Soil Fertility – Changes during the Conversion Process

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ABSTRACT
This paper describes changes in key parameters measuring aspects of soil fertility that have occurred throughout the conversion period and beyond (1996 to 2003) on ten commercial farms. The farms all produced field vegetables but otherwise they reflected a range of farming systems on varied soil types throughout England. There were very few changes in organic matter levels. The importance of the fertility building crops for providing nitrogen has been increasingly recognized by the farmers but there have been notable examples of deficiencies. Available phosphorus (P) and potassium (K) remained relatively stable overall, suggesting that the inputs of soil amendments (usually FYM) were broadly satisfactory. Problems with soil structure, particularly compaction, were apparent on several farms. Sometimes this was due to pre-existing problems which had been masked by the use of conventional fertilizers.

INTRODUCTION

Soil fertility is of fundamental importance in organic agriculture. Farmers considering conversion are often concerned about the transition from a system in which nutrients are supplied in a soluble form as fertilizers to one in which there is a much greater emphasis on the use of fertility building crops with limited use of soil amendments. Regular sampling and analysis is often advocated as the best method of monitoring fertility but routine analysis may not give the full picture, particularly with respect to the physical and biological aspects of the soil.

The work described in this paper was part of a wider project to monitor all agronomic and economic aspects of conversion to organic field vegetable production (HDRA 2000). Data was collected from commercial farms making their own management decisions in the light of 'best practice' management advice. The period of study covered the two year conversion phase itself followed by at least three years of organic cropping.

METHODS

Samples were taken from ten commercial farms in England beginning at the start of their conversion from conventional agriculture. The farms were selected to reflect a range of soil types and systems (focusing on field vegetable production in both stockless and livestock/arable rotations). Details of fertility building crops, soil amendments and cash crop yields were also recorded.

Soil from selected fields was sampled in March each year (between 1997 and 2003). At least sixteen soil cores (0-30 cm) were taken with an auger and pooled before being analysed by NRM Ltd (Bracknell). The analysis methods were those of Elm Farm Research Centre (EFRC, 1985); these were used since many organic farmers have their soils tested in this way and much of the relevant advice is tailored to interpretations of these results. Phosphorus (P) was measured by four different methods. Olsen P (bicarbonate extraction) is the standard ADAS technique and is suitable for all soils. The three acid extractants also used (acetic acid, lactic acid and citric acid) are not suitable for alkaline soils. Potassium (K) and magnesium (Mg) were measured using lactic acid extractions.

Visual observations were also made of soil structure and of crop growth.

RESULTS

Table 1 gives general information about soils on the selected farms together with some of the key results from the most recent soil sampling.

Table 1. Data relating to soil fertility on nine recently converted farms; samples were taken in spring 2003. The status of organic matter, P and K is based on the threshold values appropriate for the soil type that are used by Elm Farm Research Centre. The figures in brackets refer to the percentage of fields in each category on each farm.

Farm	Location	Soil type	Organic matter	Available P	Available K
1	S. Lincs.	Silty loam	OK (13) Low (87)	OK (100) Low (none)	OK (none) Low (100)
2	S. Lincs	Silty loam	OK (50) Low (50)	OK (100) Low (none)	Good (100) Low (none)
4	Warks	Clay loam	OK (20) Low (80)	OK (20) Low (80)	OK (20) Low (80)
5	N. Lincs	Sandy loam - peaty	Good (100) Low (none)	OK (9) Low (91)	OK (64) Low (36)
6	Cornwall	Loam l	OK (90) Low (10)	OK (none) Low (100)	Good (40) Low (60)
7	Devon	Clay loam	OK (39) Low (61)	OK (8) Low (92)	OK (8) Low (92)
8	Notts.	Sandy	OK (none Low (100)	OK (38) Low (62)	OK (63) Low (37)
9	Lancs	Loam/peat.	Good (91) Low (9)	OK (33) Low (67)	Good (92) Low (8)
10	Beds.	Sandy	OK (0) Low (100)	OK (100) Low (none	Good (100) Low (none)

Organic matter levels varied greatly between farms reflecting the variations in soil type, e.g. one site was on peaty soil with organic matter levels as high as 30%, another site on a sandy soil had only approximately 1.5% organic matter. On the individual farms there has been little change in organic matter levels since conversion began.

