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Multifunctionality

TOWARDS AN ANALYTICAL
FRAMEWORK



ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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FOREWORD

This booklet contains the summary and conclusions of the study *Multifunctionality: Towards an Analytical Framework* carried out under the 1999-2000 Programme of Work of the OECD's Committee for Agriculture. The study seeks to provide a conceptual basis for policy discussions by focussing on the production, externality and public good aspects of multifunctionality. The table of contents of the full report is included at the end of this booklet.

The principal authors of the study are Leo Maier and Mikitaro Shobayashi. The full report will be available in April 2001. Should you wish to purchase it, please contact the OECD Bookshop, 2, rue André-Pascal, 75775 Paris Cedex 16 (www.electrade.gfi.fr/cgi-bin/OECDBookShop.storefront).

SUMMARY AND CONCLUSIONS

Background

The OECD has over a long period analysed the non-commodity outputs¹ of agriculture, including its environmental impacts and its contribution to rural employment, and has undertaken substantive work in these areas. The introduction of the concept of multifunctionality by Agriculture Ministers at their meeting of 5-6 March 1998 added a further perspective to this discussion. The Ministerial Communiqué (OECD, 1998a) recognises that beyond its primary function of supplying food and fibre, agricultural activity can also shape the landscape, provide environmental benefits such as land conservation, the sustainable management of renewable natural resources and the preservation of biodiversity, and contribute to the socio-economic viability of many rural areas.

The shared goals set out by Ministers take account of the multifunctional character of agriculture but also aim for the sector to be responsive to market signals and further integrated into the multilateral trading system. Agro-food policies should strengthen the intrinsic complementarities between the shared goals and ensure that the growing concerns regarding food safety, food security, environmental protection and the viability of rural areas are met in ways that maximise benefits, are most cost-efficient and avoid distortion of production and trade.

The discussion of multifunctionality in the OECD and elsewhere has been beset by the problem that the concept of multifunctionality is not well defined and prone to different interpretations. The Secretariat therefore focussed in its initial work on elaborating a common terminology, identifying the key policy issues and developing a framework for analysis that would be acceptable to all Member countries and which would eventually clarify the meaning of the term “multifunctionality” and the way it is used in Member countries. The reactions to this early work reinforced the impression that Member countries have fundamentally different opinions and positions concerning the definition of multifunctionality, its utility for the agricultural policy debate and its implications for policy reform.

Nevertheless, the discussions converged on three distinct but connected sets of issues, which came to form the nucleus for the development of a work programme on multifunctionality. The first of these concerns the production relationships underlying the multiple outputs of agriculture, and the externality and public good aspects of these outputs. The second comprises methodological and empirical issues related to the measurement of the demand for non-commodity outputs, criteria and procedures for specifying domestic policy objectives, and mechanisms for evaluating progress. The third set of issues concerns the policy aspects of multifunctionality, including its implications for policy reform and trade liberalisation.

It was decided to begin with an analysis of the production, externality and public good aspects of the various non-commodity outputs of agriculture. This work should shed light on the supply and demand characteristics of the positive and negative outputs of agriculture and explore agricultural and non-agricultural ways of supplying the non-commodity outputs demanded by society. The results should provide the analytical basis for discussing, in a second step, the implications of multifunctionality for agricultural policy reform and trade liberalisation.

There are strong complementarities between the work on multifunctionality and other work carried out in the Agriculture Directorate [on sustainable agriculture (Box I.1), agri-environmental policy, agri-environmental indicators, structural adjustment, farm household income, income risk management,

Box I.1. Multifunctionality and sustainability

One question that has arisen in the discussions leading up to this work is how multifunctionality relates to sustainability. Sustainable development, and sustainable agriculture in particular, have been the subject of numerous conferences and discussions over the last ten years, and have been enshrined as guiding principles in several international agreements and action plans. The OECD itself has carried out a considerable amount of work on sustainable agriculture (for example, OECD, 1995a).

Sustainability refers to the use of resources, human, natural and man-made, in ways that allow current generations to satisfy their needs without jeopardising the capacity of future generations to meet theirs. As such, sustainability is a resource-oriented, long-term and global concept. It is resource oriented because we do not know which use future generations will make of the resources and which economic activities they will engage in; it is, by definition, long-term as it involves the interests of future generations; and it is inherently global as long-run sustainable resource use in a sector, country or a region can hardly be achieved if resource use in other sectors, countries or regions is non-sustainable.

Multifunctionality refers to the fact that an economic activity may have multiple outputs and, by virtue of this, may contribute to several societal objectives at once. Multifunctionality is thus an activity-oriented concept that refers to specific properties of the production process and its multiple outputs.

The concept of sustainability is essentially *goal-oriented*, implying that resources should be used in such a way that the value of the entire stock of capital (including its option value) does not diminish and an indefinite stream of benefits can be obtained. The goal-oriented element may not always be evident, such as when the purpose of the exercise is to explore whether a particular type of agriculture is currently sustainable or not. But there is always an underlying assumption that the ultimate objective is to achieve sustainability. If an economic activity is not compatible with sustainable resource use, there is a problem that needs to be addressed. By comparison, if an activity is not multifunctional, there is no imperative to make it multifunctional. According to the working definition proposed in this report, multifunctionality is a *characteristic* of the production process that can have implications for achieving multiple societal goals.

It could be argued that this distinction is somewhat artificial. Sustainability is not an exclusively goal-oriented concept; it can also be used in a “positive” context. Similarly, multifunctionality can be given a “normative” aspect, as in paragraph 15 of the 1998 OECD Ministerial Communiqué, which lists as one of the adopted policy principles to “... preserve and strengthen the multifunctional character of agriculture...”. Paragraph 13 stipulates that “... agro-food policies should ... [allow] agriculture to manifest its multifunctional character...” (OECD, 1998a).

The work plan on multifunctionality and the work on sustainable agriculture carried out in the OECD reflect these differences in perspective. The sustainability work examines the reasons why some current agricultural practices are not sustainable and explores the possibilities for corrective action. The work on multifunctionality emphasises the joint production and (both positive and negative) externality and public good aspects of the multiple outputs of agriculture, and their implications for policy formation.

the Policy Evaluation Matrix, decoupling, and trade] and in other parts of the Organisation, notably the Territorial Development Service (work on rural amenities and on rural indicators) and the Environment Directorate (work on biodiversity). There are also links with the OECD horizontal activity on sustainable development. The work on multifunctionality builds on these efforts, while trying to address the commodity and non-commodity outputs of agriculture within a unifying framework that reflects the way in which these outputs are generated and in which they impact on producers, consumers and taxpayers.

