Multi-functional roles of grassland in organic farming systems

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ABSTRACT

Grassland supports commodity production and maintenance of soil fertility, as well as environmental, economic and social functions beyond the farm. These include biodiversity and landscape; soil, air and water quality; recreation, rural employment and social benefits. This paper discusses whether organic grassland management delivers benefits, compared with other farming systems, within this multi-functional context, and how future land-use systems might meet a wider range of objectives.

INTRODUCTION

Grassland in the British Isles has evolved under centuries of grazing by wild herbivores and pastoral farming, with progressively greater use of external inputs and technological improvements from the late 19th century onwards. The eventual outcomes of surplus production, environmental damage and resource depletion focused attention on the need for reform which recognises that agricultural land also has environmental, economic and social functions. This paper discusses the potential for organic grassland to deliver benefits within this multi-functional context.

COMMODITY OUTPUTS

Irrespective of the farming system the primary function of most agricultural grassland is forage for ruminants, and indirectly food for human consumption, plus various by-products. In organic systems in particular, a secondary commodity function of grassland is to support crops in ley/arable rotations (cash crops or livestock feed crops for use on the farm) through the accumulation of organic matter, N fixation, and nutrients from animal excreta. Organic grassland is capable of high levels of forage yield and livestock production in relation to inputs (e.g. Cobb *et al*., 1999). Organic grassland production relies on internal sustainability, placing a premium on the feed quality of forage to supply production requirements as well as maintenance. Whilst not unique to organic grassland, production based on home-produced quality forage carries a quality assurance value, with added value for producers and consumer confidence in livestock products in terms of safety and animal welfare.

NON-COMMODITY OUTPUTS

Organic grassland farming retains some characteristics of extensive grassland, including delivery of specific environmental benefits, and of the sustainable attributes of some conventional systems, e.g. use of legumes. However, on a spectrum of land-use management, organic grassland is a long way from the most intensive and environmentally damaging farming systems, but also from natural biotopes, and from extensive systems that can support wildlife in refugia alongside farming.

Biodiversity and wildlife protection

All forms of agriculture compromise wildlife, and the greatest biodiversity is achieved in wilderness situations with high levels of structural diversity (e.g. the groves in the New Forest which can support up to 178 species /km^2 (Vera, 2000)). UK farmland has a particularly important role in supporting wildlife habitats, and plant communities exist that have developed under specific types of past agricultural management, and which now require positive management, e.g. ESA management agreements. Organic farming standards also require farmers to maintain features such as field margins and species-rich pastures; and the exclusion of inorganic fertilisers, herbicides and anthelmintics has potential to deliver additional biodiversity benefits. The effects of organic farming on biodiversity has been widely reviewed in the UK and European literature (e.g. Younie & Baars, 1997; Morris *et al.,* 2001). Some features of organic grassland farming (N-fixation from legumes, grass/crop rotations) may conflict with the habitat requirements of particular species or communities that require lower trophic conditions than is compatible with productive organic farming. Protection of particular habitats or species may require financial support through a management agreement, regardless of farming system. Nevertheless, a general conclusion from the literature of numerous studies is that plant diversity on permanent grassland, and on field margins, is generally (though not necessarily) favoured by organic management, and that birds, aquatic fauna, butterflies and other insects are widely reported to benefit from organic farming.

Soil quality

Organic standards include protecting fertility through the maintenance of organic matter and development of soil biological activity. Indicators of soil quality, e.g. dehydrogenase levels and bacterial and fungal counts, are higher on soils under organic management than on inorganically fertilised soils (Bardgett *et al.,* 1997). Long-term benefits associated with organic farming (not specifically grassland) include greater top soil depth, more moisture retention and reduced soil erosion (Reganold *et al*., 1987).

