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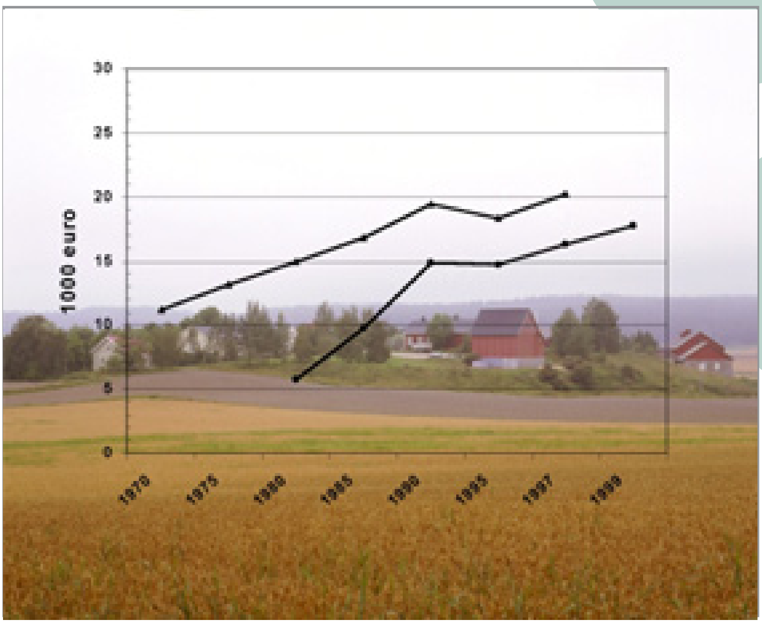
Agri-environmental and rural development indicators: a proposal

Anja Yli-Viikari, Helmi Risku-Norja, Visa Nuutinen, Esa Heinonen, Reija Hietala-Koivu, Erja Huusela-Veistola, Terho Hyvönen, Juha Kantanen, Satu Raussi, Pasi Rikkonen, Anu Seppälä and Elina Vehmasto



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Abstract

The present work is a proposal of a set of indicators prepared for the Ministry of Agriculture and Forestry. The indicators are to be used in monitoring the implementation of the Ministry’s strategy for sustainable use of natural resources. The goals of the strategy define the issues to be monitored. In selecting the indicators care has been taken, that the information provided by the chosen assessment themes and methods is based on reliable research data.

In the beginning of the paper the theoretical framework enabling the choice of the indicators is constructed. The indicator concept is then introduced. The general requirements in selecting the indicators as well as their role in decision-making are discussed. The present status of the national and international agri-environmental and rural development indicator work is shortly summarised.

The core of the present work is in setting up an indicator system, which is structured around specific themes. The focus is on the assessment of agricultural and rural development. At the end, an attempt is made to provide a comprehensive picture by considering the mutual inter-linkages between the various indicators.

The urgency to further develop the system approach as well as the indicator approach itself as a tool for decision-making is stressed. Many problems relate to inadequate and diffuse data available. The scarcity is especially accentuated in case of socio-cultural indicators, but also the environmental data are often insufficient and fragmentary. The prerequisite for balanced and coherent development is that due attention is paid to the various aspects of sustainability. Future indicator work requires that the assessment methods be improved, but also that the policy goals are expressed more precisely.

Key words: use of natural resources, sustainable agriculture, agri-environmental, rural development, indicators

Maatalouden ja maaseudun kestävän kehityksen indikaattorit: esitys luonnonvarastrategian seurantaan

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Tiivistelmä

Tämä julkaisu käsittelee uusiutuvien luonnonvarojen kestävän käytön arviointimenetelmiä. Indikaattorit on suunniteltu Maa- ja metsätalousministeriön luonnonvarastrategian seurantaa varten.

Aluksi esitellään arvioinnin teoreettinen viitekehys ja tarkastellaan yleisesti maatalouden kestävyyden määrittämistä. Lisäksi käsitellään lyhyesti indikaattoreiden valintaperusteet ja indikaattoreiden merkitys päätöksenteolle. Mukana on myös lyhyt katsaus nykyisin käytössä olevista kansallisista ja kansainvälisistä indikaattoreista.

Indikaattorit on valittu luonnonvarastrategiassa asetettujen tavoitteiden pohjalta. Valinnassa otetaan lisäksi huomioon se, kuinka indikaattoreista on saatavilla luotettavaa seurantatietoa. Mahdollisuuksien mukaan pyritään samanlaiseen tiedonkeruuseen kuin kansainvälisissä s eurannoissa.

Maatalouden seurantaan ehdotetaan 13 teemaa: luonnonvarojen käytön tehokkuus, torjunta-aineiden käyttö ja ympäristöriskit, maaperän laatu, vesistökuormitus, kasvihuone- ja ammoniakkipäästöt, tuotantokasvien ja -eläinten perinnöllinen monimuotoisuus, luonnonvaraisten lajien monimuotoisuus, maisema, eläinten hyvinvointi, alueellinen tuotantorakenne, maataloustulo, tuotannon jatkuvuus ja laatu. Maaseutukehityksen tarkasteluun ehdotetaan seuraavia seitsämää teemaa: maaseututuotteiden ja palveluiden käyttö, maaseudun yritystoiminta ja maatalouden monitoimisuus, kuluttajien asenteet ja tietoisuus, alueellinen kehitys ja maaseudun hyvinvointi, maaseutuyhteisöjen resurssit omaehtoiseen kehitykseen, palveluiden saatavuus ja luonnonvaratiedon hallinta. Lopuksi erilliset teemat kootaan yhteen, ja luonnonvarojen käyttöä tarkastellaan kokonaisuutena.

Tämä esitys luonnonvaraseurannan teemoista ja indikaattoreista tehtiin nykyisin saatavilla olevan tiedon ja osaamisen perusteella. Indikaattoreiden käyttöä päätöksenteossa on kuitenkin vielä kehitettävä. Monia arviointimenetelmiä on parannettava ja tietoaineistojen kattavuutta lisättävä. Suurimmat puutteet ovat sosiaalisen ja kulttuurisen tiedon saatavuudessa, mutta myös maatalouden ympäristöseuranta on vielä osin hajanaisten selvitysten varassa. Luonnonvarojen käyttöön liittyvää systeeminäkökulmaa tulee selkeyttää, jotta irrallinen tieto indikaattoreista kertoisi laajemmin luonnonvarojen käytön seurauksista.

Avainsanat: luonnonvarat, kestävä kehitys, maatalous, maaseutu, indikaattorit

Foreword

The Natural Resources Unit of the Ministry of Agriculture and Forestry commissioned MTT Agrifood Research Finland in January 2001 to prepare a follow-up report for the strategy of the use of natural resources. The basis of the work is the compilation of the indicators for the sustainable use of the renewable natural resources published in 1999. The aim of the Ministry is to couple the indicators firmly with the monitoring the implementation of the Ministry's strategy. This requires that the interest is focused on the most relevant themes, and that the clarity of the interpretation and of the visual presentation of the results be improved.

The Ministry appointed for the project an executive group, chaired by Heikki Granholm from the Ministry. The other members are Elina Nikkola also from the Ministry and the professors Sirpa Kurppa and Martti Esala from MTT. The specialist members of the executive group are the researchers Anja Yli-Viikari and Jukka Peltola, both from MTT.

Monitoring of the natural resource use requires wide expertise and familiarity with the cause-effect relationships of the most diverse phenomena. The specialists of the various research areas represent this expertise. The members of the research group from MTT and their specific area of responsibility are:

Esa Heinonen	– system analysis
Reija Hietala-Koivu	– landscape
Erja Huusela-Veistola	– plant protection
Terho Hyvönen	– species diversity
Juha Kantanen	– genetic diversity
Visa Nuutinen	– soil, water and air
Satu Raussi	– animal welfare
Pasi Rikkonen	– economy
Helmi Risku-Norja	– natural resource use
Anu Seppälä	– socio-cultural aspects
Elina Vehmasto	– socio-cultural aspects
Anja Yli-Viikari	– theoretical framework

In addition to the research group, also the following persons have contributed to the work: *Agrifood Research Finland:* Katriina Soini, Laura Alakukku, Martti Esala, Riitta Lemola, Outi Manninen, Ritva Mäkelä-Kurtto, Ansa Palojärvi, Jouko Sippola, Jukka Salonen, Hanna-Riikka Tuhkanen, Eila Turtola; Sanni Junnila, Pirkko Laitinen, Risto Uusitalo, Sirpa Kurppa;

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Their help in form of advice, critical comments and discussions is gratefully acknowledged. The present work contributes to the discussion on assessing the sustainability of agriculture and rural development and we hope that the discussion continues.

The Ministry's strategy covers also forestry and fishery as well as game and reindeer husbandry. The work on agricultural and rural development indicators has been done in co-operation with the organisations responsible for these activities, but their indicators are not included in this report.

The actual compilation of the report was done by Anja Yli-Viikari, Helmi Risku-Norja and Visa Nuutinen.

Jokioinen, 20 May 2002

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1 Introduction

Agriculture, forestry, game and reindeer husbandry and fishery are practised under the supervision of the Ministry of Agriculture and Forestry. The starting point for these activities are the goals that have been defined for the future development and that are expressed in the Ministry's strategy for the use of the natural resources.

The first strategy for the sustainable use of rural natural resources in Finland was prepared in 1997 (Ministry of Agriculture and Forestry 1997a). Although in that strategy the focus was on the ecological consequences of the resource use, the links to the economic and social development were also pointed out. The strategy has now been revised by taking into the account the recent challenges, such as the harmonisation of the environmental concerns within the EU, the work of the UN Committee for Sustainable Development as well as the measures required by the international agreements (Ministry of Agriculture and Forestry 2001b)

Information is the central prerequisite in the strategy planning. Accurate and up-to-date data are necessary in setting realistic and meaningful goals for the future development as well as in deciding about the appropriate measures to reach the goals. Data are needed also in measuring the progress towards the defined goals. In the new strategy attention has been paid especially to the development of the monitoring system. This is where the expertise knowledge has been called for.

Indicators are an area of growing interest as they provide a tool to handle and to control the complex issues of the societal development. Methodologically the formulation of the indicators implies organising and presenting the data in a form that is transparent and comprehensible for the various users. The basis for monitoring is the preliminary set of indicators, which was published in 1999 (Ministry of Agriculture and Forestry 1999a). In that report a set of 152 indicators for agriculture, game and reindeer husbandry, fishery and water management as well as for rural development was introduced. An extensive group of experts representing various research fields and stakeholders selected the indicators in a participatory process. For the forestry sector, the set of indicators was formulated and implemented as a part of the Finland's national forest programme (Ministry of Agriculture and Forestry 1999b, Ministry of Agriculture and Forestry 2000a).

Indicators for the sustainable use of the rural resources have now been tested for some years, and several serious defects have become apparent. The preliminary compilation is far too extensive, the data are still rather fragmentary and not always very informative as regards to the Ministry's strategy goals. The various sectors of the Ministry's area of responsibility are very heterogeneously represented, and the various aspects of sustainability are not adequately addressed. Furthermore, the mutual interdependencies of the various indicators have been ignored.

In the present work an effort to overcome the obvious deficiencies is made by focusing and further developing the indicator work. The monitoring system is also sharpened by concentrating on the central themes that have been emphasised in the Ministry's strategy, and a system approach is adopted in order to provide a more holistic picture of the various aspects of the sustainability.

The aim is:

1) to define a relevant theoretical framework for assessing the development of agriculture and rural areas;

2) to propose a coherent set of indicators with which the performance of agriculture and the rural development in Finland can be described.

Indicators for agriculture and rural development have emerged in recent years also into the focus of international interest. These issues are emphasised also in this work, and the sustainable use of the rural renewable resources is mainly reflected through agriculture. The present work, thus, aims at contribution to the national and international discussion concerning the indicators and their methodological development. On the other hand, the proposed set of indicators outlined here is to be used as a practical tool in monitoring, planning and decision-making.