Structure of the report

This report presents the results of analytical work on multifunctionality carried out in the OECD. They should provide the basic elements for future policy analysis. Part II addresses the production aspects of multifunctionality. In particular, it explores the production relationships that distinguish multifunctional activities from other economic activities; assesses the extent to which multifunctional characteristics are present in agriculture; and examines how such characteristics can influence the provision of commodity and non-commodity outputs, both within agriculture and relative to non-agricultural provision. Special

attention is given to the possibility of cost savings due to the joint provision of outputs (“economies of scope”), and to the problems that arise if the joint outputs are generated in the wrong composition or proportion, if they differ in their geographical dimension, or if the beneficial effects are accompanied by harmful effects that can not be dissociated from the activity.

Part III examines the precise nature of the positive and negative externalities and the public goods generated by agricultural activities, and considers policy approaches that address under- or overprovision due to market failure. Since the externality and public good characteristics of the non-commodity outputs are determined by the way in which the benefits and costs of the outputs are distributed in society, this work has links to demand analysis. A wide range of market and policy options is considered in the analysis, and their usefulness for correcting market failure is assessed as a function of the externality and public good aspects of the non-commodity outputs. Consumption links (complements and substitutes) among the outputs are also analysed and some policy issues that arise when multiple outputs are consumed together are highlighted. The importance of incorporating both positive and negative externalities is stressed throughout this report.

Annexes 1 and 2 provide a thorough discussion of the concept of joint production and its applicability to multifunctionality. Annex 3 reviews how issues that are similar to multifunctionality are treated in other economic sectors. The review is part of an effort to ensure that key issues are treated consistently across sectors. There is no presumption that agriculture is the only economic activity with multifunctional characteristics (Box I.2). Annexes 4 to 7 include technical material that complements the analysis of externalities and public goods.

The division of the work into production aspects on the one hand and externality and public good aspects on the other is, however, somewhat arbitrary. The two sets of issues are closely linked from a policy perspective and neither can be treated without reference to the other. Part I therefore tries to bridge this divide by synthesising the lessons that can be drawn from the two analytical pieces, which are presented in Parts II and III.

Questions of measurability of the non-commodity outputs and demand estimation, although important for policy formation, are not explicitly covered in this report, as they form part of the second cluster of the work.² However, Part III on externalities and public goods implicitly acknowledges the measurement difficulties by stressing policy options that do not require demand estimation. In addition, Annex 1 mentions the implications of measurability problems for policy analysis.

A “working definition” of multifunctionality

The term “multifunctionality” has been used with various meanings in the agricultural policy debate, depending on the country and on the context in which it has arisen. While it is not the primary purpose of this report to develop a precise definition of multifunctionality (although such a definition may subsequently be established on the basis of the analysis), it is nevertheless necessary to adopt a “working definition” that provides an anchor for the discussion and defines the angle from which to approach the analysis.

Such a working definition needs to encompass the core elements of multifunctionality that have been recognised by Member countries. The key elements of multifunctionality are: *i*) the existence of multiple commodity and non-commodity outputs that are jointly produced by agriculture; and *ii*) the fact that some of the non-commodity outputs exhibit the characteristics of externalities or public goods, with the result that markets for these goods do not exist or function poorly. Before any attempt can be made to draw policy-relevant conclusions, the different elements that are put forward as pertaining to the multifunctionality of agriculture need to be examined in the light of this working definition.

This study makes reference to specific non-commodity outputs of agriculture to illustrate key points of the discussion.³ These examples are not meant to constitute an implicit list of non-commodity outputs that are part of multifunctionality. Rather, the aim is to explore how various non-commodity outputs that have been cited in previous discussions in the OECD, fit into the proposed framework of analysis. The examples are kept short, and are often accompanied by cross-references to other work

Box I.2. Multifunctionality: a specificity of agriculture?

If multifunctionality is first and foremost a characteristic of an economic activity, then the question arises why this issue has become policy relevant in agriculture and not also in other parts of the economy. It is unlikely that the existence of jointly produced outputs should be so heavily concentrated in agriculture that it confers a special status on this sector. Whatever definition of “output” is adopted, many economic activities have, in addition to their intended output (which constitutes their *raison d'être*), other (often unintended) outputs or effects. Thus, the mere existence of multiple outputs that are interconnected does not in itself distinguish agricultural from non-agricultural activities.

Similarly, the fact that some of the outputs are externalities or public goods, does not explain why debate on the concept of multifunctionality has not spread beyond agriculture. One can think of many cases where non-agricultural activities produce side-benefits that are non-excludable and non-rival (public goods). Hence, based on the presence of joint outputs, some of which are public goods, there is no reason to believe that multifunctionality is a specifically agricultural phenomenon. In fact, many issues that are conceptually similar to those discussed under the heading of multifunctionality in agriculture have also been addressed in other economic sectors, albeit under different headings and in different policy contexts.

Most of the relevant examples of joint production found in the literature review (Annex 3) are in forestry, with some additional applications to the fisheries sector and to household production. The examples from *forestry* are particularly interesting and relevant, as there are many similarities between agriculture and forestry regarding the provision of private and public goods, the importance of land as an input, the role of biological processes in production, the close relationship with the environment, and the impact on the rural economy. It is notable that joint production has entered the policy debate specifically in agriculture and forestry – the two major land-using activities in OECD countries.

A frequently asked question in these studies is whether joint provision of goods and services is cheaper (or more costly) or results in a higher (or lower) quality output than separate provision. Joint provision usually receives a favourable rating in situations where there is a high degree of complementarity among the outputs and where synergy effects can be increased, and conflicts reduced, through appropriate management decisions. A cautious evaluation and interpretation of experience in other economic fields can benefit the work on multifunctionality in agriculture and ensure that the main issues are addressed in consistent ways across different sectors of the economy.

