Developing Sustainable Agriculture

IAN BOWLER

ABSTRACT: Throughout the world, agriculture is under pressure to develop as a more sustainable economic activity. This article first summarises the causes of the unsustainability of modern farming, then describes three emerging approaches to the development of a more sustainable agriculture: namely, the production of environmental goods, integrated farming systems and alternative agricultures. To-date, none of the three approaches has been widely implemented and the final section reviews the potential of different institutional structures adopted around the world to promote and implement sustainable agriculture. A continuum of structures is identified, ranging from voluntarism, through local knowledge communities, to state regulation. It is concluded that a sustainable agriculture requires a new social contract between food producers, food retailers, food consumers and the state, set within an holistic rather than disintegrated framework of local development.

THROUGHOUT THE WORLD, agriculture is under pressure to develop as a more sustainable economic activity, but the context for such development is complex. For example, national and regional heterogeneity can be observed in such features as the natural resource base (e.g. climate, soils and topography), the level of technical development in farming, farm-size structure, and the orientation of farm production (e.g. between milk, cereals, and vegetables). In addition agriculture varies in its significance within economy and society, for instance in its contribution to gross domestic product (GDP) and employment at both national and regional levels. Moreover, in developed countries 'sustainability' issues in agriculture have become conflated with wider concerns over food health and food quality; whereas in developing countries poverty and population pressure are more significant factors. In both groups of countries, agriculture is having to develop under an emerging neo-liberal trading regime supervised by the World Trade Organisation. Thus, from the outset, agriculture offers a complex and varying context for its sustainable development and a 'one size fits all' approach is unlikely to succeed. Nor is the constitution of sustainable agriculture clear. Other articles in this issue show how the concept of sustainable development is both socially constructed and contested so that, unsurprisingly, no agreed definition for agriculture exits. Nevertheless a consensus of informed opinion recognises three dimensions in sustainable development – environment, economy and society – which can be applied to agriculture. Most attention tends to be given to the *environmental* dimension, including the reproduction of natural capital (such as soil and water), the enhancement of biodiversity, and the recycling of farm wastes and nutrients so as to avoid pollution of the biosphere, especially water resources. The *economic* dimension concerns the maintenance of supplies of agricultural raw materials and services to both the farm and non-farm populations, but including the attainment of satisfactory levels in the economic returns to farm land, labour and capital, and the costs of state subsidies to farming. Here the definitions of 'satisfactory' are contested between farm and non-farm interests and are largely determined through the political process. On the *social* dimension, sustainable development includes the retention of an optimum level of farm population, the maintenance of an acceptable quality of farm life, the equitable distribution of material benefits from economic growth, and the building of 'capacity' in the farm community to participate in the development process, including the use of knowledge to create new choices and options over time. Here the constitution of 'optimum' and 'equitable' is contested. In the development of sustainable agriculture, these three inter-related dimensions, sometimes equated with natural, human-made and human capitals respectively, are pursued simultaneously. The broad aims, therefore, are to achieve environmental stability, economic profitability, productivity in terms of maintaining food supplies to the non-farm population, and support for the rural community (Brklacich *et al.*, 1991; D'Souza and Gebremedhin, 1998).

The basis of unsustainable agricultural development

The causes of unsustainable agricultural development are well known, as are the negative

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impacts on the environment, economy and society (Young, 1991). This section merely summarises the main arguments.