The system approach and the general framework of assessment is first presented. The various aspects of sustainability are discussed in the section 2.3. The general criteria for selecting the indicators as well as the possibilities and the restrictions of the indicators as the source of information are discussed in section 2.4. The present status of the national and international agri-environmental and rural development indicator work is shortly summarised in the beginning of the section 3. The emphasis in section 3 is in setting up an indicator system, which is explicitly formulated to monitor the realisation of the Ministry's natural resources strategy. The indicator system is structured around the specific themes, which have been defined on the basis of the strategy goals. In section 3.3, the system perspective is adopted, and attention is drawn to the mutual linkages between the proposed indicators. In the concluding chapter the methodological problems are addressed and the needs for further development are pointed out.

2 Framework for assessment of the performance of agriculture and the rural development

2.1 Background

Agri-food sector is a crucially important part of the society, because it is a major factor affecting the public welfare and health and it also notably contributes - directly and indirectly - to the national gross product. Securing the renewal and productive capacity of the natural resources is considered to be of primary importance and this prioritisation forms the core of the Ministry's strategy planning.

Agriculture is an economic activity, which heavily relies on the availability of the natural resources. During the past few decennia agriculture has experienced a profound structural change, which is manifested e.g. in decreasing number of farms and farmers, in increased farm size and regional specialisation of the production (Statistics Finland 2000). Inevitably these changes have also a considerable impact on the environment and on the viability of the rural areas.

Beside the international trends towards more specialised production, the concern about the environment has led to quite opposite development with the interest focusing towards less intensive production, organic production and smaller production units. At the moment organic production in Finland comprises about 7 % of the total agricultural production. With the incentives of growing demand of organic products and the subsidies allowed for the transition period the share of the organic production is expected to the increase also in the future.

Whatever the production mode is, food has to be produced also in the future and the production will continue to modify the environment and the society in various ways. Both the Finnish Government and the European Union have confirmed sustainable development as the central goal for agriculture (Ministry of the Environment 1998a, CEC 2000). With the perception of the intimate link between agriculture and rural viability the view on the issues involved has become increasingly holistic. Although on a general level there is a broad agreement on the common goal of sustainable development, there is a still disagreement on what sustainability actually means and how it is promoted.

Agriculture has evolved along with the rest of the society towards an information society, where the various policy programmes and quality requirements guide the activity. Data are produced to plan the programmes, to follow their realisation, and to fulfil the increasing number of national and international standards. The data are supposed to increase the control over the development, but often the overwhelming flow of data appears confusing. On the basis of the fragmentary data quite contradictory opinions and measures can be interpreted as sustainable development.

2.2 Defining the rural renewable resources in a system approach

The first step of the assessment is to define the system to be investigated. The concept ”natural resource” is rarely used in the context of agricultural production, whereas the terms ”environment” and ”environmental management” have been more commonly used. These concepts differ somewhat as to the approach and the main emphasis. In environmental issues, the discussion has been dominated by the natural sciences, and the point of view is mainly from outside the farming activity. In the “resource use” the approach is more tightly fixed to the prerequisites for continuation of agricultural production and, therefore, also economic and social aspects are involved. The economic research has been especially active in developing these approaches.

However, the production system is crucially dependent on the environment and the environmental needs and conditions should, therefore, be considered as an internal component of the system. Furthermore, to obtain a real understanding of the system behaviour, it is necessary to use multidisciplinary approach and to pay attention to the interactions between the various factors and levels.

The agricultural system is defined here starting from its ecological basis (Fig. 1). Fertility of the cultivated *soils* is one of the basic ecological conditions of food production. *Cultivated plants* assimilate the solar energy and transform it into the primary products, which are further processed within the *animal husbandry* into the various animal products. The functioning of the production system is secured by the micro-organisms and a wide range of wild flora and fauna. These together comprise the agro-ecosystem, which provides the society with the food products and contributes to the availability of the *ecosystem services* and other public commodities within the society.

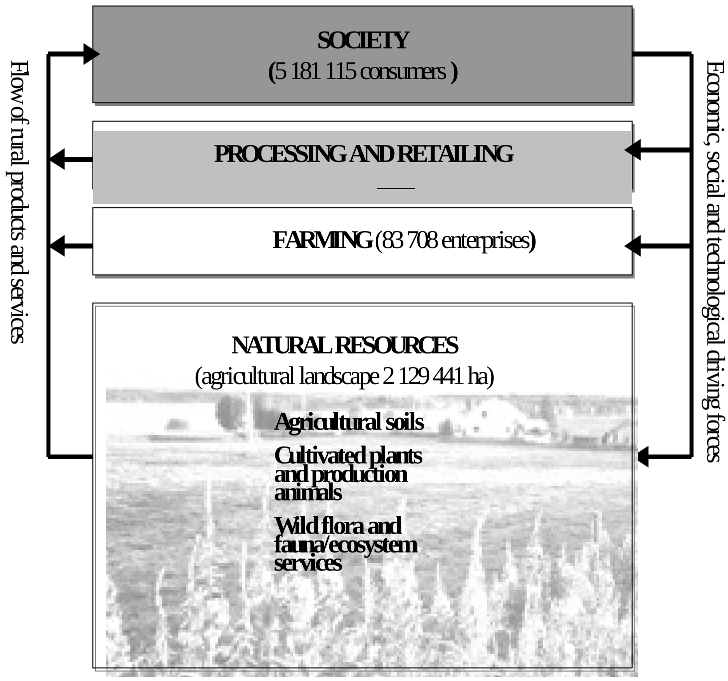

Fig. 1. The Finnish agri-food system. (Photo: Tapio Tuomela/MTT Agrifood Research Finland).

The agro-ecosystems are connected to other ecosystems via various inputs and outputs. Modern agriculture uses external inputs, which are imported from outside the local area. Some of the resources are renewable like the manure returned to the fields or the wood materials used in agricultural buildings, whereas others, such as fossil energy and mineral fertilisers, are non-renewable. On the output side, the agricultural products are used as raw materials for food, feed, fibre and energy industries. The environmental impact is not restricted to the agro-ecosystems, but has wider consequences, as the gaseous emissions and soluble and solid discharges are spread out into the air, watersheds, groundwater and soils and along the food chains.

The economic and social conditions largely dictate the extent and the patterns of the exploitation of the resources and, therefore, in the agricultural systems the ecological processes are interwoven with the economic and social development. The resource use is partly controlled administratively, but ultimately it is determined by the market demand, which depends on the consumption patterns and which is constantly modified by the cultural and technological changes. Altogether, the agri-food chain is a complex network, in which the farmers, processing and marketing enterprises, consumers as well as administrative, research and educational institutions each play a role. Sustainable use of the resources requires that there be, at every level of the system, a common view on what sustainable development means and how it is promoted. System dynamics have to be accounted.

The Ministry's strategy emphasises also the rural development perspective. Agriculture and the rural development are regularly studied apart from of each other, and they have also been developed as separate sectors of the society. However, rural development is intimately interlinked with agriculture. The origin of natural resources is in the countryside and the human knowledge as how to manage these resources is also rooted in the countryside.

For to conclude, in this work the term "natural resource" is understood in a very broad meaning comprising not only the raw materials of the production, but also the ecosystems as the source of the raw materials and as the target of multiple human measures and interactions.

2.3 Sustainability in agricultural production

The concept "sustainable development" (SD) was first introduced to the international forum in 1987 by the Brundtland Commission on Sustainable Development. SD was defined as "*a progress that meets the needs of the present generations without compromising the ability of future generations to meet their own needs*" (WCED 1987). During the 1990'ies the idea of sustainability has penetrated practically through all levels and sectors of the societies, inclusive agriculture and the food production.

The concept has contributed to the environmental discussion in several ways. It has pointed out the urgent need to extend all planning over long time horizons and it emphasises responsibilities towards the future generations. Environmental issues have been brought also to a broader framework by taking into account the economic and social aspects. Furthermore, the debate on sustainability has drawn the attention to the global nature of the environmental issues although, at the same time, the necessity of the local actions in tackling the problems is emphasised.

The term "sustainability" is very general and rather vaguely defined, which is seen also as the main weakness of the concept. The researchers are still debating about the content of the definition. In the political rhetorics SD has been successfully used for promising good for everyone without the necessity of making any commitments. The critics claim, that much more could have been achieved with a more precisely defined and concrete concept.

In spite of the criticism, the sustainability concept provides a basis for the discussions concerning the environment and the development. However, when discussing the sustainability issues also the restrictions of the term should also be born in mind.

For the first, all the needs of the future generations cannot be foreseen nor is it realistic to set fixed goals and to assume them to hold out over generations. Extending the time horizon means inevitably increasing the uncertainty (Pearce 1999). It has been suggested that the planning for the future should deal more with the qualitative questions and that the main focus should be on maintaining the ability to manage with the future problems. Adaptive management procedures leaning on the past experiences and responding appropriately should be adopted (Holling et al. 1997, Haila & Jokinen 2001).

Secondly, the environmental problems and the ways to solve them have proven to be very variable in different situations. It is not possible to define sustainability in a way, which would be universally true and which would, at the same time, provide precise operational guidelines.

Thirdly, the decisions on what is sustainable, for example regarding the use of the rural resources, are essentially value-related choices intermingled with multiple interests. Making these choices implies trade-offs between those who benefit and those who loose. The choices should be transparent so that the values and options behind them are visible and the choices are not blurred by the overwhelming sustainability rhetorics.

Fourthly, within the sustainability concept three basic elements - ecological, economic and socio-cultural - are embedded. Paying attention to each of these and applying the system approach, the concept provides a useful framework within which the overall impact of the resource use can be described. Within this broad framework, it is necessary to pinpoint also more precise questions and to use more precise terms and concepts.

In the following, the ecological, economic and social aspects are considered separately. However, it should be borne in mind that achieving an overall sustainability requires simultaneous development along each of the three lines.

2.3.1 Ecological sustainability

The ecological sustainability deals with nature and its ability to cope with pressures caused by human activities. The main concerns have been the depletion of the natural resources, the deterioration of the environment and the loss of the biodiversity.

Among the early warnings that brought into the public awareness the ecological limits of the Earth was the book “Silent spring”by Rachel Carson (1962). This was followed by the report of the Club of Rome, which emphasised that the resource base of the human existence is rapidly exhausted by the continuously increasing consumption and demand coupled with the exponential growth of human population (Meadows et al. 1972). With the discovery of new reserves, technological development and substitution of the materials the threat of the raw materials exhaustion proved to be premature. Instead, the modern society is facing the problems of the environmental deterioration and the loss of the biodiversity. This shifted the interest to the “end-of-pipe” thinking. In Finnish agriculture, the nutrient loading of the watersheds emerged in recent years as the major environmental problem, and a number of protection measures such as improving storage of manure, restrictions on fertilisation and creating buffer zones along waterways have been initialised.

However, there is an increasing awareness, that in addition to the outputs at the end-of-pipe, also the input side of the economy has to be accounted for. The measures of the society aiming at relieve the environmental burden are not adequate unless the level of the overall materials use is also reduced. This is framed out in the Fifth Action Programme on the Environment and Sustainable Development in the EU (CEC 1993):

”*the flow of substances through the various stages of processing, consumption and use should be managed as to facilitate and encourage optimum reuse and recycling, thereby avoiding wastage and preventing depletion of natural resource stock: production and consumption of energy should be rationalised; and consumption and behaviour patterns of society should be altered.*”

SD means adjusting the production and consumption patterns to the carrying capacity of the Earth. This requires that the world-wide materials throughput be halved within the next decades. By reducing the volume of the extracted raw materials, the environmental impact is relieved both at the input and output side of the production. This is because the extraction directly interferes with the functioning of the ecosystems, and because sooner or later the extracted raw materials are returned back to nature, usually in an altered form and in wrong places (Schmidt-Bleek 1998). Because at the same time the aim is to improve the standard of living in the developing countries, the main responsibility lies upon the industrialised countries. On the general level, the attempts to cut down the resource use have been expressed as the Factor-goals. In the industrialised countries the use of the natural resources has to be reduced to one tenth compared to the situation today. The same goal can be reached by decreasing the raw materials and energy input of the production, increasing the production per unit input or by carrying out both measures simultaneously (Factor 10 Club 1997, Lovins et al. 1997, Weizsäcker et al. 1997).