But there are also a number of questions that need to be addressed in agriculture, which may not be of equal importance in other sectors, and these factors might explain why multifunctionality has become policy relevant especially in agriculture. Some of these may relate to characteristics of agriculture as an industry, such as the geographical dispersion of farm enterprises, and others to the political decision making process and the high levels of support and protection that continue to be provided to the sector.

carried out in the OECD. This is especially true with regard to environmental outputs, which have been the subject of considerable work in the Joint Working Party of the Committee for Agriculture and the Environment Policy Committee.⁴

The inclusion of rural employment and food security in the discussion of multifunctionality has been controversial. Clearly, rural employment related to agriculture is an input either of commodity production or wider agro-food industries, and cannot be considered as a non-commodity output of agriculture or as an externality. Nonetheless, it may have impacts on society, which might be considered as externalities (for example, slowing the migration from rural to urban areas). The nature of the relationship between commodity production and rural employment is examined in Part II. The relevance of the analysis of possible externality and public good aspects of rural employment conducted in Part III then depends on the outcome of the analysis in Part II, in particular the degree to which there is jointness and possibilities for non-agricultural provision. The main issues associated with food security lie in its link with domestic production as opposed to alternative supply sources, as discussed in Part II. The impact of domestic production on food security could be either a positive or a negative externality of domestic production, as discussed in Part III.

Box I.3. Multifunctionality: a characteristic or an objective?

There are essentially two approaches to the analysis of multifunctionality. One is to interpret multifunctionality as a characteristic of an economic activity. The particular characteristic that makes an economic activity multifunctional are its multiple, interconnected outputs or effects. These outputs can be positive or negative, intended or unintended, complementary or conflicting, reinforcing or offsetting. Some of the outputs are valued in existing markets, whereas others may elude the market mechanism.

Multifunctionality, interpreted in this way, is not specific to agriculture; it is a property of many economic activities. There are numerous ways in which economic activities can be multifunctional. A certain activity may be multifunctional or not, but there is no implicit notion that it should be multifunctional. This view can be termed the “positive” concept of multifunctionality.

The second way of interpreting multifunctionality is in terms of multiple roles assigned to agriculture. In this view, agriculture as an activity is entrusted with fulfilling certain functions in society. Consequently, multifunctionality is not merely a characteristic of the production process, it takes on a value in itself. Maintaining a multifunctional activity or making an activity “more” multifunctional, can become a policy objective. This view can be termed the “normative” concept of multifunctionality.

The analysis in this report is based on the “positive” concept of multifunctionality. The positive approach chosen by the Secretariat does not exclude policies that “... allow agriculture to manifest its multifunctional character...” (1998 Ministerial Communiqué, OECD, 1998*a*). Moreover, relating multifunctionality to economic characteristics of the agricultural production process and its outputs, provides a framework for discussion that allows a wide range of producer, consumer and taxpayer concerns to be addressed.

Putting the emphasis on the “positive” approach does not exclude a discussion of the “normative” concept of multifunctionality, both approaches being recognised in the Agricultural Ministers Communiqué of 1998. By placing multifunctionality in a “normative” context, the focus of the discussion would shift towards the societal objectives associated with agriculture in the various countries, including equity and stability objectives. The normative aspects of multifunctionality could thus be suitably addressed in the context of empirical work on multifunctionality and policy implications.

This working definition associates multifunctionality with particular characteristics of the agricultural production process and its outputs. Alternative interpretations that are sometimes encountered in the public debate liken multifunctionality to an objective rather than to a characteristic (Box I.3). This other approach will not be considered in the analysis presented here.

The fact that an activity produces multiple inter-connected outputs can acquire economic relevance if this characteristic influences the way in which scarce resources are used in the economy to meet the demands of society. Moreover, the multifunctional characteristic can become policy relevant if, among the multiple outputs generated, there are some that are welfare-enhancing or welfare-reducing but for which no private markets exist. If, in such a case, a policy action is deemed necessary to internalise an externality, the characteristics of the activity involved have implications for the design and the implementation of the correcting action.

Policy context

The policy context for the work on multifunctionality is provided by Member countries' commitments to further progressive reductions in domestic agricultural support and border protection, and a shift away from policy measures that encourage higher levels of food production and input use, towards measures that are less distorting of markets and trade. At the same time, there is a growing awareness of the positive and negative non-commodity outputs of agriculture among rural and urban citizens, and governments are increasingly looking for ways to ensure that the non-commodity outputs of agriculture correspond in quantity, composition and quality to those demanded by society.

Some Member countries are concerned that reductions in production-linked support and trade liberalisation may, through a decline in food production, reduce some of the positive non-commodity outputs of agriculture that are jointly produced with food and for which no markets exist, below the levels desired by society. Conversely, there are fears on the part of the trading partners that those countries might try to safeguard their non-commodity outputs through the continued protection of their domestic food markets, or even expand these outputs through measures that lead to increased food production. Underlying the debate on multifunctionality are some of the same considerations as the discussion of “non-trade concerns” that has evolved in the context of multilateral trade negotiations. These “non-trade concerns” can have important effects on trade and on producers in other countries.

The standard policy recommendation in situations where a combination of private and public goods is produced, is to let market forces freely determine the level of production, consumption and trade of the private goods, while at the same time addressing any underprovision of public goods and any positive or negative externalities through targeted and decoupled policy measures. Moreover, each public good objective or externality should be addressed through a separate policy instrument that influences the target variable directly. This standard recommendation corresponds to the well-known result from the theory of economic policy that, in order to simultaneously achieve a set of objectives, the number of policy instruments has to be equal to or greater than the number of goals (Tinbergen, 1952).

The challenge for the work on multifunctionality is to test the validity of the standard policy recommendation against the additional aspects introduced by multifunctionality: the simultaneous consideration of the various positive and negative effects of agriculture, and their joint production, externality and public good aspects. ***The eventual goal is to establish principles of good policy practice that permit the achievement of multiple food and non-food objectives in the most cost-effective manner, taking into account the direct and indirect costs of international spillover effects. On a broader scale, the work on multifunctionality is part of an ongoing effort by the Secretariat to address domestic non-trade concerns, including equity and stability issues, and trade liberalisation in mutually consistent ways.***

Summary of production aspects

Key concepts and questions

The principal issue on the production side of multifunctionality concerns the nature and degree of jointness in the production of commodity and non-commodity outputs. If production were non-joint, the non-commodity outputs could be supplied independently of agricultural commodities and domestic non-trade concerns could be pursued irrespective of trade considerations.

Jointness adds two new elements. First, any change in commodity production, be it market-led or policy-driven, entails a change in the levels of the non-commodity outputs that are jointly produced with commodities. Secondly, jointness can create possibilities for ***economies of scope***, that is, cost savings that are generated through the joint provision of several outputs as opposed to their separate provision.