Unsustainable agriculture is commonly traced to a period of farming development in the late twentieth century termed 'productivism' or 'the second food regime' (Le Heron, 1993). The following key processes are implicated: the modernisation of farming practices; the incorporation of the farm sector into an industrialised food supply system for mass markets; and strong state protection for agriculture. Modernisation in agriculture, for example, involves the processes of intensification, concentration and specialisation (Bowler, 1992a). *Intensification* describes the rising level of purchased agri-inputs (e.g. new technologies for fertilisers, agri-chemicals and farm machinery) and increases in outputs per hectare of farmland of both crops and livestock products. The term *concentration* summarises the competitive market process that drives the least economically successful farm businesses from agriculture and enables their land to be purchased by the remaining, larger, more successful businesses. *Specialisation* in agriculture enables farm businesses to gain economies of scale by limiting production to fewer products on the farm and so concentrate the costs of production on a narrow range of crops and livestock (e.g. monoculture). To these developments *internal* to farming can be added the incorporation of agriculture into *external* national and global food supply systems dominated by non-farm capitals (i.e. agri-inputs corporations, food processors and food retailers). Non-farm capitals can control both the input costs to farming and agricultural product prices; they are able to place downward economic pressure on farmers to apply cost-reducing and output-increasing farm technologies. Forward contracts between farmers and food processors or retailers, for example, commonly specify the farm technologies to be employed, as well as the product price to be received; they are now being introduced into developing countries by non-farm capitals located in developed countries (Barrett *et al.*, 1999). *Intervention by the state* has been deeply implicated in many of these developments throughout the world. Summarising, the state has: subsidised programmes of farm modernisation to raise the level of intensification in agriculture; supported product prices received at the farm gate, thereby maintaining the capacity of farmers to invest in new technology; funded education and extension services, whereby advice and information on new farming technology is diffused through the farm population; and subsidised research and development in the production of new farm technologies (e.g. experimental farms and research laboratories).

Considerable research has been devoted to recording the negative impacts of these processes in creating a model of agricultural development that is unsustainable. Looking first at the *environmental* dimension, a wide range of surveys around the world has recorded the following problems (e.g. Young, 1991; Blume *et al.*, 1998; Kronert *et al.*, 1999): the loss of biodiversity (e.g. wetland, moorland and forest); the nitrification (pollution) of groundwater and eutrophication of watercourses from the use of inorganic fertilisers associated with increases in arable land; rising levels of soil erosion and salinity; the lowering of water tables from the draining of wetlands; the increased incidence of soil compaction; the discharge of pesticides into rivers; pollution of ground water by wastes from intensive livestock units; and overgrazing of pasture land. On *socio-economic* dimensions, attention has been directed to the excessive, and now unsustainable, financial costs of state farm subsidies in many developed countries, as well as the food surpluses that they have generated.

Despite state intervention, farm incomes have remained under pressure, especially relative to the rising incomes of the non-farm population; consequently the farm population in most countries has continued to leave the countryside for urban areas and non-farm employment, thereby threatening the viability of the rural communities left behind. The *food health/quality* dimension comprises the most recent concern about the sustainability of the productivist model of agricultural development. Awareness of the risks attached to the consumption of high fat and high protein products, such as red meats, dairy products and eggs, in relation to heart disease and obesity, has increased. In addition, concern over sugar, salt and chemical additives in processed food is growing, together with rising figures on the incidence of food allergies (Atkins and Bowler, 2001). Also there has been a series of well-publicised food problems, such as pesticide residues in vegetable foods, salmonella and *E. coli* infection in eggs and meat, variant Creutzfeldt-Jacob disease (vCJD) from beef cattle infected by bovine spongiform encephalopothy (BSE), the use of growth-promoting hormones and antibiotics in animal feeds or through direct injection into livestock, and the inclusion of genetically modified organisms in food products.

The production of environmental goods

A search for sustainable agriculture has emerged from the recognition that modernised farming and industrialised food production is unsustainable and a wide range of 'indicators' of sustainable agriculture has been proposed by researchers for this purpose (Table 1). Three broad models have emerged: (1) the production of environmental goods, (2) integrated farming systems, and (3) alternative agricultures. The three models exist along a continuum of required change in productivist agriculture, from relatively low levels of change in model (1), to high levels in model (3).

Looking first at the production of environmental goods, three broad sub-models can be identified: extensification, the regulation of the externalities of agriculture, and agri-environmental measures.

Extensification

Extensification implies the phased reduction by farmers of their inputs of fertilisers and agri-chemicals or stocking densities of livestock; environmental gains have been expected from reduced inputs to farming following the withdrawal of state intervention and the lowering of farm price supports (i.e. 'perverse subsidies'). While there is some research evidence of reduced inputs, demonstrating a relationship with environmental gains is problematic, not least because farm businesses have to respond to other forces in maintaining their economic viability, such as increased global competition. Brouwer and Lowe (2000), for example, despite an extensive survey of changes to farm support mechanisms in the European Union (EU), were able to demonstrate only weak and generalised relationships between post-1992 reforms to the Common Agricultural Policy (e.g. reductions in product price subsidies) and environmental benefits.