The World Business Council for Sustainable Development first introduced in 1992 the ecoefficiency-concept (WBCSD 2001). Ecoefficiency-thinking is also thinking in terms of the whole production chain. Improving ecoefficiency means lowering the environmental burden without decreasing the human welfare or the profitability of the production (OECD 1997, Ministry of Trade and Industry 1998).

The essence of ecoefficiency is to produce more out of less. Applied to agriculture, ecoefficiency means production of nutritionally better food by using less inputs and by reducing the environmental burden. The efforts to improve ecoefficiency can be concretised with the Factor-goals. The feasibility to realise the Factor-goals within the food chain has been investigated in Sweden. The results show that, by directing the measures to the whole chain, it is fully possible to improve the efficiency of the resource use by several factors without considerable changes in the present consumption behaviour (SEPA 1999a).

However, assessing the ecological sustainability from the data on materials use, with the focus either on the input or on the output side of the production, is not enough. Ultimately ecological sustainability depends on the ecosystem viability and on the availability of the ecosystem services. These include factors such as maintenance of fertile soils, nutrient recycling, detoxification and assimilation of wastes, sequestration of carbon dioxide, biotic regulation and maintenance of genetic information. The agro-ecosystems contribute to the availability of these functions, but also their own internal structure, resilience, regeneration and productivity rely on these life-supporting bio-physical processes *(*Daily 1997).

The agro-ecosystem and its functions at the interface of the natural and socio-economic systems is shown in Fig. 2. The present trend of the modern agriculture towards large-scale and one-sided production with increasing regional specialisation is crucially dependent on the external inputs, mineral fertilisers and fossil energy. This causes problems both within and outside the agro-ecosystems. The environmental consequences of the unsustainable agricultural practices are seen as losses of biodiversity, decreasing fertility of the cultivated soils, eutrophication of the watersheds and emissions of the greenhouse gases. A prerequisite for the ecologically more sustainable agriculture is to decrease the overall materials use and to relieve the environmental burden of the production. In this way also the viability and productivity of the agro-ecosystems is maintained and the availability of safe and healthy agricultural products as well as public commodities is secured. These are the issues that have emerged in the recent sustainability discussions (Kloppenburg et al. 1996, Helenius 2000).

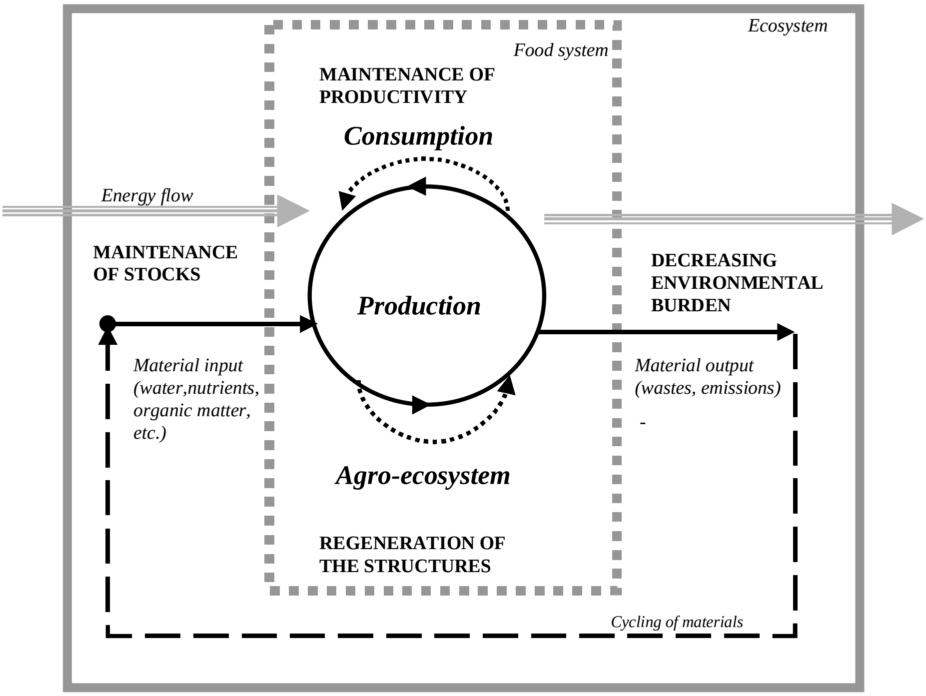

Fig. 2. Foodsystem and its functions at the interface with other ecosystems.

2.3.2 Economic sustainability

Within the border conditions of the ecological sustainability, there is still a range of possibilities to provide the society with food and other rural products and services. The economic approach stresses the *efficiency of the production*. In optimising the efficiency the various production alternatives are weighed against the profitability of the production and its welfare effects.

At the region and enterprise level, improving efficiency means increased competitiveness. Economically viable firms can better take into the account the requirements of the customers and adjust their production accordingly. The efficiency is likely to lower the price of the products and it, thus, benefits also the citizens.

The functioning of whole food systems is in Finland organised by private enterprises. To guarantee the continuation of the production the enterprises have to be *profitable.* The prerequisite of the profitability is efficiency. The question is, however, not that simple, because agriculture produces also a number of public commodities for the society and it contributes to the availability of the ecosystem services. Profitability of the farming enterprises depends on how the society wants to arrange the food production and to what extent the environmental and social needs are emphasised. The degree of their appreciation is reflected in the amount of compensation given to the farmers. The amount of compensation that farmer receives is also a question, which relates to distribution of the welfare within the society. In this respect, the economic and social aspects of the sustainability approach each other.

The efficiency requirements in agriculture have to be balanced with the goals of the overall societal development. Maximum efficiency in monetary terms may provide the citizens with low food prices but, at the same time, it may result in increased environmental burden and in deprivation of the farmers. This causes additional environmental and social costs for the society, which should also be accounted for.

The current economic research is, among other things, interested in the repercussions of the ecological and social needs of the society on the market system. In Finland, there are two administrative programmes, which are specially directed to balance the current market system. The compensation the farmers are entitled to for providing the society with the environmental services and public commodities is considered within the Finnish Agri-environmental Programme (FAEP). The aim of the National Quality Programme is to guarantee the quality of the agricultural products and to produce objective information to enable the citizens to compare the quality-price relationship within the food markets.

The basic question could be addressed also in terms of assessing the *quality of the economic growth in agriculture*. One school of the economists point out that the liberation of the markets and globalisation of the economies brings about economic growth and that the economic welfare is again the prerequisite to satisfy the environmental and social needs of the society. Rational behind the argument is that with increased productivity and economic wealth, more funds can be released also for improving the environment (Dragun & Tidsell 1999). However, the idea of unlimited growth within a limited planet is contradictory. To avoid the overexploitation of the natural resources and the continuously increasing pressure on the environment, the focus should be shifted from the quantitative to the qualitative growth. Also in agriculture it is important to recognise those development paths that lead to maximum economic growth with minimum environmental and social costs.

Quality of the growth may be assessed by considering the maintenance of the capital stocks. Economic growth should base on the profits of the capital while preserving the capital. Sustainability approach should comprise as well the social and natural as the economic forms of capital (Pearce 1999, Pearce & Warford 1993). However, it has been argued, whether trade-offs between the various forms of capital could be acceptable and possible without depriving the future generations their options to equal welfare. A fairly common view is that the exhaustion of the natural resources is not a real threat because, to an extent, the exhausted raw materials can be substituted with the technological innovations. Supporters of the idea of ”strong sustainability”, by contrast, argue that sustainability implies that the natural capital stocks are preserved and that they are treated as a separate, non-substitutable category (Atkinson et al. 1997).

The ecological economists provide another way to evaluate the quality of the economic development. They argue that in the long-term agricultural development it is essential to find the *balance between the increasing specialisation of the production and the maintenance of the diversity of the production structures.* Increased competition will decrease the diversity of the economical systems as it does in the ecological systems (Perrings 1996, Rammel & Staudinger 2000). Under the circumstances of competition the system structures tend to become increasingly specialised. The specialised structures are vulnerable, because their resilience and their ability to adapt to the changing circumstances is lowered.

2.3.3 Social and cultural sustainability

Social and cultural issues are the third supporting corner of the sustainability concept. Although the core of the definition for SD is the human well-being, so far, surprisingly little attention has been paid to these aspects. A possible explanation is that welfare is a rather broad and vaguely defined concept. The issues are difficult to describe with quantitative key figures, the less to subordinate the decision-making to these figures. Social and cultural issues should rather be studied in qualitative terms allowing also the plurality of the values and perspectives.

The basis for the social sustainability was laid by the Brundtland commission, which stressed the right of everyone to equal opportunities for welfare, both in temporal and spatial terms (WCED 1987). The goal is commonly accepted and, in the recent decennia, both the social and economic research has been concerned in comparing and measuring the extent of human welfare. However, there are no easy ways to compare the welfare of the various nations or groups of people with different historical and cultural backgrounds. Human beings have the same basic needs concerning the food and shelter as well as the identity, freedom and self-esteem, but these needs are culturally bound, and to adequately satisfy them means different things at different times and in different cultures. The research has mostly been concerned with the material standard of living and its changes; it has largely failed to describe and to interpret, how the standard of living is qualitatively experienced in different times and in different cultures.

In the agricultural context, the key question is the *distribution of welfare between the rural and urban areas***.** In recent years along with the social processes of urbanisation, many of the rural structures and services have disappeared. To secure their livelihood people have moved to the urban areas. At the same time, the remaining rural population is growing older and the viability of the rural communities diminishes both in economic and social terms. However, the natural resources and the knowledge how to use them, remain in the rural areas. One of the key questions of the societal development is to what extent the centralisation process and the consequent depopulation of the rural areas can be regarded as acceptable.

The welfare of the rural population creates also economic competitiveness for the rural areas. When the rural population and the entrepreneurs feel their own life secure and comfortable, more human resources can be released for innovations, and the flexibility to respond to the challenges of the information society is increased.

The relevant question as regards the socio-cultural sustainability of agriculture is *the society's ability to manage the use of the natural resources*. Agenda 21 states out that sustainability is basically a process of change, which is guided by the human goals, awareness and values (Ministry of the Environment 1993). In order to improve sustainability there has to be a common social awareness of the present day situation. The goals for the future development are based on these common values. Handling the complex issues requires that the societies develop new models of actions. This takes place in the process of *social learning*, which is essential to meet the challenges of sustainability (Kloppenburg et al 1996, Bryden & Shucksmith 1998, Pretty 1998, Haila & Jokinen 2001). Social learning means also that, in addition to the assumptions explicitly shaping their own understanding, the actors recognise also the assumptions and values of other stakeholders. This allows collective negotiation about the meanings and definitions, and forms therefore, the basis for the subsequent policy development (Handmer et al. 2001).

To find the appropriate solutions requires human, social and cultural capital. *Human capital* comprises all the recorded forms of human knowledge, both scientific and the local silent knowledge, which is founded on the social learning. *Social capital* means ability of the people to co-operate and to establish social networks of trust. *Cultural capital* is the identity of the communities, and it is based on their common values and past experiences.

The concept of *participation* is also strongly emphasised in the sustainability context. Sustainable use of the rural resources cannot be planned and implemented by the authorities without the participation of the people, who make the actual decisions in their every day life (Edwards et al. 1993). Only the stakeholders have the relevant knowledge concerning themselves, and they also ultimately bear the consequences of the problems. Plurality of the values and interests, provided by the stakeholders, offers several possibilities to solve the problems. However, increasing the level of participation increases also the expenses of planning and renders the decision making more difficult. The balance between the participative bottom-up and the administrative top-down models, has to be found in each situation.

Dealing effectively with the sustainability issues, requires also sufficiently stable *institutional structures*. This is an important aspect, because it secures the coherence of the long-term development. Institutional stability has even been suggested to present the fourth dimension of the sustainability concept (Hinterberger et al. 1997).

2.3.4 Summary

Sustainability approaches, which have been discussed here, are summarised in the Table 1.

Table 1. Some key approaches for assessing sustainability in agriculture.