Much of the analytical work on the production aspects of multifunctionality has focused on these two elements. Regarding the first element, if there are linkages between the commodity and non-commodity outputs, policy reforms in the commodity sector will affect the non-commodity outputs. Conversely, measures aimed at achieving non-food objectives will have implications for commodity production and trade. ***One of the major thrusts of the work has been to establish the extent to which the non-commodity outputs of agriculture are linked to or can be dissociated from commodity production. This has important implications for policy targeting and decoupling.***

The second consideration concerns possible cost savings due to joint production. Economies of scope arise if something inherent in the production process makes it cheaper to provide two or more outputs jointly rather than separately. The second major line of investigation has therefore been oriented towards the factors that determine whether there are economies of scope in the joint provision of commodity and non-commodity outputs by agriculture.

Box I.4. A note on terminology

In drafting this report, a number of decisions concerning terminology had to be made. Multifunctionality has been the subject of very little economic analysis and there is no established terminology to describe its key elements. There are instances where several terms are available to describe a certain aspect, but none of them is perfect for the purpose in question.

An example is the use of the terms *commodity* and *non-commodity* outputs. In previous reports on multifunctionality, the terminology *food* and *non-food outputs* was used. The reason was that food production is generally the primary function of agriculture and the outputs that are jointly produced with food, such as the agricultural landscape, are non-food outputs. Yet, it was pointed out that on a significant portion of farmland, the primary products are non-food outputs, including flowers, fibres, renewable energy or raw materials for industrial production. In such cases the agricultural landscape would not be a by-product of food, but of a non-food output.

As an alternative, the terms *market* and *non-market goods* were considered. This would allow food and non-food raw materials to be subsumed under one term, but it would create another problem. One of the major objectives of the work is to assess the degree to which the non-food outputs of agriculture are marketable or non-marketable. To make a distinction (*a priori*) between market and non-market goods would amount to prejudging the outcome of the analysis.

Eventually, it was decided to use the terms commodity and non-commodity outputs, which do not suffer from either of the problems mentioned above.

The terms *by-products*, *side-effects* and *multiple outputs* are similar in certain respects, but they are not all equally appropriate in a given context. For instance, one can safely assume that the negative effects of agriculture on the environment are unintended side-effects or by-products. An attractive landscape can also be a side-effect if it is the accidental result of food production, but if the farmer is aware of its value and willing to integrate landscape considerations into his or her production decisions, it may no longer be appropriate to call it a by-product or a side-effect.

The analysis of multifunctionality favours a perspective that recognises the integrated nature of the outputs (although it should be recognised that the degree of integration differs significantly among them). For this reason, the term multiple outputs is generally preferred, as it allows the inclusion of intended outputs and not merely unintended side-effects. However, the term multiple outputs has a slightly positive connotation and may be considered less appropriate when negative effects of agriculture, such as water pollution, are examined. To circumvent this problem, the term multiple outputs is replaced by *multiple effects* when negative impacts are discussed.

Another distinction concerns the terms *multiple outputs* and *joint products*. A major goal of the work is to examine to which extent the multiple outputs of agriculture are joint products. The term joint products implies some inter-connectedness among the outputs that derives from the agricultural production process. *Jointness*, as used in these reports, includes private and public goods.

The aim in drafting these reports was to keep the terminology simple and the text readable, and to focus on what is important: a clear description of the analytical issues. The terminology may not be perfect, but it will evolve as the discussion advances and new insights are gained.

Another question concerns how the production linkages are influenced by site- and area-specific conditions. Territorial aspects, including differences in the spatial dimensions of the non-commodity outputs, have also been part of the analysis.

Finally, an important issue on the supply side of multifunctionality is whether some non-commodity outputs can be supplied at a lower cost by non-agricultural providers. In this context it is important to know whether the non-commodity outputs can be separated from agricultural production and resource use, and whether there are economies of scope that confer a cost advantage on agricultural or on non-agricultural providers. The analytical work has addressed these and other factors that influence the cost of agricultural and non-agricultural provision.

The results of the analytical work on the production aspects of multifunctionality do not allow conclusions to be drawn in terms of specific policy actions or measures. This will be the subject of future policy work, where additional factors that influence the relative merits of alternative market and policy approaches will be considered.

The nature of jointness in agriculture

The joint product relationships that characterise the non-commodity outputs of agriculture are extremely varied, including different types of technical interdependencies and shared or common resources, and linkages which defy easy classification in a joint production framework (Box I.5).

Production of commodity and non-commodity outputs is rarely observed in fixed proportion in practice. There is usually considerable scope for adjustments in the bundle of commodity and non-commodity outputs in response to changes in relative prices and policy incentives. In the case of environmental outputs, improvements can often be achieved through changes in farming technologies and practices. Some environmental outputs and landscape elements are separable in land use from commodity production, and certain cultural heritage values can be completely dissociated from farming activities.⁵ Agricultural employment is linked to commodity production, but developments in part-time farming and non-agricultural employment on the farm have changed the relationship between agriculture and rural viability. Food security is basically about consumption, but trade can allow the place of production to be dissociated from the place of consumption, at least to some extent.

Commodity and non-commodity outputs can be complements or substitutes in production depending on the underlying production relationship. Reducing a negative externality caused by a technical interdependency may lower commodity supply, whereas increasing a positive externality may

Box I.5. The sources of joint production

Joint production refers to situations where a firm produces two or more outputs that are interlinked so that an increase or decrease of the supply of one output affects the levels of the others. Three reasons for jointness are frequently distinguished: *i*) technical interdependencies in the production process; *ii*) non-allocable inputs; and/or *iii*) allocable inputs that are fixed at the firm level.

Technical interdependencies are at the origin of many of the negative non-commodity outputs of agriculture, including soil erosion, chemical residuals and nutrient leaching. Greenhouse gas emissions and problems of animal welfare are also associated with technical or biological characteristics of the production process. Positive effects due to technical interdependencies include, for instance, the pest-controlling effects of certain cropping patterns used in integrated pest management, and the impacts of crop rotations on nutrient balances and soil productivity.

The second type of jointness arises where multiple outputs are produced from the same input (non-allocable input). The classical example is the production of mutton and wool which are jointly obtained from raising sheep. The production of meat and manure, or the association of landscape with particular production systems (terraced paddy fields, Alpine pastures with cows, fields of sunflower), are other examples of joint products caused by non-allocable inputs. However, while these outputs are joint, they are rarely produced in fixed proportions and those proportions can be modified by using different production methods. Many output linkages, including those between game and timber or between food and landscape, can either be attributed to non-allocable inputs (they are produced on the same land) or to technical interdependencies.

