WORKSHOP ON
SUSTAINABLE AGRICULTURE
TECHNOLOGY AND PRACTICES

AGENTS FOR CHANGE
Summary Report from the OECD Workshop
on Sustainable Agriculture
Technology and Practices

February 11-13, 1992

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
Paris 1992
CENTRAL FINDINGS

OECD countries are concerned about the degree to which agriculture is contributing to environmental problems, particularly water and air pollution, land degradation, and a decline in landscape amenities and biodiversity. Using a range of management and technical options which optimize input efficiency and minimize environmental impacts, farmers can sustain and enhance environmental quality. Efforts to combine the knowledge and experience embodied in existing practices and programmes with that in older, traditional and newer, alternative more "environmentally friendly" agricultural systems are creating new pathways to a more environmentally sustainable agriculture.

Workshop participants recognized the wide diversity of more environmentally sustainable agriculture systems already in place or which are gradually emerging. Sustainable agriculture is not a concretely defined set of management strategies and technology, but rather an approach which targets the enhancement of natural processes, a reduction of production costs related to synthetic inputs, sustained and efficient production of agricultural products, and a reduction of human health and environmental impacts of production techniques. The workshop was a watershed event in that the discussion was clearly framed within the context of this diversity and flexibility and markedly moved beyond the antagonistic, overly simplified paradigm which has often pitted industrial agriculture against organic systems. The new paradigm recognizes that information, technology and equipment, and management skills drawn from a range of systems will provide the foundation for the farming practices of the future that by necessity will be increasingly sensitive to all on-farm and off-farm ecological, environmental, and human health impacts.

It is a central finding of the OECD workshop that environmentally and economically viable alternative agriculture systems can be, and have been, achieved. Many practical applications of sustainable techniques, from both biological/organic agriculture and integrated/low-input agriculture, have long records of success and have been shown to produce acceptable yields and quality products with fewer on-farm and off-farm impacts, at a reduced long-term cost to the farmer and to society. Participants were advised that adoption of systems which were less dependent on chemical inputs did not mean a return to low-technology farming and the associated risk of insufficient food production. Indeed, many currently successful sustainable systems rely on systems management which is information- and technology-intensive.

* The workshop is part of a cross-directorate OECD Programme on Technology and Environment, which is seeking to identify environmentally sustainable technologies in key economic sectors and evaluate policies and mechanisms which Member governments might pursue to stimulate innovation and diffusion of such technologies. Further information can be obtained from the OECD Environment Directorate, 2, rue André Pascal, 75775 Paris Cedex 16, France.
CONCEPTS AND PRINCIPLES FOR SUSTAINABLE AGRICULTURE

What is sustainable agriculture? Within the context of OECD discussions it is inappropriate and misleading to impose a rigid definition of sustainable agriculture. Countries and even regions within the same country work within different social, economic and environmental contexts; consequently, some countries currently consider only air, soil and water protection, while others also include flora and fauna, landscape amenity, energy, or climate change when assessing the impacts of agriculture on the environment and when setting agricultural and environmental objectives. Nevertheless, within the diversity of objectives that countries set for agriculture and the environment, there is an emerging consensus that sustainable forms of agriculture are characterized by the adoption of practices and technologies that:

- use integrated management techniques which maintain ecological integrity both on and off the farm;
- are necessarily site-specific and flexible;
- preserve biodiversity, landscape amenity and other public goods not valued by existing markets;
- are profitable to producers in the long-term; and
- are economically efficient from a societal perspective.

A number of countries also asserted that arrangements that preserve cultural values should be encouraged as part of structural adjustment processes.

Workshop discussions about defining sustainable agriculture also looked at the agricultural sector in a wider perspective and highlighted additional linkages between agricultural activity and broader questions of sustainable development in general. In this context, participants emphasized the need to:

- recognise and address the full range of potential on-farm and off-farm environmental and human health effects of agricultural activity,
- reduce global dependency on fossil fuels and conserve energy,
- address potential human impacts through agriculture and animal husbandry practices on global climate change,
- address questions of human and animal health, and animal welfare,
- improve land use management strategies, including reforestation, and
- develop the ability to monitor the condition of ecological resources.
Participants also made the point that any definition of sustainable agriculture must include both human and environmental dimensions. The human dimension includes two key components:

1. The farmers:
   • who are on the cutting edge of sustainable agriculture, and
   • who will only adopt sustainable practices if this can be done without sustained financial loss and if they have access to research and extension facilities (information).