Ecological aspects:

- **maintaining the stocks of the natural resources**
- **minimising the environmental burden**
- **maintaining the ecosystem viability and ecosystem services**
- **securing the availability of the rural products and services**

Economic aspects:

- **optimising the social welfare with efficient use of the resources, both in production and in environmental management**
- **maintaining the profitability of the producing, processing and retailing enterprises within the agri-food chain**
- **securing the quality of the economic growth; ecoefficiency, maintenance of the capital stocks and the resilience of the economic structures**

Social and cultural aspects:

- **securing equal opportunities for welfare in the rural and urban areas**
- **social learning in managing the natural resources**
- **promoting participation**
- **developing appropriate institutional conditions for sustainable use of natural resources.**

Ecological, economic and social goals have their own nature and rational, but they also have much in common. In each of these systems, there appears to be a continuous struggle between the short term need for increasing efficiency and specialisation and the long term need for preserving the diversity, which enables the systems to adapt to the changing circumstances.

Another essential feature is the regeneration of the system structures. The ecological sustainability depends on the natural capital and this relies on the reproductivity of the species and on the regeneration of the ecosystem structures. The economic systems require investments to maintain the material capital, and in the social systems the transfer of knowledge is necessary for maintaining the human capital.

The questions associated with the use of the natural resources are holistic. In order to find a tolerable balance between the ecological, economic and socio-cultural aspects, the questions have to be evaluated simultaneously from these different perspectives. Only then the sustainability concept can be translated into the praxis.

The operational sustainability goals for the Finnish agriculture have been specified in the Ministry's strategy (Ministry of Agriculture and Forestry 2001b). In the following, the focus is on these goals and on the indicators that are necessary to follow up the progress towards the defined goals. The general criteria for selecting the indicators as well as the possibilities and the restrictions of the indicators as the source of information are first discussed.

2.4 Assessment process and the criteria for selecting the indicators

2.4.1 Indicators as a tool for adaptive management

The purpose of an indicator is to convey information in a simple, concise and easy-to-interpret manner (Fig. 3). The term" indicator" refers to a datum, or to a value derived from a set of data, that provides key information for the decision-making about the investigated phenomenon. The significance of the indicators extends beyond that direct value of the datum itself. This means that the indicator should manifest - indicate to - some larger phenomenon than what it itself represents (Dappert et al. 1997, Hakanen 1999, OECD 1999. The data need to be comprehensible for various users. The users of the agri-environmental indicators are: 1) the policy makers, who set out the political priorities, 2) the authorities, who plan and implement the measures to meet the goals, 3) the actors of the system, who make the final decisions on the resource utilisation.

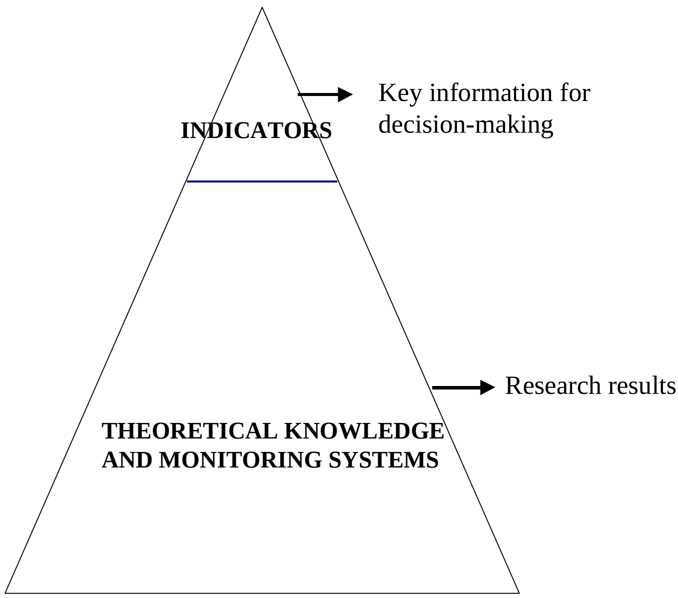

Fig. 3. Indicators are key figures, which are based on extensive research and broad understanding of the phenomenon at issue.

In a policy process, such as the ministry strategy planning, the role of the indicators is to provide information on the consequences of the political decisions. The indicators help to transform the raw data into a form that facilitates the decision-making and the managing the complex agricultural and environmental issues. On the basis of this follow-up information the goals for the future and the measures to reach the set goals can be targeted more precisely. Deeper understanding of the reasoning behind the decision-making leads to more specific assessment methods and to new indicators. Thus, this is a continuously developing process with more precise measurements and better management. In managing the use of natural resources this kind of adaptive management is especially important as the system is highly complex and the decision-making is predisposed to a number of uncertainties.

Basically, the main restriction of the indicator approach is that the indicators describe only what is happening and to what extent. However, the decision-making requires that also the processes behind the described phenomena be understood. Also the interrelationships between the various indicators at the system level have to be considered. Indicator data need to be developed within a framework, which adequately represents the system under examination (OECD 1999).

Different kinds of classifications e.g. Pressure-State-Response model (OECD 1999) have been proposed in order to describe the large systems more comprehensively. So far the indicator sets have been at a rather general level and the attempts to deal with the system dynamics have been largely ignored. In formulating new sets of indicators one of the main challenges is to describe the mutual interdependencies of the various indicators and the overall system dynamics.

The data are produced by specific methods, which are open to uncertainties and misunderstandings. In the following, the main methodological choices affecting the final data quality are shortly discussed.

2.4.2 Collecting and analysing the data

Data availability. One of the common requirements is that the implementation of the indicators should be based as far as possible on the existing statistics. In Finland, there is plenty of information available on the agricultural practices and their economic consequences. The statistics, therefore, provide a wide data basis, that can be utilised in formulating indicators for various purposes. However, the availability of environmental and socio-cultural data may be more limited.

The readily available environmental data are often based on field investigations. They are derived from certain regions in Finland and the spatial and temporal coverage is, therefore, restricted. Updating the data, which require collecting and analysis of the field samples, is very expensive. Recently, approaches based on the modelling of the management activities and on the use of the production inputs have been developed to obtain environmental data. For example the nutrient leaching can be studied by taking water samples or by modelling the farming activities. Both approaches have their own sources of uncertainties, and in future, probably the best results are obtained by using them in combination.

As to the social and cultural issues there is a clear dichotomy on the data availability. Plenty of statistical data are available on the topics such as employment, health care, education and demographic changes, which are in Finland institutionally supervised. On the other hand, the more qualitative issues, such as the rural-urban relations, social networks, social learning and cultural changes have been considered only occasionally in few, spatially and temporally limited case studies.

Data quality. Usually the raw data have to be processed before it can be used in the decision-making. In analysing the data, a number of choices are made, and these influence the quality of the final results. The first question to be considered is the representativity of the results; to what extent the results can be generalised and what kinds of uncertainties are associated with them. In some issues such e.g. the farm incomes, the data are collected yearly and the statistics cover all the farms. The data are, thus, fairly reliable. In other cases, e.g. the nutrient leaching caused by the agriculture, the situation is quite different. This is because the extent of leaching depends on the interplay of several factors, which are very different in different places and at different times.

Among the social indicators the data quality issues are the most difficult. For example, the quality management in agriculture can be described quantitatively by counting the number of the quality contracts. However, the degree of personal commitment and shared responsibility in food chain should be also regarded. Deriving this kind of data and evaluating their reliability, is much more complicated than the quantitative measuring of the physical phenomena.

The quality of the data depends also on the degree of the data aggregation. Compared to the very detailed data, the aggregated data are easier to handle in decision-making. However, by aggregating the data part of the information is inevitably lost. For example, the Total Material Requirement (TMR) sums up the weights of very different materials and the link between a specific environmental impact and its cause is lost. The Life Cycle Analysis (LCA) uses a different approach, the environmental impact of the various phases of the production are made commensurate by using specific weighing procedures. Whatever the approach is, it is essential that the methodological choices associated with the data, are transparent and the major uncertainties of the approach are presented. This allows the users themselves to evaluate the reliability of the information provided by the indicators.

Costs of the data. Also the costs of collecting and analysing the data have to be taken into account. Usually the costs increase rapidly with the improved quality and coverage. The sound decision-making is based on optimisation between the adequate amount and quality of the data and the costs of acquiring those data.

2.4.3 Presenting the data and interpreting the indicators

Indicators are tools for communicating the data to people with different occupational and educational backgrounds. The results have to be presented, therefore, in a visually clear form, preferably graphically. The essential aspects of the investigated phenomenon should be outlined with as small number of indicators as possible.

Indicator report should provide also a meaningful interpretation of the presented figures and numbers. The data can be informative as such or the development trends can be revealed by examining time series data or by comparing the performance between regions and countries. Often averages are used, but in some cases, the variation is more informative. More specific indicators are obtained by interlinking the data from various sources, e.g. the environmental data with the production volumes, the productive land area or nutritional content of the food providing thus information relative to some variable.

However, these kinds of presentations do not tell, how far the present day situation is from the desired state. Sometimes it may be necessary to set up a target level to describe the meaning of the changes for the stakeholders.

Setting of the target levels for indicators is a phase, where research results are interwoven with political and ethical claims. At this point, the researcher's contribution is to present background knowledge about the phenomenon and about the plausible effects of the alternative management practices. Feasible development, appropriate measures and a realistic time span for progress is defined on the basis of this information.

Defining target levels is a political question, because the level depends on the prioritised strategy goals. For example, the quality of the agricultural soil can be assessed in terms of maintaining the productivity. This requires, among other things, an adequate nutritional level for the cultivated plants to grow. However, the soil quality may be also considered by minimising the nutrient leaching, which may result in a different target level.

The sustainability issues are often many-faceted. They are also subject to uncertainties, because of the interplay of several factors that contribute to the development. Therefore, setting up the target levels depends essentially on the desired strategy goals, and several controversial approaches are possible. In decision-making the choices require mutual negotiations and a balance between the conflicting interests. Ultimately, the playroom for the decision-making is restricted because of the limited availability of the resources.

2.4.4 Summary

In selecting the indicators attention has to be paid to the relevance, feasibility and availability of the data. The indicators should reflect the impact of the agricultural activities. The goals of the agricultural and environmental policy define the relevance of the issues to be monitored, the feasibility is increased by applying a system approach and by considering the mutual interlinkages between the various indicators. A practical requirement is that reliable data at appropriate aggregation level are available or can be collected at reasonable cost.

3 Setting up the indicator system

3.1 International background

The national indicators of Finland should be in line with the international appraisals**.** The assessment of the environmental performance of agriculture has been for some time in the focus of the international attention, but it is still a fairly young field of research. Developing the indicator approaches were accelerated by the United Nations meeting in Rio de Janeiro, where the need for monitoring the development were specially highlighted (Ministry of the Environment 1993, UNCSD 1996).

The internationally used agri-environmental and socio-economic rural indicators are compiled in Appendix 1. OECD was among the first to start to develop the assessment methods for agriculture in the early 1990'ies. The preliminary results have been recently presented as an international comparison of the environmental performance of agriculture (OECD 2001). Agriculture is described with 29 indicators, which cover the topics of farm management, use of natural resources and environmental impact of agriculture. Also some socio-economic indicators on the changes in farm financial resources as well as data that link the agriculture to the broader context as part of the society are presented.

The European Commission has also been also active in this field. Environmental assessment methods have been developed in collaboration between the Directorates General for Agriculture and Environment, EUROSTAT, the Joint Research Centre (ISPRA) and the European Environment Agency. The EC indicators have been formulated with the primary aim to monitor the effects of the implementation of the Fifth Environmental Programme and to integrate the environmental requirements into the Common Agricultural Policy - CAP (CEC 1999b, EEA 1999, 2000).

So far, the commission has proposed its own set of environmental indicators for agriculture and has outlined a preliminary framework for selecting the social and economic indicators. Especially the possibilities and the methods to integrate the statistical and administrative data with the land use information have been actively explored. The report on agriculture, environment and rural development presents the current statistics on these issues (CEC 1999a, 2000, 2001a, 2001b).