Jointness can also be caused by allocable fixed factors. Such factors are available to the firm in a fixed amount and are allocated to the various outputs in the production process. An increase or decrease in the production of one output changes the amount of the factor available for the supply of the others, thus creating a linkage among the outputs. This source of jointness has attracted a lot of attention among agricultural economists because farmland and self-employed labour are allocable fixed factors. For the analysis of multifunctionality, however, it may be less important than the other two sources of jointness.

The overall jointness effect is often due to a combination of different sources, the relative importance of which can be difficult to assess. Moreover, there are outputs that are mentioned in the discussion of multifunctionality but which do not correspond neatly to the three sources of jointness. One of these is the contribution of agriculture to rural employment, which is linked to agricultural labour use. Another is the contribution of agriculture to food security, where the linkage is with food itself, which is a primary output, and a tradable good, whereas other multifunctional outputs are non-tradable.

expand it. Where non-commodity outputs compete with commodities for land, an increase in the non-commodity output will generally imply a reduction in commodity production.

Providing support to commodity production with the aim of achieving certain non-commodity objectives is likely to cause undesirable effects with respect to other non-commodity outputs. Addressing the non-commodity outcomes directly instead of focussing on commodity production will steer the agricultural activity in a direction of greater non-commodity benefits and smaller trade-offs in line with society's preferences. Direct incentives for the provision of non-commodity outputs will lead to the strongest possible dissociation of the non-commodity outputs from commodity production, and the smallest trade distortions, within the limits imposed by the underlying production relationships. Policy targeting increases precision and reduces distortions in commodity markets, but the gains will have to be weighed against any increases in transaction costs.

Since many of the non-commodity outputs of agriculture are, in one way or the other, linked to agricultural activities or resource use, achieving domestic non-commodity objectives will have some repercussions – positive or negative – on commodity production. Unavoidable trade effects and their welfare implications in other countries have to be taken into account when considering the costs and benefits of pursuing domestic non-commodity objectives. International spillover effects should also be taken into consideration in analysing the merits of alternative policy approaches.

The links between the commodity and non-commodity outputs have to be seen in a dynamic context. The intensity of agricultural production can be changed to modify the relationship between commodity and non-commodity outputs. New information, technologies and farmer experience create new ways of using a farm's resources and may influence the bundle of non-commodity outputs generated in the process. Agricultural research and development, in combination with farmer training, are potentially effective ways of modifying the linkages that determine the non-commodity outputs of agriculture. The degree of jointness between outputs may change in the future.⁶

The spatial, scale and time dimensions of non-commodity outputs

The costs of providing non-commodity outputs and the quality of these outputs can differ substantially within and across countries. Moreover, each non-commodity output has its particular territorial scale. Differences in site productivities and scale dimensions, in combination with spatial variations in the demand for non-commodity outputs, suggest that there will be no single response to multiple non-trade concerns that is optimal for all areas. On the contrary, spatial and scale differences reduce the usefulness of market and policy approaches that can not be implemented using area-specific or local criteria. Ignoring differences in site productivities and scale dimensions of non-commodity outputs can lead to local over- or underprovision of these outputs.

If the various functions of agriculture were completely separable, each non-commodity output could be addressed at the appropriate geographical level. However, jointness in production requires that multiple outputs be considered simultaneously. This can make it difficult to develop an approach that preserves the advantages of scale-specific solutions and permits differences in site productivities of non-commodity outputs to be taken into account. One way to proceed would be to identify dominant land uses for different areas based on the non-commodity outputs that are most in demand in these areas or that can be provided most efficiently under the local conditions, and to explore whether scale similarities allow several non-food concerns to be addressed on the same scale. In this context it is also important to identify the appropriate administrative level at which market or policy responses should be organised.

Apart from the spatial dimension, the non-commodity outputs also have an important time dimension. While it has not been possible to address this dimension in detail in the analysis, questions concerning the length of time it takes for a non-commodity output to be produced, the pattern of development it follows during that period, the speed at which farming practices and systems can be adjusted, and whether a non-food concern is permanent or temporary, have been raised. The different time dimensions of the non-commodity outputs need to be taken into consideration in policy analysis.

Non-agricultural provision

The issue of agricultural versus non-agricultural provision of non-commodity outputs revolves around three questions: can the supply of non-commodity outputs be dissociated from agricultural production; to what extent are non-commodity outputs that are supplied by non-agricultural activities substitutes for those supplied by agriculture; and how can the demand for the non-commodity outputs be satisfied with the least resource cost to the domestic and international economy?

Regarding the possibilities for non-agricultural provision of non-commodity outputs, the picture that emerges from the analysis is rather complex. For non-commodity outputs that are tied to agricultural land, including some ecological and amenity services, provision by non-agricultural groups or enterprises is only possible if these are granted access to the land and if the functions they perform do not conflict with the agricultural activity. These conditions are most easily satisfied in cases where the commodity and non-commodity outputs are separable in land use. If this separation is not feasible, there will only be limited possibilities for farmers and non-agricultural providers to perform different functions side by side.

With respect to services that are not tied to agricultural land, there are few or no technical limits to non-agricultural provision. This concerns, for instance, the viability of rural communities or the maintenance of historical buildings in rural areas. Agriculture can no longer be counted on for vigorous employment creation, but in areas where no feasible economic alternatives exist, a slowdown of employment loss in agriculture can alleviate depopulation problems. In areas where non-agricultural employment is a realistic option, there may be some questions as to whether the replacement of agricultural employment by non-agricultural activities entails a loss of traditional lifestyles, customs and values, but a certain amount of change will be acceptable, while the most valuable traditions can be perpetuated in other ways.

Regarding food security, the issue is foremost one of food supplies from current domestic production versus supplies from foreign sources, from food stocks and from the activation of production potential in times of crisis. Non-agricultural contributions to food security include macroeconomic policies that raise the general income level and improve the affordability of food and measures that increase access to food, including through the development of a stable transportation and distribution system. Maintaining domestic food production above market levels for reasons of domestic food security creates costs for taxpayers, consumers and foreign suppliers and may impact negatively on global food security. Whether food security can be entirely ensured by alternatives to domestic food production depends on the contingency cases. Food security is neither simply a joint product of domestic food production nor simply a joint product of agricultural trade.