The regulation of the externalities of agriculture

Another approach has been through the regulation of the externalities of agriculture, including the enforcement of codes of conduct in farming practices (e.g. the handling and spraying of pesticides or the use of growth-promoting hormones in livestock), legal prosecution for failing to observe prescribed practices (e.g. on the seasonality of spreading animal manures, including the uncontrolled discharge of livestock slurry and silage effluent), and the granting of licences for environmentally damaging practices (e.g. the cutting of woodland, the grubbing-up of hedgerows, the draining of wetland or the filling-in of farm ponds). Alternatively, some farmers have been offered financial compensation for amending their environmentally damaging farming practices (e.g. for lower crop yields associated with reduced fertiliser applications in nitrate vulnerable zones (NVZ) within the EU), or investing in pollution control measures (e.g. effluent storage tanks). Overall, regulations have placed constraints on damaging economic activities but with narrowly defined environmental benefits.

Agri-environmental measures

State-funded agri-environmental measures also contribute to the production of environmental goods, such as herb-rich meadows, moorlands, wetlands and heathlands. Indeed one feature of recent agricultural policy making has been the redirection of state farm subsidies from price supports for the production of food towards payments for the production of such environmental goods (i.e. conservation compliance). This approach has been underpinned recently in the UK by a report from the Policy Commission on the 'Future of Farming and Food' (Policy Commission, 2002). The outcome, at least in western Europe, has been a broader role for farmers in the application of more environmentally sensitive farming practices. In

Table 1
Examples of agri-environmental indicators in sustainable agriculture

Biodiversity	Management
Number and variety of breeding birds	Damage to designated and protected areas
Level of plant diversity in hedgerows	Nitrogen usage per unit area
Level of habitat fragmentation	Pesticide usage per unit area
Number and variety of mammal populations	Length of landscape linear features

Source: adapted from Moxey *et al.*, 1998.

Table 2
Criticisms of agri-environmental programmes (AEPs)

- A means of directing state money towards marginal farmers in an era of otherwise falling subsidies to agriculture.
- Fail to bring about changes in the attitudes and behaviours of farmers that outlast the programme.
- Participating farmers are drawn disproportionately from those with resource-poor farming systems, rather than from those with industrialised farming systems.
- Land ownership change can have either constructive or destructive consequences for AEPs at the farm level depending on the motives of the new owner.
- Participating farmers tend to implement narrowly defined schemes of environmental conservation rather than sustainable development on a whole-farm plan basis.
- Entry into contracts under the AEPs is voluntary with no overall planning, co-ordination or integration of developments; environmental benefits are achieved in isolation from each other.
- Farmers in AEPs tend to receive financial aid to continue with those pre-existing farming systems deemed to be environmentally sensitive, rather than to change their farming methods significantly.

Source: consolidated from various publications by Bowler, 2002.

the EU, for example, a range of national Agri-Environmental Programmes (AEP – Regulation 2078/92) has been developed, representing a shift in the conservation effort away from designated sites (e.g. national parks, nature reserves, sites of special scientific interest) and towards more extensive tracts of countryside (Wynne, 1994). Each member state has been required to develop and implement its own national programme, with up to 50% of the cost paid by the European Agricultural Guidance and Guarantee Fund (EAGGF). Even so, the proportion of the EAGGF spent on agri-environmental measures remains below 5%, while evaluations of AEPs at the farm level have raised a number of criticisms – summarised in Table 2. The most significant limitations of AEPs appear to be their fragmented spatial implementation, time-limited financial support, and narrowly defined environmental benefits.