2. The consumers:
   • whose demand for a safe, quality food supply must be recognized, and
   • who must be educated about the full social costs of agricultural products in the absence of accurate market values which make otherwise hidden environmental costs visible.

Finally, participants stressed that sustainable forms of agriculture require a systems approach both in terms of on-farm management of resources and also in a wider socioeconomic context of national resource management, food production, and on-farm employment. This in turn requires better recognition by farmers, consumers and governments of the short- and long-term effects of particular agricultural practices on the integrity and productivity of natural resources. It also requires heightened cooperation among these groups to define and achieve environmentally sustainable agricultural systems. Particular attention also needs to be paid to marketing systems, which have a powerful influence on encouraging or discouraging the adoption of sustainable agricultural practices.

What becomes clear is that sustainable agriculture is a system of technologies and practices not only to ensure satisfactory production, but also to achieve environmental objectives. Accordingly, those environmental objectives must be identified, and monitoring capacities must be developed that evaluate progress towards achieving these objectives and which facilitate the possibility of strengthening land management from an ecological perspective.

CHALLENGES

In its pursuit of pathways and policy frameworks that will make agriculture more sustainable, the workshop sought to identify:

• the potential of known or emerging practices and technologies to provide agricultural products without degrading the environment,
reducing long-term economic viability, or compromising the interests of future
generations (minimising the use of agrichemicals, conserving soil, water,
biodiversity, etc.);

- research priorities and technical opportunities to promote a
transition to more sustainable forms of agricultural development; and

- economic, institutional and cultural barriers to the development
and adoption of sustainable agricultural practices and
technologies.

TECHNICAL OPPORTUNITIES

Workshop participants** -- agricultural producers and advisers, researchers,
OECD government policy makers, and agricultural and environmental non-
governmental groups -- identified many field-tested practices and technologies
currently in use in more sustainable agricultural operations. In some cases
minor modification to conventional practices are all that appear to be
necessary while in other circumstances substantial reform may be required.

In separate sessions on cereals/grains and on fruits/vines/vegetables,
delegates gave details of multi-year, whole-farm use of practices such as strip
cropping, intercropping, and the use of ridge tillage. In each case, speakers
provided data showing that the use of off-farm purchased inputs, including both
synthetic fertilizers and pesticides, was either significantly reduced or
completely eliminated while sustaining or increasing profits. Responding to a
recurrent theme of the workshop that no agricultural practice will be truly
sustainable if it is not cost-effective, the speakers also provided data
showing that many of these practices have proven to be fully competitive with
more conventional methods at current relative prices. Indeed, examples of
extensive commercial-scale field testing were given where the farmer’s net
return was improved by reducing to a minimum or eliminating the use of
synthetic fertilizers and pesticides.

In another session on animal husbandry, particular interest focused on the
issues of both the management of manure generated by intensive livestock
operations and the related overall problem of dealing with nutrient excesses
at regional or national levels. In the spirit of seeing every problem as an
opportunity, speakers reported on the development of nutrient-management
solutions which take such forms as legislatively fixed limits on the timing
and dosage of applications (i.e., no fall or winter field application of
manure, split spring applications timed to match plant needs, etc.) and new
equipment for storing manure and applying liquid manure in the sub-surface to
both enhance uptake and reduce volatility problems. Sub-surface applications,
however, may not be appropriate where groundwater contamination is a potential
problem.

** See Profile of Workshop Participants, pp. 15-16.
In the case of relatively new manure storage and spreading equipment, as for other sophisticated new equipment in general, a number of farmers and farm-group representatives pointed out that the high cost of such equipment currently impedes their use except for the largest-scale farming operations. Accordingly, these speakers called for governments to increase financial support for the purchase of such equipment where warranted by the environmental gains from their use. In contrast, other countries expressed the view that no forms of pollution control should be subsidized, consistent with the OECD Polluter-Pays Principle. In addition, some countries asked whether, despite waste management efforts, highly intensive livestock operations can be considered as sustainable.

Integrated systems

Extensive discussions centred around the recently accepted view that converting to more sustainable agricultural systems will require a high level of management skills on the farmer’s part. Speakers went into detail concerning the complex interactions which must be closely tracked at the farm level in order to minimise use of synthetic pesticides and to reduce such adverse off-farm effects as the degradation of downstream and underground water supplies, which can result from both fertilizer and chemical pesticide runoff.