Carbon sequestration and energy conservation

Agriculture contributes to CO_2 emissions from fossil energy consumption and from breakdown of soil organic matter during cultivation. CO_2 emissions from grassland farming can be offset by carbon sequestration (32 t/ha C accumulation of over 50 years when arable land is converted to [conventional] permanent grassland; Armstrong Brown *et al*., 1997). Organic farming results in higher soil organic matter, and a more efficient CO_2 budget relative to conventional agriculture (Kopke & Haas, 1996). Reduced use of fossil energy on organic grassland (e.g. omitting N fertilizer) also results in reduced CO_2 emissions. There are also potential economic implications associated with C sequestration. The Kyoto Protocol specifically mentions human-induced land management as a provider of sinks for greenhouse gases (GHGs) for which sequestration credits can be claimed. A carbon sequestration value under organic grassland of £3-£20/ha/year can be attributed (see Crabtree, 1997). There is further scope for energy savings from agriculture generally through local marketing of farm produce. On balance, low input grassland has C sequestration benefits relative to arable and intensive grassland, but C sequestration would be higher under a land use comprised of forest, rough grassland and blanket bog (Adger *et al*., 1992).

Nutrient balances and gaseous emissions

Whole-farm nutrient budgets are becoming increasingly accepted as a way of describing nutrient flows within farming systems (Stockdale *et al*., 2001). Livestock enterprises on grassland are inherently 'leaky' in terms of nutrient utilisation, particularly of N. There is a need to consider whether organic grassland performs better in this context than conventional grassland, and thereby be considered as having a nutrient-conservation function. The loss and conservation of nutrients depends more on grazing stocking rates, timing of cultivation and optimisation of nutrient management than whether grassland is specifically organic or conventional. However, in addition to the generally lower stocking rates on organic grassland, there is further potential for better nutrient conservation within the soil-plant-animal system associated and the substitution of N-fixing legumes for inorganic N. Improvements in soil structure and well-developed rooting systems may further improve nutrient uptake by plants. Grassland farming also contributes to emissions of GHGs (NH_3, CH_4 and NO_x). Although emissions of these gases per hectare are typically lower on organic than conventional grassland, on a unit output basis organic systems may fare worse because of the greater numbers of animals required to produce the same quantity of livestock products (e.g. Subak, 1997; Moss & Jarvis, 2001).

Social and economic functions

Whilst economic functions of grassland are generally perceived mainly in commodity terms (the value of produce at the farm gate in relation to costs and subsidies) there is a further need to consider external costs and benefits. Although all agriculture imposes external costs, organic management arguably goes some way to recognising the need for trade-offs and meeting other, non-production, targets. Organic grassland farming (and other low-input systems which seek to deliver environmental benefits) have potential for enhanced economic value, e.g. through greater recreational opportunities and on-farm and off-farm agro-tourism enterprises and farm-shop marketing of local organic produce. Research on the social impacts of organic farming are limited (Morris *et al*., 2001). Social functions are often, unfortunately, conflated with economic functions, but there are benefits that go beyond pure monetary valuation. These include improved self esteem and quality of life (e.g. Rickson *et al*., 1999), and the strengthening of community ties between producers and their locale. There is a significant labour impact resulting from organic conversion. There are also important functions that arise from increased biodiversity that go beyond compliance with policy targets, and biodiversity improvements create further social benefits (Cobb *et al.,* 1999). Questions also arise about inherent values of nature and the ways in which people 'use' nature, including passive existence valuations (Freyfogle, 1998).

DISCUSSION

There is strong evidence that organic grassland farming can deliver a range of environmental benefits including management systems that are favourable to the survival of many threatened farmland habitats and species, improved soil quality, and better utilisation of nutrients. There are also on-farm and off-farm social and economic benefits. Issues that remain unanswered or partly answered include the time scales of environmental and biological change following conversion of conventional to organic management, and the effects of components of organic management versus system effects.

A clearer vision of how humans fit within the rest of nature needs to emerge and agricultural grassland management considered within a wider context of the ethics of land health; what Leopold (1949) described as the 'integrity, stability and beauty' of ecological communities (Freyfogle, 1998). Conservation and agricultural policies also need to evolve to meet the environmental and social challenges posed by climate change and declining resources, with greater emphasis on connectivity between food producers and consumers, and land use that incorporates recreational opportunities, carbon sequestration, biofuel production and managed wilderness, alongside the functions described here.

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