Integrated farming systems

Integrated farming systems (IFS) – a term which includes integrated crop management (ICM), integrated livestock management (ILM), integrated pest management (IPM) and agro-forestry (AF) – offer another approach to achieving sustainable agriculture. In the United States, the 1980s LISA programme (Low Input Sustainable Agriculture – later the Sustainable Agriculture Research and Education programme: SARE) became one of the better known institutionalised examples of this approach (D'Souza and Gebremedhin, 1998). IFS involve farmers in embedding a range of sustainable farming practices within existing farming systems, but on a whole-farm basis. These practices include: crop rotations for land use diversity; biological controls for crop pests and fungal diseases to reduce, but not replace, all agri-chemicals; the management of field margins to increase biodiversity and create habitats for predators of crop pests (e.g. beetles and parasitic hymenoptera); the use of green and animal manures to reduce, but not eliminate, inputs of inorganic fertilisers; and practices to manage water and combat soil erosion (e.g. minimum cultivation, winter cover crops and contour ploughing). Called a 'third way' between conventional and alternative agricultures by Morris and Winter (1999), these practices leave the final farm product largely unchanged and are less stringent in requiring alterations to existing farming systems. Rather the aim is a multi-goal approach to secure, simultaneously, food production, income and the environment on a whole-farm basis: Tilzey (2000) extends this aim to a 'whole countryside' approach. Pretty suggests that, under IFS, industrialised farming could yield environmental benefits from less intensive production while retaining its profitability; Green Revolution farming could maintain its present level of food production with environmental gains; while the productivity of resource-poor farming, characteristic of agriculture in many developing countries, could increase under 'sustainable intensification' (1995, p. 20). The first two types of farming are more embedded in the logic of capitalist accumulation than the third, so that the adjustments needed to current farming systems face more resistance. Pretty (1995) further argues that where positive results have been achieved with IFS, especially in resource-poor developing countries, they are the outcome of the interaction between locally adapted resource-conserving technologies, co-ordinated

action by groups or communities at the local level, and supportive external government and non-government institutions working in partnership with farmers.

However, whole-farm IFS have not been widely diffused through the farm community: surveys with farmers reveal that IFS are still perceived as too risky in delivering required volumes of agricultural produce for economic viability. Compared with conventional agriculture, new types of information, knowledge and management skills are needed to implement the more complex and risky (e.g. biological control of pests) farming practices of IFS. With networks of agencies to provide the necessary information emerging in many countries, the main problem remains in recruiting a sufficiently large number of farmers to participate in acquiring new, and sharing existing 'local' knowledge and skills.

Alternative agricultures

A range of proposals for alternative agricultures has emerged over the years (e.g. Merril, 1976; Edwards *et al.*, 1990; Curry-Roper, 1992). Alternative agricultures cover a range of philosophies on sustainable farming, including ecological, biodynamic, humus, low external input, permaculture, biological, resource-conserving and regenerative systems. The distinctions between them and conventional agriculture are summarised in Table 3. In more detail, the following range of principles is advanced: the holism of a farming system; a return to national crop-based (protein) diets so as to remove the inefficiencies associated with feeding cereals to livestock for intensive meat and milk production; a reduction in the fossil fuel inputs to farming (e.g. as inorganic fertilisers, agri-chemicals or diesel for engine power); a return to polyculture; a return to national and regional self-reliance in food production; the maintenance of smaller farming units; the absence of inorganic fertilisers and agri-chemicals; multifunctional land use; minimum soil cultivation; the reintegration of crop and grass-based livestock farming; crop rotations; organic manures; nutrient recycling; low energy inputs; and biological pest and disease control. Together the principles offer a challenge to most of the features of the industrial model of productivist agricultural development.

Looking at organic farming as one type of alternative agriculture, emergent producers in developed and developing countries alike have tended to polarise (Bowler, 1992b). On the one hand are those who are in small-scale production, retain the original environmental philosophy of the first organic farmers about the simplicity of food production, distribution and consumption, and who supply mainly local markets through market stalls, farm shops, small retail outlets, or vegebox deliveries direct to consumers. When such producers form co-operatives, as is happening in some developing countries (Barrett *et al.*, 1999), they are able to supply mass markets. On the other hand are the large, commercial producers, supplying organic produce in volume to supermarket chains or wholesale markets through national and international trade (Monk, 1999). These producers are motivated mainly by commercial considerations and may not even have all of their farmland under organic

Table 3
Characteristics of conventional and alternative agricultures

Conventional agriculture	Alternative agricultures
Centralisation	*Decentralisation*
National and international production, processing and marketing	Local/regional production, processing and marketing
Concentration of resources	Dispersed resources
Fewer farms	More farms
Individualism and competition	*Community*
Self interest	Increased co-operation
Reduced labour	Meaningful labour
Farming as a business	Farming as a way of life
External costs ignored	All costs considered
Material success	Non-material values
Scientific paradigm	*Reconceptualisation of science*
Specialisation	Diversification
Standardised production	Localised production
Farming components	Agroecosystems