For fertilization, not only must manure and/or synthetic fertilizer applications be carefully matched to current plant requirements, but a farmer’s livestock numbers must be carefully calculated beforehand to ensure that the manure produced will not exceed the amount that the farmer will be able to store or dispose of in an environmentally acceptable way at appropriate times during the coming year (taking particular account of the level of nitrogen and phosphorus in the soil). Ecological interactions are also complex for the grain or vegetable farmer operating without livestock. For these farmers to reduce synthetic fertilizer use effectively, plant nutrient needs can be monitored on a regular basis using simple tests, and the timing and amount of applications subsequently adjusted to suit plant growth given other factors such as temperature, soil moisture, and possible insect or disease stress.

When irrigation is necessary, a significant reduction of environmental impacts can be achieved through the use of systems which provide the precise amount of water necessary and appropriate drainage in order to avoid erosion and secondary effects on salinity. Technology is still needed to address salinization problems, especially where natural forms of drainage are not available.

With more sustainable practices, farm management itself becomes an essential input, in many ways replacing purchased chemicals and other inputs. Additional costs associated with management-intensive systems may be progressively or entirely offset by savings in other areas, particularly for synthetic chemical input costs. In addition, the farmer’s net return tends to improve when his/her crops command a premium price, either due to organic certification, or where the low-chemical or no-chemical produce is of excellent quality and thus attractive to consumers. Increases in prices of agrichemicals (pesticides and fertilizers) would facilitate a progressive move to these practices.
Erosion Control

Many countries signaled the importance for controlling erosion of ground cover, either by non-harvested plants or inert materials, and preventive measures, such as planting new vineyards according to contour lines. Participants also agreed that mechanized operations must be reduced to a strict minimum and must be accomplished through the use of tractors and tools specifically developed to conserve the soil and ground cover. Similarly, extensive water management structures alone cannot resolve soil erosion problems and must be combined with cultivation techniques that best respect the structural stability of the soil. The agricultural solution for erosion control must be chosen in each case as a function of the characteristics of the soil, potential problems, and the technical and cost constraints of the solution in question.

Pest Management

Alternative pest management strategies have made great advances in recent years, but remain an important challenge for sustainable agriculture. Industrial agriculture has been characterized by high levels of synthetic pesticide use, frequently applied as a preventive measure according to "worst case" expectations with little attention to actual infestation. This practice has become common and is supported by the current marketing practices of the agri-chemical industry, which is often the major supplier of pest control information to the farmer. Current pest control practices in many cases adversely affect water supplies and soil fertility, as well as human and animal health; they are also expensive for farmers. In addition, farmers and researchers pointed to the problem of pests developing resistance -- sometimes within a very short period -- to chemical pesticides. Thus, while the strategic role of appropriate pesticide use in controlling crop losses from specific pests was a recurrent theme, it is clear that new integrated control strategies are needed.

More sustainable forms of agriculture work through the entire crop production system to control crop losses from pests or disease. Integrated systems involve cropping variations (intercropping, rotation), fertilization, tillage practices, scouting for pests, the use of pest or disease resistant plant varieties, the use of biological controls (particularly beneficial insects, pheromones, etc.), and when necessary, precision application of less biologically active pesticides. These strategies work to reduce the opportunities for pest or disease outbreaks and to reduce environmental impacts when chemical treatment is needed. Some speakers noted that in some cases, certain pests have reappeared following the withdrawal of wide spectrum pesticides and that such reappearances can be handled in many instances through the use of monitoring combined with biological measures, such as the introduction of a new predator and/or other control methods.

Speakers also provided specific examples of integrated strategies already at work in the field. In certain cases, farmers have discovered that planting a non-harvested plant between rows of the harvested crop will provide a more attractive feeding or mating site for a particular pest and so prevent damage to the crop. Such strategies, developed on commercial farms, are
typical of sustainable agriculture. Nevertheless, farmers and researchers repeatedly pointed out that constant experimentation with new pest management strategies will be required in order to continually refine and improve sustainable pest management technologies and practices.

There is an expectation that biotechnology could provide a valuable tool for sustainable agriculture if market values for biotechnology products can steer research into more environmentally-oriented directions and into areas that specifically serve the sustainable agriculture community. This is an area where government policy and research funds could stimulate development.