The UN Commission on Sustainable Development (CSD), European Centre for Nature Conservation (ECNC), World Bank, FAO and several single nations have also contributed to the development of the agri-environmental and rural indicators (FAO 1998, Bryden et al. 2000, MAFF 2000, McRae et al. 2000, Wascher 2000, World Bank 2000, WWF 2000, Bryden 2001).

In the international assessment the issues are usually discussed at a very general level. Also a large variety of approaches and assessment methods is still used. One of the major problems in the multinational appraisals has been the availability of the data. This has resulted in an inadequate coverage and it affects also the quality of the results. Comparisons between the various indicator works are, therefore, not necessarily unambiguous.

A practical example of the interpretative pitfalls is the way the biodiversity of the Finnish agricultural landscapes is presented in recent OECD report (2001). In the report it is stated that "the share of birds that uses agricultural land as habit" is 10 % in Finland. At first glance, the figure appears to be quite low compared to that in the other countries. It should be, however, noted that the figure actually tells about the diversity of the Finnish landscape, where there are plenty of other kinds of habitats available for the birds. The overall level of information regarding the biodiversity remains poor, as this data represent the only figures available on the Finnish agro-ecosystems.

The social aspect of the sustainability has been brought into the focus only recently, and the related indicators are especially poorly defined. Measuring the social and cultural performance of the nations is not a simple task, because they depend on the local situations and because each country and region has its own historical background (Soini 2000). At the moment, the main challenge is to find the appropriate themes, with which the societal development can be adequately described. OECD and EC have adopted here an approach of broader rural development (OECD 2001, Bryden et al. 2000, Bryden 2001, CEC 2001b.

Besides the methodological questions, setting up the indicator systems is inevitably also a matter of international agreements and, therefore, a political process. Ideally, the priorities are set at the policy level. The information provided by the selected indicators should then reflect the progress towards the set goals as precisely as possible. In practice, the politically defined sustainability goals are quite abstract and general. This means that the issues are focused and the actual decisions are made only during the assessment process. At this stage the opposite national interests may arise. Instead of objectively weighing the choices against the defined common goals, the indicator work may become an instrument of political power. The basic choices should be made at the political level when the goals for the overall development are agreed upon. International co-operation requires concrete and precisely defined goals that provide a sound basis for assessment and monitoring.

In conclusion, the international indicators do not yet provide adequate and reliable information for the decision-making. Common understanding is lacking and conceptually and practically satisfactory sustainability indicators are still under development. The assessment methods and the interpretation of the results have to be developed further within a system framework and in international co-operation to improve the comparability of the data. This is the prerequisite to attain a common agreement and acceptance on what the results tell. In addition, indicators that provide information about the specific local circumstances are needed as tools for the national decision-making.

3.2 Proposed indicators for agriculture

In selecting the indicators for monitoring the Ministry's strategy the topics were first outlined. The currently used national and international indicators were scrutinised (Appendix 1). Also the data availability as well as the quality and the costs of the data collection were discussed. These were the criteria when choosing among the various data sources and analysis methods the most suitable for the present proposal. The total number of indicators was kept as low as possible without losing the multiple aspects of agricultural sustainability. The management activities are not especially highlighted here, because the impact of the measures are specific to the circumstances and cannot be really evaluated at national or international level. The focus in this work is, instead, on the state indicators. The final themes and the proposed indicators are presented in Table 2.

Table 2. The themes and the proposed indicators to be described.

Strategy goals	Themes and indicators
- Ecoefficient use of resources - Maintenance of agricultural lands	**1. Use of natural resources in production** -agricultural land use -resource efficiency (TMR) -energy efficiency
- Minimising the risks of pesticide use	**2. Pesticide use and risks** - pesticide sales (kg of active ingredients per hectare) - environmental risk indicator may be later added to monitoring system
- Preserving the soil quality	**3. Soil quality** - nutrient status (P mg l^{-1}) - acidity (pH(H_2O)) - organic matter content (Org C %) - heavy metal content (Cd mg l^{-1}) - indicators of physical and biological soil condition may be later added on to the indicators
- Minimising the agricultural loading	**4. Loading to watersheds** - nitrogen balance at national and regional levels (kg ha^{-1}

	year^{-1} of total agricultural land; 1990 to present) - soil P concentration (mg l^{-1}); phosphorus balance will be later added.
- Minimising the emissions	**5. Greenhouse gas and ammonia emissions** - agricultural emissions of nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) and total greenhouse gas emissions in carbon dioxide equivalents -agricultural emissions of ammonia
- Preserving the genetic resources - Promotion of domestic species	**6. Genetic diversity** <u>domestic animal diversity:</u> - classification of the breeds and sub-populations within a breed and information on population numbers - estimation of the effective population size of the breeds and genetic distinctiveness of the breeds <u>plant diversity:</u> - total number of crop varieties that have been registered - share of key crop varieties in total marketed production - the number of national crop varieties, that are endangered
- Maintenance of diversity of wild species	**7. Diversity of wild species** <u>threatened species</u>: number of threatened species in each species group in 1985, 1991 and 2001 <u>birds:</u> population change index by habitat requirement category <u>butterflies</u>: population change index by habitat requirement category <u>non-cultivated plants</u>: average species number and average number of individuals per square meter by decade (1960s, 1980s and 1990s)
- Maintenance of diversity of habitats - Care of cultural landscape	**8. Landscape** - habitat level indicator: edge density of fields;km/100ha per Employment and Economic Development Centre. - landscape level indicator: openness in agricultural landscape; ha per Employment and Economic Development Centre. - socio-economic landscape indicator: utilisation of farm tourism accommodation in Finland ; %/year or month
- Animal welfare	**9. Animal welfare** - number of sentences for prohibited animal rearing - condemned carcasses in Finnish slaughterhouses
- Regionally diversified production structure	**10. Regional structure of agricultural production** - distribution of main production lines regionally
- Profitability of farming - Equal level of welfare of farmers	**11. Income changes in agriculture** - income changes - structure of total incomes - profitability
- Providing the societal circumstances for the occupation	**12. Continuation of farming** - investments - generation transfers
- Quality and safety of the products - Attention in food chains and traceability - Adopting of quality systems	**13. Quality management and assurance** - number of certified farms (quality & environmental quality) - number of educated farms - number of quality contracts with external clients

Theme 1 Use of natural resources in production

The following indicators provide information on the agricultural resource use:

Agricultural land use

Definition and purpose

The environmental impact of agriculture is directly dependent on the land use, and the land use also reflects the development trends of agriculture and the overall vitality of the rural areas. The arable land comprises at present about 2150 thousand ha inclusive the 223 thousand ha of fallow. This is about 7 % of the total land area in Finland. Since the beginning of the 1970 the cultivated land area has decreased by about 25 %. Although there have been no marked changes in the total area of agricultural land, during the past ten years organic production has emerged as a seriously taken alternative to the conventional agriculture. At the moment, organic production comprises about 7 % of the total agricultural production. With the incentives of growing demand and the subsidies allowed for the transition period for organic farming the share of the organic production is expected to increase also in the future. One of the goals of the Ministry is the preservation of the area of arable land under cultivation or in a form that is easily converted back to cultivation.

Evaluation of the current indicators

In the various compilations of agri-environmental indicators land use or its derivatives are in one form or other included (MAFF 2000, Agri-Food Canada 2001, CEC 2001a, OECD 2001). The agricultural land use, exclusive organic production, was also among the earlier set of the Finnish agricultural indicators (Ministry of Agriculture and Forestry 1999a. Ministry of the Environment (2000) complemented the land use indicator with the data on organic production and implemented it as one of the indicators of sustainable use of natural resources.

Sustainability cannot be directly referred from the land use, but the data on the area of conventional and organic farming as well as the share of the fallow from the arable land provide essential background information. Although there is evidence that organic farming is ecologically more sustainable than conventional, the evidence is not unambiguous (e.g. Grönroos & Seppälä 2000). Whether or not the changes in land use are coupled with the development towards increasingly sustainable agriculture as referred from the other indicators proposed in this report remains to be seen.

The methods and data requirements

Data on the area of cultivated land, fallow and organic production are annually compiled by the Ministry of Agriculture and Forestry (Ministry of Agriculture and Forestry 1983-2000). Cultivation of the energy crops has been expressed as one of the goals of the Finnish Governments Program for Sustainable Development. Eventually the area dedicated to energy production is included within the land use indicator (see 3. Energy efficiency)

The responsible organisation for monitoring and updating the data is Ministry of Agriculture and Forestry. The possible correlation of the changes in use of agricultural land with other sustainability indicators and its implications are evaluated by MTT Agrifood Research Finland.

Presentation of the results

The data on the area of conventional and organic cultivation as well as of the fallow are presented as a time series histogram. Eventually the area of energy crop production is implemented into the same histogram.

Resource efficiency

Definition and purpose

During the past decennia agricultural production has markedly intensified, in 30 years the yields per hectare have nearly doubled, but the use of agrochemicals and energy has increased almost at the same pace (Risku-Norja 1999). Inevitably these changes have also a considerable environmental impact. The problems are related to the biodiversity, the maintenance of the soil fertility, the eutrophication of the watersheds and to the emissions of the greenhouse gases. The impact is not restricted to the agro-ecosystems, but has wider consequences, because the gaseous emissions end up directly into the air and the surpluses of the nutrients and biocides enter the soil, remain there or are subsequently moved into the watersheds or into the air.

The basic factor causing environmental stress is the continuous flow of materials from nature to the economy and eventually as wastes and emissions back to nature. The material flow consists of the direct material inputs (DMI) or the material content of the final products as well as of the so-called hidden flows or the ecological rucksacks. These are those natural resources that are necessary at some stage of the production, but are not included within the final product. Together these comprise the total material requirement (TMR) of the production, which can be used as a crude overall measure on the environmental impact. This is because the extraction of the natural resources directly interferes with the functioning of the ecosystems, and because the extracted raw materials are eventually delivered as wastes and emissions back to nature. By reducing the volume of the extracted raw materials, the environmental impact is relieved both at the beginning and at the end of the materials throughput (Bringezu 1997, Schmidt-Bleek 1994).

Evaluation of the current indicators

In recent years, TMR-based indicators have been vividly developed. Indicators such as TMR/capita, BKT/TMR, resource efficiency, resource productivity and material intensity have been introduced (Adriaanse et al. 1997, World Resources Institute 2000. The benefit is often expressed in monetary units. The indicators base on highly aggregated data, and they have been used to describe the development trends at the level of nation-wide economies. Similar approach was used in assessing the efficiency of the use of the non-renewable resources in agriculture in Finland (Risku-Norja 1999). In Sweden the possibilities of the food sector to realise the Factor-goals by improving the ecoefficiency of the food production have been evaluated (SEPA 1999a). At the enterprise level, the World Business Council for Sustainable Development has been active in developing similar indicators to assess the ecoefficiency of the enterprises (WBCSD 2001).

The methods and data requirements

The TMR, of course, is dependent on the extent of production, and more meaningful information is obtained when the TMR is related to the total production volume. Resource efficiency describes the benefit-input relationship of the production; the production volume or the Direct Material Output (DMO) represents the benefits and the TMR the input needed to obtain the benefits. Improving the resource efficiency implies that the TMR is reduced without decreasing the production volume, which means that more is produced out of less. This is also the essence of the ecoefficiency -concept, and therefore, resource efficiency can be used as one expression of the ecoefficiency. The inverse of the resource efficiency - TMR/DMO - is analogous to the product-specific MIPS –indicator (Material intensity per service unit, Schmidt-Bleek 1998).

The extent and tempo of progress towards increasing resource efficiency can be evaluated by considering the numerical value of the indicator to that of a given reference year as a time series. The resulting factor is an expression of the change relative to the reference level. The approach may be helpful in defining the Factor-goals for future and in monitoring the progress towards the set goals.