A special situation arises in areas where farming becomes unprofitable but the continued provision of some of the non-commodity outputs provided until now by agriculture is considered to be essential. In this case, it is an open question whether farmers are better placed than others to provide these outputs. Agricultural incomes may be small and declining and may not allow farmers to accept a lower remuneration for the supply of the non-commodity outputs than their non-agricultural competitors. Efficient outside providers may thus start to compete with farmers for land based on the direct incentives provided for the supply of non-commodity outputs. Potential quality differences in the non-commodity outputs supplied by farmers as compared to those supplied from non-agricultural sources, and their effects on consumers' valuation, is an issue that may need to be considered.

In sum, the analysis of the production aspects of multifunctionality suggests that the various positive and negative non-commodity outputs of agriculture differ substantially in the way they are related to the agricultural activity and to each other; the degree to which they can be de-linked from commodity output; their dependence on site-specific factors; the area over which they extend; and the possibilities for non-agricultural provision. Because of such differences, it is unlikely that a set of non-food objectives could be achieved by concentrating the corrective action on commodity production and letting the non-commodity outputs adjust. Such a path of action would invariably result in a situation where some of the non-commodity outputs are over- or undersupplied, and it would ignore the possibilities for achieving the desired adjustment through direct incentives with smaller impacts on commodity markets and trade.

Summary of externality and public good aspects

If all non-commodity outputs were private goods for which functioning markets exist, private transactions would ensure that resources are used efficiently and that supply and demand are balanced in all markets. Moreover, as shown in Part II, if production is non-joint, including the case where cost effective substitutes for non-commodity outputs exist, the non-commodity output can be supplied independently of commodity production. Therefore, both the lack of markets and jointness between production and the externality are necessary for any discussion of policy implications to be warranted.

Part III, which concerns externality and public good aspects of multifunctionality, does not examine whether given non-commodity outputs meet the above criteria because it is conceptual in nature. In fact, in order to allow the overall conceptual analysis to be made without waiting for an empirical analysis of individual production relationships, some degree of jointness between commodity and non-commodity outputs was assumed.

Part III examines exactly when and how markets fail due to externalities, and shows that non-commodity outputs that constitute positive externalities do not necessarily cause market failure. Theoretically, a positive externality causes market failure because producers do not take the benefits of the externality to society into account and therefore under-provide the good that generates it. In reality, market failure is more complicated, depending on how the demand for the externality is distributed. For example, suppose that a certain externality is produced in some fixed proportion to commodity output irrespective of the location or cost of that commodity production, but that demand is fully met by the amount that is produced jointly by the lowest cost producers. In this case, no market failure occurs because the quantity of the externality that society demands can be fully met without an increase in the supply of the commodity.

If there is trade and domestic prices fall, the market failure resulting from the change in the positive externality will be different than where there is no trade. Whether the result is a net loss or gain in welfare depends on many parameters. Gains come from the private cost savings resulting from the elimination of high cost farms and higher consumer satisfaction due to increased consumption. The possible loss is the decrease in production of the positive externality because of lower domestic production.

Taking negative externalities into account reduces the possibility of market failure because a decrease in supply of a positive externality may be offset by a decrease in the negative externality. Possible consumption relationships between externalities might also affect the outcome. The existence of some negative externalities may actually reduce the demand for positive externalities, thus reducing the risk of market failure.

The assumption that output price decreases cause a reduction in production should also be carefully examined in a more dynamic framework. Production levels may be maintained through increases in productivity on the part of efficient farmers. Farmers could switch to producing a more profitable commodity, which also produces the desired positive externality. These possibilities of course reduce the risk of market failure arising from a fall in supply of a positive externality caused by an output price fall.

It is important to understand that how benefits of externalities are associated with production could be one the factors affecting the degree of market failure, although most theoretical examples assume constant marginal benefits. Externalities that are site specific (discontinuous marginal benefits) or those for which the value of additional units falls as the total supply increases (decreasing marginal benefits) are less likely to be associated with market failure than those with constant marginal benefits (under the assumption that the total benefits are the same). Some externalities that are discussed under multifunctionality are very likely to belong to these categories. Whether market failure actually occurs or not should be tested empirically.

There is some controversy concerning the appropriateness of including food security and rural employment as aspects of the multifunctionality of agriculture. Production relationships must first be examined extremely carefully, to determine what the links with domestic agricultural production are

and to explore the potential for more cost-effective non-agricultural provision. Only if (domestic) commodity production is found to be the most efficient provider, is it necessary to pose the question concerning externalities and public goods. Rural employment related to agriculture is just an input and can never be an externality of commodity production. Rural employment may, however, have impacts on society such as preventing migration of the population into cities (Similarly, fertiliser may cause an externality but is not itself an externality). If these impacts, which could be positive or negative, are not incorporated into market prices of commodities, they could be defined as externalities. With respect to food security, domestic production could affect (positively or negatively) the risk of shortfalls of food supplies, and this is often not reflected in market prices of commodities. These impacts on food security can therefore be externalities (positive or negative) of commodity production. Whether the positive impacts are greater than the negative ones (*e.g.* domestic production may mean that a country is particularly vulnerable to a production shock caused by weather because it has failed to diversify supply sources through imports) is an empirical question.

Public goods

Even if some non-commodity outputs are positive externalities that cause market failures, government intervention is not necessarily the best option. There are various ways to narrow the gap between social and private costs, depending on the specific public good characteristics of these non-commodity outputs. Many options would require no or very limited government intervention such as to facilitate market creation. A detailed classification of public goods is therefore needed. Otherwise there is a risk that goods as disparate as toll roads, national defence, community-owned natural resources, municipal fire protection services and fisheries would be discussed together without acknowledgement of the extent to which their different public good characteristics should lead to different policy conclusions.

Possible policy failures associated with incorrect estimation of the demand for public goods also strengthen the need for a detailed classification of public goods. If such errors are likely, provision arrangements that do not require demand estimation, including market provision, might be preferable to government provision, even if these alternative arrangements could also cause inefficiency (*i.e.* underprovision). Transaction and administrative costs associated with various provision mechanisms need to be included.

Six categories of positive externalities have been established based on their characteristics as pure or impure public goods. Each category would require completely different (or, sometimes, no) policy intervention.