Fertilizers

Considerable attention focused on the synthetic commercial fertilizers favored by industrial agriculture, and on the livestock and "green" manure -- provided by nitrogen-fixing plants -- that organic farmers use exclusively. In both cases, careful nutrient management strategies are required in order to prevent nitrogen run-off into surface water and nitrogen leaching into underground water supplies, which can lead to excessive levels of nitrates in drinking water and subsequent public health concerns.

Speakers emphasized the necessity of careful monitoring of nitrogen carry-over in the soil at planting time, of plant growth, and of rainfall and irrigation effects, as well as the vulnerability of the groundwater. By coupling monitoring activities with detailed knowledge of plant nutrient needs at every stage of the growing period, it is possible for farmers to prevent excess nitrogen availability and thus leaching or run-off.

Farmers and researchers are working to develop new equipment and new strategies for providing precisely calculated nutrients, including nitrogen, phosphorus and potash, at the exact moment they are needed, so that plant growth can achieve its maximum potential without degrading its ecological milieu and causing off-farm effects. Developing the monitoring, storage and application technologies needed to achieve more economically efficient and more environmentally friendly fertilizing practices will require additional funding for multi-disciplinary systems research involving soil scientists, agronomists, hydrologists, and others.

Information as an input

The development and dissemination to farmers of information on new technologies and practices was a key theme in the discussions on developing more sustainable farming practices. It has become clear that sustainable agriculture is not a return to low-technology practices but rather is highly dependent on incorporating field experiences, ecological data, and information on technological advances and new equipment into farm management strategies.
The sustainable agriculture farmer must become a "high-tech" manager capable of working with the complex interrelationships between technology and the environment to achieve acceptable yields and profits while minimising ecological impacts and achieving environmental and public health objectives. Strategies to strengthen professional training as well as the links between agricultural research institutions and extension services and sustainable farmers is needed, both to facilitate the exchange of information between these groups and to focus agriculture research and training on the needs of sustainable agriculture farmers.

Already, sustainable agricultural practices utilise management techniques and equipment that range from conventional equipment modified to meet sustainable farming requirements to the use of computer-aided decision-support systems and the use of sensors that permit the variation of nutrient applications to match precisely-calculated differing soil conditions. Rather than relying on statistical evaluations, the "sustainable" farmer needs to rely on more specialised and interactive information systems, which often involve on-farm testing. With these new systems, the farmer is able to gain access to more specialised recommendations that address the complex relationships which exist between plant growth, weather conditions and soil characteristics.

In the wider context of using information to assess progress in achieving more sustainable agriculture, environmental quality needs to be assessed at farm level, and the impact of agricultural practices measured in relation to declared environmental objectives. One example of emerging methods to "monitor" sustainability is the U.S. Environmental Monitoring and Assessment Program (EMAP) which is developing a systems-level approach to monitoring the sustainability or health of agroecosystems on a long-term (e.g. decades) regional and/or national scale.

Landscape management

Landscape management was an area of active discussion and where opinions differed according to national priorities and perspectives. Thus sustainable agriculture in the context of landscape management was defined differently according to whether the objective is to preserve small farms holdings rather than allow the depopulation of rural areas, to pursue extensive reforestation of cropland to maintain and enhance traditional landscape features and biodiversity, to follow overall criteria of economic sustainability by permitting land allocation in accordance with the most viable agricultural use, or to preserve the productivity and integrity of good agricultural land that would otherwise be taken for other uses.

One proposed resolution to this issue is that systems be developed to assign "environmental values" to particular land uses favored by society as a whole. In this case, direct payments could be offered to farmers who forgo greater earnings by maintaining their land in small farmsteads or other types of favored land use. A further model is the provisions of the conservation measures that have been extended in the U.S. under the 1990 "Farm Act". As a result of these measures, farmers with environmentally sensitive land are able to receive annual or lump sum government payments on a bid basis in return for agreeing to
permanently or temporarily retire this land from cropping and to maintain approved conservation practices on this land, including tree-planting activities. Yet another approach suggested is application of the "Polluter Pays Principle" (PPP) which would tax agricultural inputs (pesticides and fertilizers) and specific cultivation or animal husbandry practices that have negative impacts on the environment, and through this system of disincentives influence farmers’ land use decisions to better reflect environmental concerns. Clearly this area will be the subject of further discussion.