The necessary data comprise the production statistics, the sales statistics of lime, fertilisers and biocides, the energy consumption as well as the agricultural import with the associated hidden flows. The data from various sources are compiled annually by the Ministry of Agriculture and Forestry. All data must be converted to tons. The total production volume as well as the data on import inclusive the hidden flows, all converted to tons, are available from the compilation of the total material requirement of the Finnish economy, which covers the time range from 1970 to the present (Mäenpää et al. 2000). In assessing the TMR of agriculture the readily available data need to be complemented with the hidden flows of the agrochemicals. A systematic way to assess energy consumption of agriculture needs to be developed.

Monitoring requires continuous updating of the data, which should be done annually. However, the changes in the efficiency of resource use become evident only over longer time horizon. The progress could be evaluated in periods of five years. The goals for five years periods could be defined by examining the tempo of change during the past 10-20 years. The responsible organisation for updating and monitoring is Ministry of Agriculture and Forestry, evaluation and definition of the goals as well as the periodic revision of the accounting system is done in co-operation with Environmental Research of MTT Agrifood Research Finland .

Presentation of the results

Graphic presentation of the time series data.

Energy efficiency

Definition and purpose: Agriculture in Finland is crucially dependent on the non-renewable resources, mineral fertilisers and fossil fuel. These resources are gradually exhausted world-wide and, therefore, the production is inherently unsustainable. Besides the threat of the exhaustion of the non-renewable resources, their use contributes to the overall environmental deterioration as a consequence of extraction and processing the raw materials, and in form of emissions of the green house gases and nutrient leaching into the watersheds.

Although the efficiency in use of the non-renewable resources has markedly improved since the beginning of the 1990'ìes, the efforts to close the nutrient cycles are restricted mainly to organic farming, and no serious efforts to extensively substitute the fossil fuels with renewable energy sources have been made. Undoubtedly the efficiency of the non-renewable resource use can still be improved by technological innovations, more accurate targeting and timing of the cultivation measures and increasing co-operative or commercial use of the machinery, but the basic requirement is effective recycling of the nutrients and substituting the fossil energy with energy from renewable sources.

In principle, the excessive leaching of nutrients in to the watersheds can be managed, and this is monitored with the long-term nutrient balances. As long as the fossil fuels are used, their combustion contributes to the greenhouse gas emissions presumably leading to the global climate change.

In agriculture energy is used both directly for heating and in driving the machinery, and indirectly in manufacturing the fertiliser and biocides and the machinery. In 1993 the primary production, agriculture and forestry, used 34 petajoules energy, which is about 8 % of the total energy consumption in Finland (Statistics Finland 1999a). Out of the total energy consumption in Finland the renewable energy sources comprise about one quarter, the majority of which is produced and also used within the wood processing industry (Ministry of the Environment 2000). So far no data are available, how this share is allocated to the various production sectors. The renewable energy is derived from various sources, the most important of which is wood and wood chips, but also sun, wind, water, earth as well as biogas are utilised. In future, the fossil energy may be to an extent substituted with cultivated energy crops such as e.g. coppice and mustard. So far there has been only very preliminary research and development projects in this field (e.g. Laiho 2001). On the other hand, e.g. in some of the states in the USA the obligation to substitute fossil fuel with fuel from energy crops has already been implemented (e.g. Sustainable Minnesota 2001).

Evaluation of the current indicators

Fossil energy consumption is a widely used sustainability indicator (MAFF 2000, Agri-Food Canada 2001, CEC 2001a, OECD 2001). Also in Finland the urgency to develop methods to monitor the energy consumption in agriculture has been pointed out. Energy balances were suggested as one possibility (Ministry of Agriculture and Forestry 1999a). In the energy balance the sum total of the energy content of the various inputs, inclusive their manufacturing and the transports, is related to the energy content of the harvested yield (Korkman 1998). Calculating the energy balances requires a lot of detailed data, and little is gained compared to more simple methods. The efficiency of agricultural energy use in Finland has been assessed by considering the total production volume and the direct energy consumption (Risku-Norja 1999).

Methods and data requirement

One of the goals of the Ministry’s strategy is to increase the use of the renewable energy sources, but without data the realisation of the goal cannot be verified. There is, thus, an urgent need to systematically collect the relevant data. These include the amount of solar, wind and water energy as well as the bio-energy (wood and wood chips, methane from biogas, energy crops) used in agriculture. The indicator is the share of the renewable energy from the total direct energy consumption in agriculture. Eventually a simple indicator showing the area dedicated for cultivation of the energy crops can be used. As long as there are no data available on the share of the renewable energy from the total energy consumption, progress towards more sustainable production is indicated by the increase in the efficiency of the energy use.

Data on the energy consumption by the various production sectors are available from the Statistics Finland. The rural business districts would most conveniently gather the data on the use of renewable energy in agriculture. The responsible organisation for combining the data from these sources, for updating and monitoring is Ministry of agriculture and Forestry, evaluation and definition of the goals is done in co-operation with Environmental Research of MTT Agrifood Research Finland.

Presentation of the results

Efficiency of the energy use is presented in a graph with time series data on the yield per hectare and energy consumption per hectare. Changes in the efficiency are evident in decoupling the two curves. When data on the renewable energy use are available, the share of the renewable from the total energy consumption is shown in histograms. The area dedicated to cultivation of the energy crops is implemented to the histogram on land use (1: Agricultural land use).

Theme 2 Pesticide use and risks

Definition and purpose

Pesticides (insecticides, fungicides, herbicides) are used to control insects, plant diseases and weeds in order to decrease their abundance and thus to maintain or to increase crop yield and quality. Use of pesticides depends on infestation level of pest, disease and weed pressure in which weather and type of crop play a key role. Furthermore, farming and pest management practices as well as economic and policy factors affect pesticide use levels.

Although pesticides are targeted against specific pest species, they may have adverse effect on non-target species and environment. The impact of pesticides on the environment depends on the pesticide selection, application method, risk management measures and the amounts used. Many countries, including Finland, participate international programmes with commitments to reduce pesticide use and risks (e.g. CEC 2001d, UNEP 2001). Reduction in pesticide use is not always equivalent to a change in environmental risk.

Developing reliable indicators of pesticide risk is complex because pesticides include many active ingredients and the toxicities of the active ingredients vary greatly. Way of using (exposure) and characteristics of active ingredients (toxicity, mobility, persistence) cause different risk levels to terrestrial or aquatic environment and to human health. Quantity, application time and frequency of pesticide use play an important role, but the risk of the side effects of pesticides depends also on crop and site specific conditions (e.g. soil properties, weather). Although pesticide side effects on particular test organism have been detected, overall effects of pesticides and pesticide combinations on natural ecosystems are difficult to evaluate.

Evaluation of current indicators

In OECD's agri-environmental indicators, two kinds of indicators have been developed: pesticide use and pesticide risk (OECD 2001). Index of pesticide use, classified pesticide use, pesticide soil contamination and pesticides in water have been included in EU's Agricultural indicators (CEC 2001a). In Finland pesticide use (sales) is proposed as an indicator in previous indicator works (Ministry of Agriculture and Forestry 1999a, Ministry of the Environment 2000). The environmental risk indicators are still under development and it is important to find a balance between the ease of use and the complexity of terms and data requirements. Furthermore, there are very few measurements available of pesticides in water and in soil.

Method and data requirements

In Finland, statistics about the sales of pesticides have been collected since 1953 by the Plant Production Inspection Centre (KTTK) (e.g. Savela et al. 2001). Pesticide sales (active ingredients) are often used as a proxy for pesticide use, but they do not report actual area treated by pesticides or frequency of applications on a particular crop or field. Pesticide sales, however, can be used as a general indicator of pesticide use. Furthermore, by using data of Agricultural field plot database produced by the Association of Rural Advisory Centre & Finnish Agricultural Data Centre (Association of Rural Advisory Centre 2001), more detailed data on pesticide use on different crops , for example . potato, cereals, can be obtained.

The trends in pesticide use and the estimated environmental risk are often positively correlated. However, different types of toxicity and patterns of use must be taken into account when environmental risk is evaluated. Finnish Environment Institute (SYKE), has been developing the assessment of environmentally hazardous chemicals, inclusive pesticides (Seppälä 2001). The specific pesticide sub-indicator will combine the data on dangerous properties (toxicity, bio-accumulation, persistence) and use/sales of pesticides. So far, eco-toxicity assessment has been based on aquatic toxicity only, but assessment of relative weighting of these properties including also other properties is under development. Pesticide risk indicators should combine information on pesticide hazard and exposure with the quantity of pesticide used and conditions of use that might affect the risk (OECD 1999).

Therefore, more data on behaviour of pesticides in Finnish conditions are needed to create reliable indicator models.

Presentation of the results

Time series of pesticide sales (kg of active ingredients per hectare of agricultural land) from 1953 to present and the interpretation. The environmental risk indicator is under development and may be added into the monitoring system later.

Theme 3 Soil quality

Definition and purpose

Agricultural soil is the foundation of food production. Arable soils also provide a number of essential ecosystem services including the moderation of hydrological cycle and regulation of important element cycles (Daily et al. 1997). Good soil management is therefore in the core of sustainable agriculture.

The maintenance of arable soil fertility is one goal in Finland's strategy for the use natural resources. Thus the agri-environmental support programme of Finland includes several aims relating to soil management. They include the raising of soil organic matter content, improving the accuracy of fertilisation and reduction of soil acidity in certain areas. The steering of soil management towards the goals requires information on soil properties, which contribute to soils capability to produce good yields safely. Further, due to soil's role as an interface between agriculture and environment, soil information is needed to judge how favourably soils interact with water and air.

The properties which define soil's functioning in its diverse roles are chemical, physical and biological in nature. The concept of soil quality acknowledges this diversity of influences (Doran et al. 1994, Karlen & Andrews 2000). A widely used definition presents soil quality "as the capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation" (Karlen et al. 1997). Although the soil quality concept has been criticised (Sojka & Upchurch 1999), in agricultural context it is positively widening the ways by which arable soil conditions are evaluated. Agri-environmental soil quality indicators would ideally reflect this trend.

Evaluation of current indicators

Finland. In the current set of agri-environmental indicators for Finland soil quality is addressed by three indicators (MINISTRY OF AGRICULTURE AND FORESTRY 1999a).

The first indicator consists of three chemical state indicators: soil phosphorus content, pH and organic carbon content. In addition, a pressure indicator for soil compaction (weight of tractors sold) is included.

Soil phosphorus is one of the main plant nutrients and serves as an indicator for the growth conditions in the soil. Because phosphorus is the major cause of eutrophication in fresh waters (Ekholm 1998, Turtola 1999) the follow-up of soil phosphorus level is further useful in the evaluation of loading risk. As relates to pH, Finnish soils are inherently acidic and there is a risk of further acidification e.g. due to acid rains and fertilisation (Hartikainen 1992). Since low pH interferes with the nutrient uptake of plants, the monitoring of soil pH is warranted. Follow-up of soil organic matter (SOM) content is valuable because SOM interacts with a number of soil components (Doran & Jones 1996). It for instance improves the structure of mineral soils and enhances nutrient and water retaining capacity of soils. Further, SOM is the resource base of the soil decomposer food web. In the absence of more direct indicators of biological soil quality it can act as an indicator for soil's potential to maintain biological activity.

The above three indicators are derived from MTT's monitoring programme of cultivated Finnish soils (Starr et al. 2000). In the programme there has been three sampling campaigns , in 1974, 1987 and 1997. Results of the first two samplings have been published (Sippola & Tares 1978, Erviö et al. 1990). The results of the third sampling will be reported during the year 2002. In the indicator report of 1999 (Ministry of Agriculture and Forestry 1999a), additional information for the phosphorus level was derived from the soil test data set of Viljavuuspalvelu Oy (2000).

Deterioration of soil structure due to compaction is a timely threat to sustainable field crop cultivation in Finland (Alakukku 1997, Kylä-Setälä & Assmuth 1996). The monitoring of soil structural changes would therefore be important. However, no follow-up programme for physical soil quality currently exists in Finland. The tractor weight time series data applied in the earlier indicator report (Ministry of Agriculture and Forestry 1999a) was obtained from calculations done for one particular study (Alakukku 1997). While the increasing weight of field machinery is certainly linked with the compaction risk, its usefulness as the sole compaction indicator can be questioned. One reason for this is that technical developments (e.g. usage of dual tyres, new tyre and machine types) may at least partly compensate for the harmful effects of heavier machinery on topsoil compaction.