A rough classification of major externalities from a public good point of view is proposed for discussion (Box I.6). Although this classification needs to be empirically tested paying sufficient attention to factors such as technical and institutional aspects of exclusion mechanisms (*e.g.* property rights), it indicates the possibilities that many externalities belong to categories that require no or very limited government intervention. Only a few are classified as pure public goods or open access resources, which are difficult to provide optimally without government intervention. On the other hand, many are classified as common property resources or club goods, which are more manageable without government intervention (or with very limited roles of government in encouraging clubs and providing information, etc.) than pure public goods and open access resources. The possibility that many externalities could be classified as local public goods also widens the range of available policy options.

The dynamic nature of these non-commodity outputs as pure or impure public goods should also be stressed. The public good nature of certain externalities may change over time and some may even become private goods. Analysing policy options without taking these dynamic aspects into account could lead to unnecessary or harmful intervention by government.

Consumption relationships between externalities could also make their preservation without government intervention more likely. For example, the risk of underprovision of a pure public good could be reduced through voluntary provision or the market if it has a complementary consumption relationship with an impure public good or a private good.

Box I.6. Illustrative categorisation of public goods

Pure Public Goods (*e.g.* national defence): Because of non-excludability and non-rivalry, governments usually supply these goods. This is likely to result in over-provision due to difficulty in estimating real demand. Voluntary provision, which is the only private option, is on the other hand likely to result in under-provision. Whether the inefficiency associated with over-provision by the government is smaller than the inefficiency associated with under-provision by voluntary means is an empirical question. Examples could be: non-use values of landscape; natural habitat; and biodiversity.

Local Pure Public Goods (*e.g.* municipal fire protection service): Benefits are restricted to small jurisdictions. Over-provision by the government or under-provision by voluntary provision are likely to be less serious than in the case of pure public goods. Examples could be: flood control; positive impacts of rural employment; and use values of landscape.

Open Access Resources (*e.g.* fisheries in ocean): Because of non-excludability and rivalry, these goods tend to be overexploited. Converting these into community property resources is an option to achieve efficiency. Otherwise, government intervention may be required. Examples could be: food security and use value of landscape by visitors.

Common Property Resources (*e.g.* community irrigation): Because of rivalry and excludability of outsiders to the community, these goods could be efficiently managed by a community as long as it can establish rules for the use of the resources. Examples could be: groundwater recharge; and use values of natural habitat and biodiversity.

Excludable and Non-Rival Goods (*e.g.* uncongested highways): The private sector could provide these goods by charging users, but this would lead to inefficiency because potential users with a positive willingness to pay are excluded. However, private provision might be better than government provision when the possibility of over-provision by government is taken into account. These goods become club goods when there is congestion. Examples could be: non-use values of natural habitat and biodiversity if some institutional arrangements like environmental trusts could be established.

Club Goods (*e.g.* golf club): Because of their excludable and congestible nature, these goods are likely to be provided by the private sector or the public sector financed by user fees. Examples could be: non-use values of natural habitat and biodiversity if some institutional arrangements like environmental trusts could be established.

Consumption relationships among externalities must also be examined to determine whether the externalities are causing market failures. This is because demand could vary depending on whether the externalities of interest are substitutes or complements in consumption. The likelihood of consumption interlinkages among negative and positive externalities will also affect the overall analysis.

A club providing multiple impure public goods sharing common characteristics (multi-product club) could be an option to avoid trying to estimate demand for multiple externalities. Members of the club would decide whether to join the club based on the cost (*e.g.* the membership fee) and the benefit of joining the club. The benefit of joining the club indicates their willingness to pay for using the multiple externalities simultaneously, which reflects substitution or complementary relationships among them.

Stability and equity issues associated with the provision of different impure public goods are also potentially important in the context of future policy discussions. The most efficient arrangements for providing some impure public goods may not be optimal from a stability and equity perspective.

Various institutional arrangements for providing public goods (*e.g.* voluntary provision, central government provision, local government provision, provision through taking advantage of joint-production, club provision, community provision, etc.) may have different degrees of stability. The termination of provision of a given public good not only causes its underprovision (or no-provision), but could lead to a greater overall efficiency loss than the case where the provision of a different public good is terminated.

Multifunctionality could have domestic or international equity, or income distribution, implications. At the domestic level, equity issues are also much more complicated in the case of multifunctionality than in the case of a single product because, in addition to the fact that the multiple goods are related, each good (externality) has different equity implications. For example, food security (as long as it is not achieved through price support) might favour the poor more than the rich, because the rich can buy food even if prices rise due to a shortage. On the other hand, rural amenities might favour the rich more than the poor because the demand for rural amenities usually increases with income. There are two issues relating to equity or distribution in the context of multifunctionality, which are: 1) how multifunctionality affects beneficiaries (the benefit implication); and 2) how the costs of preserving multifunctionality would or would not affect income distribution patterns (the cost implication).

Trade can improve all countries' welfare because of the existence of comparative advantages. The existence of negative and positive externalities associated with traded goods, along with any policies implemented to internalise them, could affect income distribution between the countries trading in those goods. This might lead to cases where trade does not increase all countries' welfare. How income distribution patterns actually change in response to trade and externalities is an empirical question, depending largely on the amount and nature of externalities in each country and the effect on the terms of trade for a given commodity of domestic policies to internalise the externalities.

Multifunctionality may have different effects in developing countries than in developed countries, although the analytical framework developed in this work could in principle be applied to both groups. Most of the differences between developing and developed countries with respect to multifunctionality are of degree not of nature. Such differences in degree may concern the levels and patterns of demand for non-commodity outputs, the institutional framework required for market creation and voluntary provision, transaction costs and the capacity of public administrations. However, they might have policy implications related, in particular, to domestic and international income distribution issues.

From an analytical framework to policy implications

The analyses of production, externality and public good aspects of multifunctionality undertaken in Parts II and III complement one another in that they treat respectively supply and demand aspects. The conclusions emerging from each element need to be combined in order to proceed to a discussion of the policy implications of multifunctionality. For example, examining the public good characteristics of non-commodity outputs requires information on how they are produced and how they are consumed. Determining the marginal benefits and costs of an externality requires an understanding both of supply (how it is jointly produced with a commodity) and of demand (how it is valued by society).

