

Review Report

OF0143: A STUDY OF THE ADVANTAGES AND DISADVANTAGES OF BREAK CROPS FOR ORGANIC ROTATIONS

Aberdeen University/SAC

Dr Audrey Litterick

Land Management Department, SAC Environment Division, Craibstone Estate, Bucksburn, Aberdeen AB21 9YA

Sub-contractors: HDRA, HRI, WIRS

01/10/98 - 30/09/02

Total cost (£120k)

Executive Summary

Fifteen break crops were assessed in an economic and agronomic review. Most crops had attributes which could prove useful if they were grown as part of an organic rotation. Twelve of the 15 organic crops evaluated had positive net margins based on 1999 prices (including subsidies where appropriate). Carrot and potato were the most profitable crops for organic systems and mustard and sugar beet (without an organic price premium) the least. In experimental trials, crop yields and pest, disease and weed pressure differed widely between sites and between years. Weeds (all crops), pests (swede and oilseed rape), potato late blight and poor soil conditions shortly after sowing were the main causes of reduced yields. Statistical analysis is currently being carried out on results obtained in years 1999 and 2000 to determine the effects of break crops on soils and following cereals.

Introduction and Policy Rationale

Typical organic grass/arable rotations, which may include only graminaceous and legume crops, often lack sufficient crop and root system diversity. The use of break crops to provide diversity within the rotation may lead to improved pest, weed and disease control, nutrient use efficiency and economic returns to the farmer. The overall objective of this project is to identify agronomically, economically and environmentally suitable break crops for organic grass/arable rotations. The work will involve the objectives shown below. The project supports the expansion of UK organic production in line with current MAFF policy.

Objectives

- a) To review the scientific literature and evaluate known agronomic advantages and disadvantages of 15 potential break crops
- b) To evaluate the economic potential of 15 crops considered to be most suitable as break crops in the agronomic assessment
- c) To assess the suitability of ten different break crops grown between winter wheat and spring barley in small-scale experimental plots in replicated field trials. Trials will be carried out in parallel in four different climatic regions throughout the UK. The data will be used to identify specific problems associated with crops and will allow them to be ranked according to economic suitability and economic potential.

- d) To evaluate a further diversified arable/grass rotation which includes three break crops with and without grazing stock.
- e) To assess consumer acceptability, organoleptic characteristics and market potential of both cereal and vegetable crops produced in the large-scale field trials described in objective d), and to make a comparison with organic products from other sources in the UK and overseas.

Approaches

Fifteen crops including carrot, potato, swede, onion, broccoli, field bean, borage, linola, lupin, oilseed rape, hemp, soybean, red clover, sugar beet and mustard were chosen based on their potential for use in organic rotations in the UK. Economic, scientific and husbandry literature were reviewed early in the project in order to rank the 15 crops in terms of their economic performance and to optimise agronomic methods used in field trials. This information was summarised and submitted to MAFF in 1999.

Nine break crops (carrot, potato, swede, field bean, linola, lupin, oilseed rape, hemp and sugar beet) were grown with oat as a control in a cereal rotation. The crops were tested at four UK locations (Aberystwyth, Leicester, Boston and Inverness) in 1999 and three UK locations (Aberystwyth, Coventry and Aberdeen) in 2000. Crop yield, crop quality, pest, weed and disease incidence were recorded. The effect of each crop on soil structure, nutrient status and the following crop were recorded in cereal trials in 2000 and are in progress this year (2001). Organoleptic tests were carried out by the multiple retailer Tesco, on all carrot and potato crops grown in small scale field trials to determine consumer acceptability. Crop yield, quality and pest and disease incidence are also being recorded annually (1999 - 2002) in commercial carrot and potato crops grown within a further diversified cereal rotation in north east Scotland. Results are being disseminated in scientific and advisory publications, at trade shows and grower events and through the well-developed advisory services of HDRA, WIRS and SAC.

Results

An initial economic assessment showed the effect of strong demand and high prices for organic vegetables for human consumption. Net margins of £6351, £3122 and 3319 ha⁻¹ were calculated for highly mechanised organic carrots, potatoes and swedes respectively. Forage crops and oilseeds, fibre and crops requiring processing, were less profitable. Where organic processing capacity was not present in the UK, no organic premium was assumed. Following trials by British Sugar in 2000, the predicted net margin for sugar beet of -£198 ha⁻¹ (without premium) can be amended to £441 ha⁻¹ using yields and an organic price premium; British Sugar are offering contracts with an organic premium for 2001.

In most cases, crop yields from the trial plots were sufficiently high to allow a positive gross margin. Where this was not the case, weeds, pests, diseases or poor soil conditions shortly after sowing (particularly in Coventry, 2000) were the most common causes of crop failure.

Pest and disease pressure varied widely between sites and between years. Moderate to severe damage caused by pigeon, flea beetle and caterpillar was recorded on swedes and oilseed rape in all sites in both years, although in some cases, acceptable yields were still obtained. Potato late blight (*Phytophthora infestans*) caused moderate to severe yield loss in all sites in both

years. Apart from the above, pest and disease damage was slight and was confined to one or two sites per year.