Source: adapted from Curry-Roper, 1992.

production. Locationally, the small producers tend to cluster either around their markets in the large urban conurbations or on marginal land where entry costs to organic production are relatively low. In contrast, the larger producers tend to locate in farming regions traditionally associated with the production of the crop or livestock concerned, where organic food offers an alternative and growing market opportunity. Organic farming has been encouraged by state-validated certification schemes (e.g. United Kingdom Register of Organic Food Standards – UKROFS) and financial compensation for loss of income while the transition is made from conventional agriculture to certified organic production. The transition can take from two to five years, depending on regulations in particular countries, and during that time crop and animal yields are reduced without benefit of the higher price premium that certified organic food attracts. At present, few states provide subsidies to organic farming once it is established – returns have to be gained through the market. Evidence to date suggests that organic farming yields positive environmental gains in biodiversity, for instance through increased and diversified populations of insects, wild flowers, mammals and birds, together with enhanced soil structure and lower levels of soil erosion (Arden-Clark, 1988). However, there are also associated environmental problems, for example diminishing soil fertility through nutrient leaching, increased soil acidity, and heavy metal accumulation in the soil; but the problems are less than in conventional agriculture (Conacher and Conacher, 1998). Moreover, organic farming, because it is more labour intensive, supports more jobs per hectare of farmland and thereby contributes to the social sustainability of the farm population and rural society. Evidence on the economic sustainability of organic farming is more mixed: comparisons of organic with conventional farms do not reveal systematic differences in economic returns. Organic farming produces lower outputs per hectare but is compensated by higher output prices. Much depends on the relative efficiencies and sizes of the farms being compared and the prices for their respective produce at the time of the survey. While organic farms are capable of producing economic returns equal to those of conventional farms, the lower productivity per hectare of the former is unable to produce the volumes of food necessary to support the urban-industrial population.

Institutional structures for developing sustainable agriculture

To-date, none of the three models of sustainable agriculture has been widely implemented (OECD, 1995) and this section reviews the potential of different institutional structures to promote and implement them. A continuum of structures can be identified, based on the degree of intervention by the state, ranging from voluntarism, through local knowledge communities, to state regulation.

Voluntarism

Voluntarism is the most widely applied approach in developing sustainable agriculture. The state is often involved in providing financial incentives to produce, for example, a particular environmental good, organic food or environmentally sensitive farming practice. But responding to such financial incentives remains a decision for the individual farmer and the outcome is a spatially varied and largely unco-ordinated development of sustainable agriculture. Indeed this problem confronts the delivery of such approaches as the 'Natural Areas' proposed by English Nature (Tilzey, 2000). Equally, the market for food from sustainable agriculture relies on voluntary purchases by consumers at prices higher than conventionally produced food. For example, despite a recent upsurge in demand, organic farming is still supported by only a minority of consumers as an expression of their concern for the environment and the consumption of quality foods. Social élites are prepared to pay premium prices for such foods – often twice or three times the cost of conventional foods – and in developed countries larger retailers have responded to this market opportunity by placing more organic produce on their shelves. This development has not been without its problems: large retailers still insist on high volume production and high standards in the grading and quality of their merchandise, including through contracts placed with growers in developing countries (Monk, 1999).

Knowledge communities

One of the resistances to the diffusion of sustainable agriculture lies in the risks attached to implementing a relatively unknown set of technologies as far as the individual farmer is concerned. One approach to overcoming such resistance is the formation of local knowledge communities through the provision of research, demonstration farms, farmer training courses, student education

courses and outreach by extension workers. All of these provisions can be made using existing research, educational and advice services of the state, but requires further reorientation of institutional priorities away from supporting conventional agriculture. Often drawing on such provisions, farmers interested in developing sustainable agriculture have begun to form their own knowledge communities, again on a voluntary basis. A model for such development exists in the form of Landcare groups, which originated in Australia (Curtis and De Lacy, 1998) and, as a form of organisation, are now diffusing to other countries, such as in the Environmental Farm Plan programme in Ontario (Hilts, 1997). The state commonly supplies financial support to fund the salary of the co-ordinator of such community groups. Components of IFS, for example soil and water-conserving tillage, can be applied by the collaborating farmers to whole farms and water catchments as they share 'local' knowledge and skills about sustainable agriculture.