The work on production relationships and that on externality and public good aspects can also be interpreted as providing an analytical framework that defines a series of questions which should be posed sequentially in order to arrive at policy insights. More specifically, the answers to the questions will provide guidance on the appropriate policy responses, if any. Because of complicated inter-linkages, the questions may not always lend themselves to unambiguous answers. But they do provide a framework that will help keep the discussion sharply focused on the key issues that have been identified. They allow the elimination of cases in which policy interventions are not warranted while identifying others in which intervention may be beneficial and give some guidance as to the nature of the policy interventions that are likely to be most efficient. And, importantly, this analytical framework ensures rigorous, objective and consistent consideration of identified non-commodity interests and outputs.

The conceptual framework proposed would begin by examining whether a non-commodity output is jointly produced with a commodity and if so, whether it can be released from this jointness. If production is non-joint, the non-commodity outputs can be supplied independently. Similarly, if production of a non-commodity output can be separated from the production of a commodity output without any cost, the non-commodity output can be supplied independently. If this is the case, there may be no policy link between the goal of agricultural trade liberalisation and the goal of pursuing domestic non-commodity concerns. Policies that target only the supply of non-commodity outputs can

be established independently of agricultural production. However, it is still necessary to devise policies that would allow the non-commodity outputs to be sustained efficiently but this would not affect trade.

There are many ways to relax or weaken the linkages between commodity and non-commodity outputs. Changes in farming technologies and practices, for example, can reduce the degree to which environmental outputs are linked with commodity production. There are also various possibilities for lower cost non-agricultural provision of non-commodity outputs.

There may also be many non-commodity outputs, however, that cannot be released completely from jointness with commodity production. Non-commodity outputs that are jointly produced with commodities are by definition externalities but they do not always cause market failures. In this case it is necessary to examine whether the non-commodity outputs in question are causing market failures. If not, there is no policy issue, either from a trade or domestic policy perspective.

In fact, some examples of situations where positive externalities do not cause market failures have been identified. For example, supply of a non-commodity output from farmers whose production cost is lower than the market price may be sufficient to meet demand. In this case, there is no inefficiency even though the benefit of the externality has not been internalised in producers' decision making. Taking negative externalities into account could also reduce the risk of market failure associated with positive externalities.

There may still be non-commodity outputs for which both jointness and market failure have been established. In this situation it is necessary to determine if there are non-governmental options to minimise market failures. When market failures associated with externalities arise, measures are required to provide incentives to incorporate social effects into production decisions. The analysis to date suggests that there are various options for providing these incentives, depending on the public good characteristics of the externalities. For some types of public goods, non-governmental options may be the appropriate strategy.

Applying the proposed analytical framework enables identification of potential policy issues that could conflict with the goal of trade liberalisation. In summary, the questions to be addressed are:

- Is there a strong degree of jointness between commodity and non-commodity outputs that can not be altered, for example, by changes in farming practices and technologies or by pursuing lower cost non-agricultural provision of non-commodity outputs?
- If so, is there some market failure associated with the non-commodity outputs?
- If so, have non-governmental options (such as market creation or voluntary provision) been explored as the most efficient strategy?

Finally, and only if the answer to all these questions is “yes”, then the most efficient interventions will be defined by the nature of the jointness that exists on the supply side and by the different public good characteristics of the non-commodity outputs on the demand side. Various options, including central government provision, local government provision, provision through taking advantage of consumption relationships, club provision, and community provision should be carefully examined. Transaction costs, including administrative costs associated with various options should also be taken into account. Some of these options might eventually require a very limited role for the government. Stability concerns, equity concerns and international spillover effects may also affect policy choices.

It is recognised that the information requirements implied in answering this series of questions may be onerous, and that completely unambiguous answers may not always be forthcoming. Availability of information could itself affect policy choices.

It should also be noted that it may not always be possible to answer the three questions sequentially. The answer to the third question may emerge only after all the costs and benefits associated with possible options are compared. It might then be necessary to revert to the first question, for example, if agricultural provision is eventually found to be more costly than non-agricultural provision of non-commodity outputs.

Even with these practical difficulties, the framework (*i.e.* an in-depth exploration based on the three-questions) can serve as a tool to help policy makers to understand the main issues identified in this analytical work. The application of the framework is important in order to avoid policy developments that are ineffective, inefficient and costly, and that risk to conflict with international obligations. A full consideration of the costs of international spillovers of policies aimed at domestic non-commodity objectives needs to include, in addition to the market impacts caused by such policies, the positive and negative externalities created in other countries as a result of trade effects.

NOTES

1. See Box I.2 for a note on the terminology used in the study.
2. Demand assessment in the context of multiple outputs was one of the subjects of the OECD workshop on valuation issues, organised by the Territorial Development Service, the Agriculture Directorate and the Environment Directorate in Washington, DC, on 5-6 June 2000 (OECD, 2001a).
3. Most of the examples are taken from agriculture or from non-agricultural activities that compete with agriculture in the provision of non-food outputs. The agricultural focus reflects the role assigned to the Secretariat by Agriculture Ministers regarding the achievement of the shared goals for the agro-food sector, and the work programme of the Committee for Agriculture.
4. This agri-environmental work is well advanced and has covered subjects such as: policies for sustainable agriculture (OECD, 1995a); the link between farm forestry and the environment (OECD, 1995b); the environmental benefits from agriculture (OECD, 1997a); the environmental effects of land diversion schemes (OECD, 1997b); the links between agricultural trade, trade liberalisation and the environment (for example, OECD, 1997c, 2000a, 2001d); a summary of policy issues in agriculture and the environment (OECD, 1998b); the environmental effects of agricultural policy reform (OECD, 1998c); co-operative approaches to sustainable agriculture (OECD, 1998d); policies for sustainable water management in agriculture (OECD, 1998e); the role of reference levels for the remuneration of environmental services provided by farmers; criteria for the development of least-distorting agri-environmental policies; and a classification of agri-environmental measures. A workshop on sustainable farming technologies was held in July 2000 (OECD, 2001b). On the empirical side, a series of agri-environmental indicators is in the process of being developed (OECD, 1997d, 1999a and 2001c).
5. These conclusions refer to “technical” separability. Separability of a service from food production does not imply that farmers cannot be the least-cost providers of this service.
6. Some of these issues were addressed by the OECD Workshop on *Sustainable Farming Systems and Technology*, organised by the Joint Working Party of the Committee for Agriculture and the Environment Policy Committee and which took place in the Netherlands in July 2000 (OECD, 2001b). The OECD conference on Agricultural Knowledge Systems Addressing Food Safety and Environmental Issues, which took place in January 2000, also dealt with some of these issues (OECD, 2000b).

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