The second indicator is a state indicator for the heavy metal content of agricultural soils. Lead and cadmium were chosen as the indicators. Both elements can affect negatively human and animal health, if they accumulate in the food chain. Cadmium has entered agricultural soils mainly through phosphorus fertilisers containing variable amounts of this trace element, and through atmospheric deposition. Applications of animal manure and municipal sewage sludge have also had an effect on the cadmium level in arable soils. Traffic, particularly leaded gasoline used in motor vehicles, has been the most important source of lead in agricultural soils. Cadmium and lead values were derived from MTT's soil monitoring programme (above).

The third indicator relates to the organisms of arable soil. This indicator was included to emphasise the need to develop biological indicators of soil quality. No actual indicators were proposed. Information on particular aspects of soil biota in Finnish arable soils is available. It involves, for instance, knowledge on various aspects of soil communities in organically vs. conventionally managed fields (Hannukkala et al. 1990, Kukkonen & Vesalo 2000, Palojärvi et al. 2000), under different levels of fertilisation (Kahiluoto 2000) and in differently tilled soils (Nuutinen 1992). However, the lack of knowledge on the importance of soil biota in Finnish arable soils and on the effects of soil management on soil life has been repeatedly recognised (Kylä-Setälä & Assmuth 1996, YM 1998a,b). This relates to the research needs in soil physical quality as soil organisms affect soil structural features in a number of ways.

OECD and EU. Two of OECD's agri-environmental indicators, risks of soil erosion by water and wind, deal with soil quality (OECD 2001). Both indicators measure the risk of actual soil loss from arable land. So far the water erosion risk has been evaluated comprehensively within OECD by applying the universal soil loss equation (USLE). Within the tolerance limits set, risk of water erosion is not deemed a problem in Finland. However, for instance in steep, clayey riverside valleys under continuous cereal production in southern Finland erosion can be a local problem (Rekolainen et al. 1992). It is obvious that wind erosion is a minor problem in Finland.

EU indicators of soil quality are under development and presently described only sketchily. The proposed soil quality indicator is defined as a measure of agricultural areas where there is a mismatch between soil capability and the actual or impending land-use (CEC 2001a). Future will tell how this indicator will be implemented in practice.

Conclusions. Agri-environmental indicators of OECD deal with soil quality rather narrowly and the indicators chosen there are not particularly well suited for Finland. In EU the soil quality indicators are still taking their form. At present, a set of national soil quality indicators for Finland is therefore necessary and well justified. Evidently for the same reason national soil quality indicators are being used also in other countries (e.g. SEPA 1999b, MAFF 2000, McRae et al. 2000).

The current set of chemical soil quality indicators provides a base for further indicator follow-up in Finland. The set resembles the national soil quality indicators in Sweden (SEPA 1999b) and United Kingdom (MAFF 2000). Also, the European soil monitoring framework proposal includes indicators for soil nutrient supply, soil acidification and heavy metal content (EEA 2001).

MTT's soil monitoring programme is unique in Scandinavia for its spatial and temporal coverage. However, the programme has suffered from insecure and diminishing funding. This has resulted in constant decline in the number of fields included in the follow-up (2000 sites in 1974, 1320 in 1987 and 752 in 1998). It is important for the agri-environmental indicator programme that the continuation of MTT's monitoring study is guaranteed. Viljavuuspalvelu Oy's data will be available for indicator follow-up also in the future. For soil phosphorus and pH levels this data set can be used, if necessary, to cover the time intervals for which MTT's data are not available.

The continuation of heavy metal monitoring is important, cadmium being the most timely target for the follow-up. MTT's monitoring programme is the only long term data set on heavy metal concentrations in Finnish arable soils, which further underlines programme's value for the indicator purpose.

For physical and biological aspects of soil quality the opportunities for indicator follow-up are not as good as for chemical indicators. There is a clear need to develop physical indicators to monitor structural soil deterioration. The importance of soil compaction follow-up has been noticed elsewhere and field measurement and modelling based approaches have been adopted (SEPA 1999b, McRae et al. 2000). Occurrence of surface water on fields is used as an indicator of soil structural problems in the monitoring of agri-environmental programme’s effectiveness in Finland (Mytvas2; 2000-2006). If that method proves efficient, it could in future be added into the indicator set.

The possibilities to develop biological soil quality indicators should be thoroughly investigated. National arable soil monitoring programmes, which include biological soil variables, are being carried out or planned in a number of European countries (Bloem). MTT is presently participating in an EU funded project: “Biotechnology of soil: Monitoring, conservation and remediation" (COST 831)”. Programme's one goal is to develop microbiological and biochemical methods for soil quality monitoring. Further, a plan to incorporate selected soil macrofauna in MTT's national soil monitoring programme is included in the initiative for national biodiversity monitoring (Ministry of the Environment 2001).

Method and data requirements

It is suggested, that the soil quality follow-up will presently be based on four indicators: 1) *nutrient status* (P mg l^{-1}), 2) *acidity* (pH(H_2O)), 3) *organic matter content* (Org C %), 4) *heavy metal content* (Cd mg l^{-1}).

The indicators will be derived from three data sets. *The first data set* is based on MTT's monitoring programme of cultivated Finnish soils. It involves all four indicators. Sampling at fixed field sites is carried out at ten year intervals. The fourth sampling of the programme will take place in 2008. The sampling scheme and the soil analyses of the study are described by Erviö et al. (1990). *The second data set* is Viljavuuspalvelu Oy's constantly accumulating data set from farmers' fields. Of the four indicators this material involves phosphorus and pH. Depending on the time interval of indicator reports, this data set may in some years be the only available source of up to date soil information. In the Viljavuuspalvelu Oy's data set a change of target population occurred in 1990's. This must be taken into account in the planning of data collection and in the interpretation of the results. *The third data set* originates from MTT's monitoring programme of 150 sites in the fields of MTT’s farms and regional research units. It includes all the four indicators (Urvas 1995, Sippola et al. 2001). This programme was started in 1992, and the second sampling was carried out in 1997. Resampling is planned to occur at five year intervals, the next sampling taking place in 2002.

Phosphorus and pH values can be evaluated by relating them to the reference values prepared for different soil types (Viljavuuspalvelu 2000). Phosphorus levels can be further evaluated by comparing them to the values defined as critical for leaching (Yli-Halla et al. 2001 and references therein). Due to the great variability of soils across the country, a well-grounded division of the data must be planned for the reporting of the indicators (for example mineral vs. organic soils, different geographical districts).

At EU level, the indicators relate to at least two directives. As a leaching risk indicator, soil phosphorus content links with the framework directive for water policy (60/2000). Evaluation of pH and cadmium contents are included in the list of necessary prior measurements in the sludge application (sludge directive, 1986/278/EEC). There is also a link with cadmium’s health and environmental risk assessment which is being been carried out in EU to evaluate the need of setting a cadmium limit for phosphorus fertilisers (Ministry of Agriculture and Forestry 1997b, Louekari et al. 2000).

Responsible organisation. Environmental Research of MTT Agrifood Research Finland. The evaluation of Viljavuuspalvelu Oy's data is carried out in collaboration with the company.

Presentation of the results

Time series of each indicator is presented for the whole country and by relevant subcategories.

Theme 4 Loading to watersheds

Definition and purpose

In Finland agriculture is a major contributor to phosphorus and nitrogen loading to watersheds (Rekolainen & Leek 1996, Ekholm 1998, Turtola 1999). According to one estimate, 43 % of phosphorus and 27 % of nitrogen leaching comes from agriculture (Statistics Finland 1999a). Leaching of nutrients from arable soil causes not only pollution but also economic losses to farmers. Diminishing of the loading is therefore a major goal in Finland's strategy for sustainable use of natural resources. One of the main objectives of the agri-environmental programme and the associated support to farmers is to reduce nutrient load to surface waters. The programme actions include plant cover on fields during the winter, reduced tillage, improved accuracy of fertilisation and establishment of buffer zones. The follow-up of nitrogen and phosphorus leaching risk is necessary to evaluate how effectively the targets defined for the reduction of loading (Ministry of the Environment 1998b) are being reached.

Evaluation of current indicators

Finland. In the 1999 indicator report two indicators for loading and erosion from arable land were included: the sales statistics of fertilisers (N, P and K; kg arable ha^{-1}) and water quality classification of rivers and lakes heavily influenced by agriculture (Ministry of Agriculture and Forestry 1999a). For the latter indicator, a classification was prepared for three time periods (mid 1980's, early 1990 and the target year 2005) during the definition of the national water protection targets (YM 1998c). Fertiliser sales statistics were obtained from the company sales data of Kemira Oyj. The statistics are representative due to company’s leading market position.

OECD and EU. Both in OECD and EU, soil surface nitrogen balance has been proposed as an indicator for nitrogen leaching risk (OECD 2001, CEC 2001a). The indicator is defined as the physical difference - surplus or deficit - between nitrogen inputs and outputs in the agricultural system. In OECD the indicator is expressed as kilograms of nitrogen per hectare of total agricultural land. A persistent surplus is taken as an indication of potential loading to watersheds. Refined risk indicator for water quality has been proposed within OECD but it has been not yet widely adopted (OECD 2001). Moreover, water quality state indicator for nitrate and phosphorus in vulnerable agricultural areas is included in OECD indicators. Corresponding indicators of EU are under development.

Conclusions. The need to develop leaching risk indicators was emphasised already during the earlier agri-environmental indicator work in Finland (Ministry of Agriculture and Forestry 1999a). The soil nutrient balance approach has since been applied in the set of indicators for sustainable development in Finland (Ministry of the Environment 2000). The same method is currently being applied in the follow-up study of the effectiveness of the agri-environmental programme in Finland (Mytvas2; 2000-2006). In that study the nitrogen balance will be calculated for the whole country and different agricultural districts from 1990 to present. The same approach could be used for the phosphorus leaching risk. Althought owing to the differing dynamics of the nutrients, the balance approach is less suitable for phosphorus than for nitrogen. The development of phosporus balance at state level will be estimated in the evaluation of the Horizontal Rural Development Programme.

It will be suggested here that the leaching risk indicators for nitrogen and phosporus would be based on nutrient balance calculations. For phosphorus leaching risk, topsoil phosphorus concentration (Theme 3) will be used as an additional indicator.

The strength of the soil based loading risk indicators is that they may respond rapidly to the changes in farming practices whereas there is a significant lag in the response of water quality in catchment scale. As the ultimate interest lies in water protection, also indicators of water quality should in future be incorporated in the follow-up. Extensive water quality monitoring is carried out by the Finnish Environment Institute (SYKE) and the usefulness of the data sets for the follow-up of long-term term development should be investigated. Of SYKE's study projects, the small catchment follow-up (Rekolainen 1989) and the recently started monitoring of lakes influenced by agriculture appear particularly promising for the development of agri-environmental indicators.

Method and data requirements

It is proposed that nutrient leaching risk from arable land will be monitored by two indicators: 1) Nitrogen: *Nitrogen budget of agricultural soil in state and regional levels* (surplus or deficit, kg ha^{-1}), 2) Phosphorus: *Topsoil phosphorus levels. Phosporus budget of agricultural soil* will be included in the indicator set when the data becomes available.

Nitrogen: Indicator for nitrogen leaching risk will be obtained from the follow-up study of the effectiveness of the agri-environmental programme in Finland (Mytvas2; 2000-2006). In the programme, the nitrogen balances are estimated at state and region levels and at a few selected farms. Nitrogen output in yield is subtracted from nitrogen input in manure, inorganic fertilisers and other sources. The difference, nitrogen surplus or deficit, is used as an indicator for leaching risk. A surplus is taken to indicate the risk for leaching to watersheds. The indicator will be calculated starting from year 1990 to present. Information needed for the calculations is obtained from official agricultural censuses and sales statistics. After termination of the Mytvas2 -project the follow-up can be continued with the same method. Because nutrient balances do not necessarily estimate accurately the risk of adverse environmental effects, the results must be evaluated critically and attempts made to develop the approach.