The role of afforestation and reforestation in landscape management, and as part of sustainable farms, was also a subject of active discussion. Forests play crucial roles in economic and ecological systems in erosion control, water regulation, biodiversity, global climate change, and forest product production, recreation, etc. In many OECD countries, and in Mediterranean Europe in particular, reforestation of marginal agricultural lands already plays an important role in environmentally sustainable landscape management. The central role that forests play in global climate change, particularly in the context of deforestation trends in tropical forests, is another compelling reason for OECD member countries to actively reexamine their forestry policies. The request was made during the workshop to consider forestry as an important part of the discussion on agriculture and the environment and to allow more time for discussion of forestry-related matters.

BARRIERS TO THE ADOPTION OF MORE SUSTAINABLE AGRICULTURE TECHNOLOGIES AND PRACTICES

There are many barriers to the adoption of more sustainable forms of agricultural practice and technology. One of the most significant of these barriers is the sheer complexity and sometimes conflicting objectives of existing policies and programmes. The information flows between consumer preferences and production are often masked, and consequently, farmers respond to price signals that do not reflect the full social costs of using the natural resource base. The result, in many countries, has been the emergence of a farming community that lacks the resilience necessary to respond positively to different agricultural technologies.

Market failure to send production signals that are coupled to the environment’s capacity to sustain production is another problem. Where markets for landscape, conservation (soil, water, biodiversity, etc.), cultural and other similar values do not exist, farmers do not pay for the costs of pollution damage, control, or prevention. As a result, price signals do not make consumers fully aware of the impact of agriculture on the environment. Governments, however, appear to be aware of some of these problems and are seeking to resolve them with a variety of national and international responses.
Production assistance programmes

Information supplied by many countries suggested that most forms of production support would fail an environmental impact assessment on the simple grounds that they have the effect of increasing the intensity and extent of land use in some situations beyond what is now regarded as sustainable. This occurs because assistance encourages a higher level of production than would otherwise be the case and production systems tend to use more capital and purchased inputs relative to, for example, labour. As a direct result, OECD agriculture tends to be characterised by a high degree of specialisation, less use of crop rotations to maintain the soil and water resource base, less innovation, reduced diversity, and hence, a reduced capacity to adjust. Both distorted price signals and the lack of information to farmers about natural advantages and natural assimilative capacity place farmers who choose to develop alternative crops and use alternative technologies at a disadvantage.

Farm inputs policies

Barriers to the more appropriate use of farm inputs and the development of incentives that encourage farmers to manage inputs more efficiently lie in three areas.

The first problem relates to the difficulties farmers face in obtaining access to information about the availability of substitutes and the efficacy of inputs in improving the profitability of their operations. For example, despite the fact that groundwater contamination is an increasing problem, pesticide labeling requirements do not always require manufacturing companies to inform farmers about tradeoffs between application rates and degree of pest control.

The second problem relates to the tendency of governments to supply inputs, including irrigation water and other inputs, to farmers at less than marginal social cost. As a result, farmers tend to use more inputs than are socially optimal.

A third problem is the lack of clarity in input use specifications and the failure to enforce codes of practice. As a direct result, water pollution and land degradation are greater than they might otherwise be.

Institutional arrangements

Information supplied by countries suggested that, in a number of cases, policy formulation tends to be of a "top-down" character with the result that important information about local conditions is not adequately accounted for during policy design. Similarly, the complex institutional structures that characterise agricultural policy administration in many governments make it difficult to adjust policies and programmes and to correct problems. A number of administrative arrangements also create the impression that it is the government alone, rather than governments and farmers in partnership (with better informed consumers as well), who are responsible for ensuring that agricultural practice is sustainable.
SIGNIFICANT POLICY OPPORTUNITIES

OECD Ministers have agreed that agricultural policy reform is urgently needed. This could offer a number of opportunities to facilitate a transition to more sustainable forms of agriculture through policy design that distinguishes between agricultural and environmental objectives, to encourage both the development of market-oriented agricultural production and the maintenance of the natural resource base. As indicated above, one of the barriers to the adoption of more sustainable agricultural practices and technology has been the level and means of delivery of assistance through agricultural policies, which have sometimes been to the detriment of the resource base. Moreover, some of the social costs and benefits of sustainable agriculture have not been fully accounted for in producers’ decisions. In those OECD countries where too much emphasis is put on a limited range of policy instruments in order to achieve multiple objectives, this can lead to sub-optimal outcomes. Recognition of this dilemma suggests that it might be preferable if separate objectives were formulated for "agriculture" and for other "goods" whose value is not adequately reflected in markets, such as the maintenance of soil, water, landscape amenity, biodiversity and cultural values. Better targeted policy instruments, either separately or in an integrated policy framework, as appropriate, might be used to achieve a more optimal solution that takes full account of the specific nature, potential, and capacity of each farm to contribute to these objectives.