On most sites pH was managed by applications of lime; our data shows a lot of annual fluctuation because individual fields were limed at different times related to the occurrence of particular stages of the rotation. The target pH is the same in conventional and organic agriculture although some of the quicker acting lime amendments are not permitted under an organic management.

There was no overall general pattern for P availability. The initial values were very different between sites and six of the ten farms had fields considered (according to standard Elm Farm interpretations) to be low in phosphorus. On some farms there was a slight decline in levels over the period of study, whilst in others there was an increase in P status.

Initial levels of K availability were also variable between the various farms. Through the period of study, levels of available K tended to decline at all sites. At the most recent sampling, seven of the ten farms had fields low in potassium (according to standard Elm Farm interpretations). Magnesium levels were generally stable – low levels were only measured at two of the farms.

Six farms had high levels of at least one trace element (manganese, iron, copper or zinc). This was usually a reflection of basic rock type. Trace element availability can also indicate certain soil problems e.g. high manganese levels can be linked to compaction. Soil structural problems were seen on several of the farms. Compaction was associated with harvesting of vegetables in wet conditions (as dictated by marketing considerations) and also occurred on some sites as a result of repeated mowing of fertility building leys.

Nitrogen (N) is most commonly the limiting nutrient in organic farming but there is no routine test available to predict how much N may be made available during the growing season. Organic farmers often use a N budgeting approach to see if the fertility–building crops within the rotations will sustain the cash cropping. In practice this approach then relies on the fertility building crops performing as well as expected. Adverse weather can make it difficult to establish cover crops; other farm operations which give a direct financial return may also be prioritized ahead of the management of fertility-building crops. Often these crops are new to conventional vegetable farmers and in this study some had problems with their management (for example not mowing leys often enough). We also noted relatively poor utilization of winter green manures; sometimes these were established too late in the season to fulfil their full potential. The two farms on the lightest soils had the greatest problems with nitrogen availability. The situation was improved by the composting of FYM in one case and the application of pelleted chicken manure in the other.

DISCUSSION

Organic matter levels are widely considered to be higher under organic than under conventional management. However, this study showed very little change in organic matter status after the start of conversion. This is not surprising in view of the relatively short period of study and also because, depending on rotation, organic matter inputs are not necessarily greater than in conventional agriculture – lower yields also mean less crop residues are returned to the soil. Gosling and Shepherd (2002) also found that that, in paired organic and conventional farms, soil organic matter levels were very similar.

Regular analysis of available P and K in the soil showed little change overall through the period of study. This would suggest that there is no general 'mining' of soil reserves by organic farming. This is not unexpected since almost all the fields monitored (except on Farm 1 where available P and available K both declined slightly) received amendments of acceptable inputs. The picture is a complicated one as many of these materials provide several nutrients (as well as being a source of bulky organic matter). The most common input was FYM, either produced on the same farm or bought into the holding. In addition one farm used rock phosphate, one farm Silvinite (a source of K) and two farms pelleted chicken manure. It is necessary to demonstrate a need for such materials in order to obtain a derogation from the certifying body before they may be used by organic farmers.

Organic standards place a lot of emphasis on good soil management but problems with the soil physical condition were often seen. These were almost certainly present before conversion, but the poor growth which they caused was masked by the use of conventional farming practices. These problems were more serious on the larger farms where big machinery was used for cultivation and harvesting. Since organic farming relies much more on a healthy soil to supply nutrients to the crops it is important that such issues are addressed.

CONCLUSIONS

On the ten farms monitored there were relatively few changes in soil fertility during the conversion period and in the years immediately afterwards. Although there were specific problems, most farmers were able to develop strategies to address them. However, it is too early to detect the effect of the new regime on many soil properties and it is important that regular assessments continue to be made so that management can be modified in the light of any changes. Six of the farms in this study will continue to be monitored within new DEFRA-funded projects.

ACKNOWLEDGEMENTS

We thank DEFRA for funding this research (Projects OF0126T and OF0191).

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