Weeds had the potential to cause severe yield loss in all crops in all sites and hand weeding was done twice in most crops on all sites. Weed growth was most prolific and caused greatest yield loss in the least competitive crops such as sugar beet, swede and carrot. Lupin, hemp, linola and potato suffered least from weed pressure. Weed diversity was high on all sites (> 15 weed species per site), but the species present and balance of species differed between sites. On some sites, problem weeds became dominant in part or all of the trial site, for example couch grass (Aberdeen, 2000), redshank (Inverness, 1999; Aberystwyth, 1999, 2000) and docks (Aberdeen 2000). However in most cases a diverse mix of weeds was present throughout the site.

There is potential for some of the less profitable break crops to be grown within organic rotations, because of the benefits which they bring to soils and to the following, more profitable crops. The work to investigate effects of individual break crops on soils and following cereals is still underway. Early results suggest that hemp has beneficial effects on soil structure in some soils and that hemp, lupins and possibly linola may exhibit allelopathic effects on weeds

Carrot and potato samples prepared from all small scale break crop trial sites were classed as "good" in consumer taste tests, (i.e. they had good flavour and appearance). However, samples from Coventry and Aberystwyth (2000) were rejected by Tesco's quality control system due to small sized and irregular shaped roots/tubers

Two carrot and two potato crops were grown in 1999 and 2000 on a commercial scale on a stockless organic cereal rotation in north-east Scotland. Fertility was maintained through the use of grass/clover leys and composted farmyard manure. Yields of potatoes ranged from 32 - 40 tha^{-1} . No pest problems were recorded and no diseases other than potato blight occurred. The incidence of late blight meant that haulms were destroyed 2 to 4 weeks before senescence, in order to prevent tuber blight. Carrot yields ranged from 21 - 38 tha^{-1} . Very low levels of carrot fly were recorded in the crop, and damage was not significant. Low levels of several diseases including cavity spot and liquorice rot were recorded, but none were significant. The entire crop of potatoes and carrots passed quality assurance inspection by a multiple retailer (Tesco buyer).

Conclusions and Relevance to Policy

There is a good price premium and a strong demand for organic vegetables for human consumption. This work has shown that acceptable yields of organic vegetables can be produced on a range of soil types throughout the UK, provided that the key agronomic requirements are met for each crop. Some of the organic crops tested suffered from pest or disease attack, but damage levels were generally low (with the exception of late blight on potatoes which occurred on all sites in both years). Statistical analysis to assess the effects of individual break crops on soils and the following cereals will be completed in 2002. This work will provide information to help UK farmers and advisors choose crops for organic rotations based on their agronomic requirements and their break crop effects. The results will help address MAFF's objective of aiding the expansion of UK organic production.

Future Work

a) within life of project

The investigation into the effects of ten crops on soil structure, soil nutrient content and the following cereal crop will continue at three UK sites. Yield, pest, disease and weed incidence, soil nutrient content and weather data will be recorded from all three sites and from commercial carrot and potato crops in north-east Scotland. Soil and plant nutrient analysis from these trials will be completed by April 2002. Statistical analysis will be carried out on data obtained from work carried out from 1998 - 2002 in order to compile the final report.

b) beyond life of project

Funding will be sought to investigate:

- The effect of variety on break crop performance in organic systems
- Nutrient use efficiencies of different break crop varieties in different organic cropping systems
- In greater detail - break crop effects on soil structure, organic matter, following crop nutrition, allelopathy (against weeds) and pest and disease incidence in following crops

Technology Transfer

a) events

Attended Royal show, Royal Highland show, Potato Show, Hortex and Vegex in 1999 and 2000. Spoke to farmers and food processors there and at organic conferences including the Soil Association (1999, 2000, 2001), SAC (2000) and the Biodynamic Agricultural Association (2001)

b) reports and publications

Fowler, S.M. & Lampkin, N. (1999) An economic evaluation of potential organic break crops. University of Wales, Aberystwyth, unpublished.

Robson, M.C., Litterick, A.M., Fowler, S.M., Jackson, L., Paterson, C. & Watson, C.A. (2000) Potential of nine break crops in organic arable rotations. *Aspects of Applied Biology* **62**, 107-112.

Robson, M.C., Litterick, A.M., Fowler, S.M., Jackson, L., Paterson, C. & Watson, C.A. (2000) Potential of nine break crops in organic arable rotations. (Poster) *Association of Applied Biologists - Farming Systems for the New Millennium Conference*. December 2000, Cambridge.

Robson, M.C., Litterick, A.M., Fowler, S.M., Jackson, L., Paterson, C. & Watson, C.A. (2000) Potential of nine break crops in organic arable rotations. (Poster) *Soil Association Conference*. January 2001, Cirencester.

Robson, M.C., Watson, C. A., Fowler, S.M., Leitch, M, Litterick, A.M. & Robinson, D. (2001) The agronomic and economic potential of break crops for ley/arable rotations in temperate organic agriculture. *Advances in Agronomy*, In Press.