Coupling markets to the environment

The capacity of commodity markets to inform farmers about the environmental consequences of their decisions is dependent upon the degree to which programmes mask signals about the social costs of production. Recognition of this suggests that arrangements that reduce production-distorting measures of assistance could facilitate the move to more sustainable agricultural practices. Many workshop participants also stressed the need for the development of an internationally consistent "eco-labelling" system for agricultural goods produced in sustainable systems to inform consumers, through the market, of the price of environmentally sustainable production.

At the same time, there are opportunities to make greater use of economic instruments and other mechanisms, such as the use of property rights, to internalise the costs of off-farm effects from agriculture. Instruments that facilitate this include pollution charges and levies, transferable irrigation entitlement, enforceable regulations, and incentives for provision of positive benefits.

Assigning environmental responsibility to farmers

In many OECD countries, agricultural programmes and policies are designed with incentives that make it the responsibility of the government alone to ensure that resources are used sustainably. Disaster subsidies, for example, can reduce the incentive for farmers to plan for such events. Similarly, subsidies for soil conservation, etc. tend to create the impression that
this type of activity should only be undertaken when it is subsidized. An alternative approach is one that formalizes expected codes of resource use and devolves responsibility for resource conservation to local communities and farmers through land care and similar programmes. It should be emphasized, however, that farmers are only one part of the food production cycle, and as such respond to both consumer signals and land use and production policies and objectives. It is crucial to see this wider context when apportioning responsibility for environmentally sustainable land use: farmers are willing contributors to positive change.

Creating markets for public goods

Agricultural production provides a range of goods and services. Not only food and fibre, but also public goods such as landscape amenity and biodiversity are the "output" of agricultural activities. Policy makers need to recognise this distinction. In the context of reforming existing agricultural policies or implementing new ones to correct for market and government policy failure, governments will need to identify the nature and scale of externalities and public goods resulting from agricultural activity and facilitate the creation of "markets" for environmental quality benefits of sustainable agricultural systems for which current markets provide no value. Recognising the potential of this type of activity to protect the interests of future generations, maintain ecological integrity, and improve environmental quality, delegates drew attention to the capacity of landscape maintenance contracts and conservation easements to achieve such objectives.

Transitional arrangements

Participants noted that a transition to the widespread adoption of more sustainable agricultural technologies and practices is contingent upon capitalising on the policy opportunities discussed above. It was also suggested that farmers making the conversion to sustainable agricultural systems face very real adjustment costs in the transition period during which production is variable as crops are weaned off chemical reliance and new pest management strategies are introduced, high up-front costs for new equipment are incurred, and before the farmer can earn any premium prices for his/her "biological" produce. In certain circumstances, therefore, transitional policy intervention may be necessary. These arrangements, however, should be adopted only when they are likely to bring about a speedier or less onerous transition to sustainable techniques, when they have clear sunset provisions, and when they are compatible with a move to a market-oriented agricultural sector.
CONCLUSIONS

The OECD Workshop on Sustainable Agriculture Technologies and APractices took an important step in moving towards a positive and constructive dialogue on how to move all forms of agriculture towards sustainability. Participants welcomed the technological focus and the opportunity to exchange information on concepts and technological opportunities in each of the major production areas. In addition, while there is an emerging consensus on the need to reform current agricultural policies and practices, there is no single or "unique" solution. Nevertheless, it is possible to list some features of sustainable agriculture:

- the need for the farmer to take responsibility for the change-over from conventional to sustainable farming, and for governments to facilitate the necessary decision-making by applying an appropriate combination of policy instruments;
- the achievement in the long-term of profitability under market-oriented conditions;
- the need for knowledge-intensive, skilled whole-farm management that is site-specific and which uses a systems approach;
- the reduction or alleviation of on- and off-farm negative effects of agricultural practices;
- the recognition of sustainable agriculture’s contribution to environmental "goods" not yet adequately reflected in market values;
- the need for the establishment of a "Code of Best Management Practices" to guide farmers in the transition to, and practice of, sustainable farming techniques; and
- better information for consumers through (quality labelling, information channels).

