economics and Statistics Division

HDRA Consultants (1999). Using Green Waste Compost in Agriculture, HDRA Consultants, Ryton Organic Gardens, Coventry

Lampkin, N & Measures, M (1999). *Organic Farm Management Handbook.* 3rd edition. Welsh Institute of Rural Studies, Aberystwyth. Elm Farm Research Centre, Berkshire.

MAFF (1980). An introduction to farm business management, ADAS 381, Ministry of Agriculture, Fisheries and Food.

Melander B (2000). Economic Aspects of Physical Intra-Row Weed Control in Seeded Onions. *Proceedings from 4th European Weed Research Society Conference*, Elspeet, Netherlands, 20-22 March 2000.

Mitchell, R, Chambers, B, Webb, J & Garwood, T. (1998) Nutrient budgets for managed grasslands in England and Wales (1969-93). Report prepared for MAFF contract CSA2845

Personal communication EFRC, Elm Farm Research Centre, Newbury, Berkshire

Ricketts M E & Roberts H A (1979). Quantitative relationship between the weed flora after cultivation and the seed population in the soil. *Weed Research* 19 269-275.

Roberts H A & Stokes F G (1966). Studies on the weeds of vegetable crops. VI. Seed populations of soil under commercial cropping. *J. appl. Ecol.*, 3 181-90.

Soil Association (1999). *Food and Farming report.* The Soil Association, Bristol.

Vaughan, R (1995-1980). Farm Business Data, Department of Agricultural and Food Economics, University of Reading, Berkshire

Whitfield W A D (1974). The soils of the National Vegetable Research Station, Wellesbourne. *Report of the National Vegetable Research Station for 1974*, 21-30.

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