Regulation

Attention was drawn earlier to the positive role that the state can play in the regulation of agriculture. One role is to curb the worst excesses of environmental pollution and implement sustainable farming practices, although to date no government has forced a full internalisation of environmental costs on the farming community (i.e. the 'polluter pays' principle). A second role is to remove the 'perverse subsidies' that support productivist agriculture, and this is underway in many developed countries, including the EU. More recently the state has become involved in regulating the outputs from agriculture (i.e. food quality), thereby addressing the increasing consumer resistance to 'industrial' food production, as articulated by interest groups based on the environment, community-supported agriculture, food health, genetic resources conservation, animal rights, rural social justice, consumer preference (e.g. organic food), non-traditional medicine, and ethnic cuisine. So-called 'Green' consumerism within social élites in developed countries provides the necessary market base for the production of 'quality food' (QF). 'Quality' here implies a food product that is differentiated in a positive manner from the standard product by reason of one or more factors (Ilbery and Kneafsey, 2000). Such factors include the association of a food with a particular location, the specification of the method of production (e.g. organic farming), the certification (traceability) of the food with a quality label (e.g. Quality Assurance Scheme – QAS), and the attraction of the food in terms of its taste or texture.

Supermarket chains, working with large producer groups (e.g. farmer co-operatives) and industrialised farm businesses, have recognised the market opportunity for QF by establishing their own self-regulated QAS. While such QAS guarantee food health/safety/animal welfare standards, they tend to deal with mass-produced food and have little explicit regard for sustainable agriculture *per se*. However, QF are also produced by small farm businesses processing their own produce, or by non-farm businesses assembling and processing raw materials produced on farms in the local area or region (e.g. organic food, hams, meats, yoghurts, farmhouse cheeses, wines, berries, fruit and meat pies). Moves to 'institutionalise' alternative forms of food production have been extended in the EU: under Regulation 2081/92 on the protection of geographical indications (PGI) and the protection of designations of origin (PDO); Regulation 2082/92 on certificates of special character (CSC); and Regulations 2092/91 and 2083/92 on biological agriculture (labelling and inspection). At the time of writing, nearly 500 products were protected by PDO and PGI regulations within the EU, with their associated guarantees of quality.

Conclusion

There is little evidence at a global level that sustainable agriculture is being promoted widely. Productivist agriculture remains the dominant model of agricultural development under increasingly neo-liberal trading relations, particularly given its ability to produce food in the volumes necessary to feed a growing world population (Atkins and Bowler, 2001). At best palliative measures are being implemented to curb the worst environmental, social and economic symptoms of unsustainable agricultural development. Nevertheless, from this analysis, IFS, on a whole-farm basis, appear to offer the most pragmatic, although still problematic, way forward in achieving more sustainable farming. IFS allow conventional farming systems to be significantly modified, without requiring the complete changes in farming methods associated with alternative agricultures. Even so the successful implementation of alternative models of sustainable agriculture requires the support of a new social contract between farmers, food processors/retailers, consumers and the state. In

effect new food networks are needed, with consumers reconnected to the sources of their food supply after the dislocation caused by the industrialisation of the agro-food system. Several commentators make the case for this reconnection to be made at local rather than national or global levels (e.g. Couzens, 2001), thereby recognising the heterogeneous context for agricultural development. Nevertheless, many farmers, in developed and developing countries alike, will elect to further intensify their production, with no environmental gains. Others will adjust by extensifying and diversifying their land uses, including IFS, to yield some environmental benefits. A minority seem likely to develop alternative agricultures. Without strong regulation, sustainable agriculture will continue to develop on an adventitious and spatially fragmented basis.

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Ian Bowler is a Professor of Human Geography in the Department of Geography at the University of Leicester, Leicester LE1 7RH (e-mail: irb@le.ac.uk, tel: 0116 2523837, fax: 0116 2523854).