Finally, while the focus of this workshop was primarily on technological opportunities in sustainable agriculture, there are clear policy issues that will have a significant impact on the degree and rate of transition to sustainable agricultural practices. In all cases, the development of institutional, policy and programme arrangements to encourage this transition must foremost seek to foster the innovation, development, and adoption of improved agricultural technologies and practices, in a manner that makes technological advancement a hallmark of the sustainable agriculture movement.

It is imperative that the transition towards sustainable agriculture take account of the need to maintain an economically efficient and competitive agricultural sector that is responsive to changing consumer preferences, and that facilitates the development of market-oriented trade, while preserving the environment and the resource base into the future. These sometimes conflicting objectives, will form a major part of the policy agenda in the future.
The workshop discussions highlighted several areas where further analysis, discussion, and recommendations could contribute to the advancement of agricultural production systems towards sustainability. The OECD Secretariat is currently exploring possible options for further discussion in the appropriate fora, which could include some of the following:

- Developing a communications network that would facilitate the exchange of technical information among researchers and farmers in several countries employing biological or integrated practices.

- Analysing emerging national labelling systems for "sustainable agriculture" products to improve consumer understanding of the quality of agricultural products and practices. This analysis could also be conducted with a longer-term objective of facilitating the development of an international voluntary labelling system.

- Analysing other aspects of current marketing systems in terms of creating incentives and disincentives for sustainable agriculture products.

- Organising a follow-up workshop on sustainable agriculture technology and information transfer to non-Member countries, in cooperation with UNEP and FAO.

- Analysing agricultural research and development programmes to determine the relative importance placed on intensifying agriculture as opposed to making it more environmentally sensitive, and making recommendations on how to move these programmes from the current "reductionist" approach to a more integrated "whole farm" or systems approach.

- Organising a workshop on forestry and agriculture to explore in greater detail the role of forestation in sustainable agriculture systems.

- Analysing the policy implications and directions governments should explore to facilitate the further development and popularisation of sustainable agriculture.
PROFILE OF WORKSHOP PARTICIPANTS

OECD MEMBER COUNTRIES REPRESENTED:

Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany,
Iceland, Ireland, Italy, Japan, The Netherlands, New Zealand, Norway, Portugal,
Spain, Sweden, Switzerland, United Kingdom, United States

INTERNATIONAL ORGANIZATIONS

Commission of the European Communities
United Nations Economic Commission for Europe/Food and Agriculture Organization
United Nations Environment Programme, Industry and Environment Office
United Nations Conference on Environment and Development

NON-GOVERNMENTAL ORGANIZATIONS AND FARMERS GROUPS

Association Natures, Sciences, Sociétés
Confédération Européene de l’Agriculture
English Nature
Greenpeace International
Groupement Suisse pour les régions de montagne
International Federation of Agricultural Producers
International Federation of Organic Agriculture Movements
Ligne Suisse pour la Protection de la Nature
Japan Organic Agriculture Association
M.O.A. (Association Culturelle Mokitchi Okada)
Nature et Progrès: Association Européene d’Agriculture et d’Hygiène Biologique
Royal Society for the Protection of Birds

(Continued)
PROFILE OF WORKSHOP PARTICIPANTS (continued)

INDUSTRY ASSOCIATIONS

Fedération International des Semences
International Fertilizer Industry Association
International Group of National Associations of Manufacturers of Agrochemical Products/DU PONT

UNIVERSITIES AND RESEARCH INSTITUTES

Austrian Association for Agricultural Research, Austria
Centrum voor Agrobiologisch Onderzoek, The Netherlands
Erasmus Universiteit Rotterdam, The Netherlands
Horticulture Research International, Great Britain
Instituto Sperimentale per la Nutrizione delle Piante, Italy
Iowa State University, USA
National Association of State Universities and Land Grant Colleges, USA
National Institute of Public Health and Environmental Protection, The Netherlands
North Carolina State University, USA
Norwegian Agriculture University, Norway
Rodale Institute, USA
Silsoe Research Institute, Great Britain
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AGRICULTURAL PRODUCERS FROM

Austria, Canada, France, Germany, Iceland, Japan, Sweden,
Switzerland, United Kingdom, United States

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