Phosphorus: Data on the soil phosphorus levels will be obtained from the sources specified earlier in Theme 3. The rationale of phosporus balance calculations is similar to the calculations descriped above for nitrogen. The calculations will be done at state level during the mid-term evaluation of the Horizontal Rural Development Programme.

The two indicators relate to several targets, regulations and agreements of water protection. Nationally the most important one is the water protection target to 2005 (Ministry of the Environment 1998c). The indicators relate closely to agreements on the protection of the Baltic Sea (see e.g. Statistics Finland 1999a). The indicators are closely linked with EU's nitrate directive (91/676/ETY) and the framework directive for water policy (60/2000).

Responsible organisations would be MTT Agrifood Research Finland. Information on nitrogen will be collected in department of Environmental Research, Soils and Environment and information on phosphorus in department of Environmental Research, Environmental Management.

Presentation of the results

Nitrogen: Time series of nitrogen balance (kg ha^{-1} $year^{-1}$ of total agricultural land; 1990 to present) at state and regional levels. *Phosphorus*: Development of soil P concentration (mg l^{-1}) in MTT's and Viljavuuspalvelu Oy's data sets; time series of phosporus balance.

Theme 5 Greenhouse gas and ammonia emissions

Definition and purpose

Agriculture is one source of the greenhouse gases, which are widely believed to contribute to the warming of the atmosphere and climate change. Arable soils have also potential to act as significant sink of greenhouse gases. Gaseous emissions of agriculture include ammonia which originates mainly from manure and slurries and contributes to soil acidification and eutrophication of waters.

Estimation of agricultural emissions to air is difficult due to the decentralised nature of production, and there is much insecurity involved in the estimates. It has been calculated that in Finland 10-15 % of the reported greenhouse gas emissions come from agriculture (Pipatti et al. 2000, Ministry of Agriculture and Forestry 2001a). The main greenhouse gases produced by agriculture are, in the order of importance, nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2). Nitrous oxide originates from nitrification and denitrification and causes approximately 40 % of total emissions from agriculture. Methane sources include enteric fermentation of livestock and anaerobic decomposition of organic matter. The main carbon dioxide sources are decomposition of organic matter, liming and combustion.

One topical goal in Finland's strategy for the sustainable use natural resources is to diminish the emissions to atmosphere. Indicators are needed to follow how effectively the reduction is being reached. As relates to greenhouse gases, according to the Kyoto Protocol of Climate Change, Finland must restrict its emissions to the level of year 1990 during the years 2008-2012.

Evaluation of current indicators

Finland. Time series of ammonia emissions (kt NH_3 $year^{-1}$; 1950-1995) is the sole indicator for gaseous emissions in the previous set of agri-environmental indicators for Finland (Ministry of Agriculture and Forestry 1999a). The estimate was prepared by the Finnish Environment Institute (SYKE).

OECD and EU. In OECD the indicator of agricultural greenhouse gas emissions is the total agricultural emissions of N_2O, CH_4 and CO_2, expressed in CO_2 equivalents (OECD 2001). Estimate is calculated following the guidelines of Intergovernmental Panel on Climate Change (IPCC). In the indicator proposed for EU, aggregated annual emissions of the three gases, weighed by their warming potential, are reported separately (CEC 2001a).

Conclusions. At present there is an international agreement within the IPCC how to calculate the greenhouse gas emissions of agriculture. The methods are applied in international (OECD 2001 and national (e.g. MAFF 2000, McRae et al. 2000) agri-environmental indicators. The methods are currently used in Finland's national greenhouse gas inventory, which is compiled annually by the Finnish Environment Institute (SYKE) for United Nations within the Frame Convention for Climate Change. In the inventory, agricultural emissions of the three main greenhouse gases are calculated for each year from 1990 to present.

It is proposed here that in addition to ammonia emissions, estimates of N_2O, CH_4, CO_2 and total greenhouse gas emissions are included in the indicator set.

Method and data requirements

The proposed indicator for gaseous emissions consists of two parts: 1) *Annual agricultural emissions of nitrous oxide* (N_2O), *methane* (CH_4) *and carbon dioxide* (CO_2) *plus total greenhouse gas emissions in carbon dioxide equivalents, 2) Annual agricultural emissions of ammonia*.

Indicator values for greenhouse gases will be calculated following the internationally agreed guidelines of IPCC as a part of Finland's national greenhouse gas inventory. The calculation method and its Finnish applications are described in detail by Kulmala & Esala (2000) and Pipatti et al. (2000). Estimates are calculated from 1990 to present. The calculation method is constantly improved and when changes in the method are introduced the time series is recalculated accordingly. Ammonia emissions are estimated in connection with the greenhouse gas inventory.

Responsible organisation. At present Finnish Environment Institute (SYKE), from 2002 on Environmental Research of MTT Agrifood Research Finland.

Presentation of the results

Greenhouse gases: Time series (1990 to present) of annual agricultural emissions for N_2O, CH_4 and CO_2, plus gross agricultural total emissions in CO_2 equivalents (Tg CO_2 equivalents year^{-1}). *Ammonia*: Time series of total NH_3 emissions from agriculture (from 1950 to present, tentatively).

Theme 6 Genetic Diversity

Definition and purpose

Genetic variation of the domestic animals and crop plants is an essential resource of the agricultural production. During the last decennia, as a consequence of demands for high-input farming systems, locally adapted farm animal breeds have been almost totally displaced by international breeds (Scherf 2000). In crop plants, a similar trend is seen in disappearance of cultivated landrace varieties and their replacement with uniform, commercial cultivars (e.g. Ahokas & Manninen 2000). Animal breeding methods, such as artificial insemination and embryo technology have made the propagation of desirable genotypes efficient. However, conservation of the existing genetic variation is vital for maintaining the genetic diversity of the domesticated animals and crop plants, because it guarantees the vitality, adaptation ability and breeding potential of the various production species. Furthermore, the local native breeds and crop varieties are a valuable part of the cultural heritage.

Method and data requirements

The relevant indicators for animal genetic diversity are listed in the OECD paper (2001): 1) for the main farm animal categories, the total number of farm animal breeds that have been registered and certified for marketing, 2) the share of key farm animal breeds in the total animal numbers (e.g. the share of Holstein cattle in total cattle numbers), 3) the number of national livestock breeds (native breeds) that are endangered.

The OECD approach can be expanded and modified for the Finnish purposes. The following indicators for animal genetic diversity are suggested:

1) Classification of the breeds and sub-populations within a breed using the following criteria: a) The actual population size in breeding females. Depending on the number of breeding females, it is possible to classify the breeds into five different categories of endangerment (Table 3). b) Existence of conservation program for an endangered breed or sub-population within a breed; i.e. special breeding plans, conservation herds, gene banking of semen and embryos; c) Origin of the breed (native, non-native imported); native like Eastern Finncattle, Finnsheep, non-native like Finnish Ayrshire, Oxford Down sheep. The trends and changes of the population sizes should be followed.

Table 3. Classification of farm animal breeds (Bodó 1989)

Status of endangerment	Population size in breeding females
Critical	< 100
Endangered	100 – 1,000
Vulnerable	1,000 – 5,000
Insecure	5,000 – 10,000
Normal	> 10,000

2) More detailed information on population numbers: a) The share of the most popular breed in Finland in the total number of individuals within one farm animal species. b) The number of breeders of the native breeds; i.e. the number of different herds, flocks etc, in which the Finnish native breeds are raised. The trends and changes over time should be followed.

3) Estimation of the effective population size of the breeds. In order to predict loss of genetic diversity per generation within a domestic animal breed, the effective population size (N_e) needs to be determined. The N_e can be derived e.g. from temporal changes of the allele frequencies over generations or the increase of inbreeding rate per generation (see e.g. Hartl & Clark 1989).

4) Genetic distinctiveness of the breeds. Genetic relationships and the magnitude of genetic differentiation among the breeds can be assessed by molecular genetic markers, such as blood groups, proteins, and DNA markers. Breeds showing differentiation in molecular genetic studies can have a unique evolutionary history. These breeds could have a value in the maintenance of genetic diversity at the species level.

The indicators 1 and 2 could be monitored jointly by the Ministry of Agriculture and Forestry, Animal Production of MTT Agrifood Research Finland and the Finnish Animal Breeding Association. The indicators 3 and 4 require an expertise approach is, and the responsible organisations would be MTT and Helsinki University, Department of Animal Science.

The genetic diversity of crop plants can be described with the OECD indicators (OECD 2001). They include: 1) *total number of crop varieties that have been registered and certified for marketing, 2) share of key crop varieties in total marketed production, 3) number of national crop varieties that are endangered.* The OECD scheme can be later expanded and specified for Finnish purposes.

The indicators would be developed by MTT Agrifood Research Finland, who is responsible for the monitoring of national programme for preserving the genetic resources (National Gene Resource Programme).

Presentation of the results

In diversity of domestic animals, the first two indicators including the numbers and names of the breeds could be given in a table. The breeds will be sorted into different classes according the three criteria, population size, existence of conservation program and the origin of the breed. The second indicator is also illustrated graphically. The third and fourth indicators are presented with a short description based on published research results.

In diversity of crop plants, the tabulation and graphical presentation used by OECD (2001; Chapter 5) will be applied.

Theme 7 Diversity of wild species

Definition and purpose

Species diversity is composed of the richness and abundance of species. Species abundance measures both the decline and increase of populations while species richness refers to the number of species per site or specific area. Since species richness measures presence/absence of species, it is a relatively insensitive variable compared to species abundance.

The general intensification of agriculture has been mentioned as one of the reasons for the decline in species diversity. The loss of field margins and the replacement of traditional agricultural practices such as haymaking by silage production has resulted in tremendous decline in the area of species rich habitats. Open farmed landscape, which was typical of traditional agriculture, is an especially important habitat for many threatened vascular plants and butterflies in Finland. The area of arable land has grown at the expense of the area of meadows. Spring cereal fields comprise the largest habitat on arable land in Finland. The intensification of cropping practices in terms of the use of chemical fertilisers and pesticides with reduced crop rotations has led to the decline in species diversity of arable land. Indicators of species diversity should describe the change in species diversity both in open farmland habitats and on arable land. The first habitat represents ‘hot spots’ of species diversity in agricultural habitats, whereas the second habitat is the area under present management practices.

A good indicator species or a species group should be linked closely with the agricultural habitat and should react to the management; the change in the abundance should be a consequence of the change in agricultural practices and land use. Species differ both in their linkage to a specific habitat and in their response to the habitat quality, which is a result of management. Species capable of moving, e.g., birds, use several habitats and, thus, respond primarily to the changes in the habitat composition of the landscape. In comparison, species restricted in their ability to move, e.g. plants, respond to the management of the specific habitat their occupy. Since each species group responds primarily to changes at specific spatial scale, several species groups are required to express change in agriculture with species diversity indicators.

Evaluation of current indicators

In the previous indicator works, both species richness and species abundance of several species groups have been proposed as indicators. OECD’s report on Environmental Indicators for Agriculture proposed trends of populations of birds (common pheasant, partridge) and mammals (e.g., hare) and the number of threatened species among vertebrates, invertebrates, vascular plants and cryptograms as indicators for species diversity (OECD 2001. In the report of EU Commission, the use of species richness as an indicator of species diversity was discussed. Availability of data on a long-enough monitoring period was emphasised (CEC 2000, 2001a). In Finland, the first indicator work of Ministry (Ministry of Agriculture and Forestry 1999a) discussed the use of following species groups as indicators of species diversity: butterflies, dung beetles, pollinator insects, vascular plants of arable land, vascular plants of field margins and farmland birds. Monitoring data are available on butterflies, vascular plants of arable land and farmland birds.

Method and data requirements

The proposed indicators are: 1) *the trend in the number of threatened species of agricultural habitats*, 2) *population trends of farmland birds*, 3) *population trends of farmland butterflies* and 4) *the trend in the abundance and in the number of species of vascular plants of arable land*. The indicators represent both open farmland habitats and arable land, and the species groups responding to the management at different spatial scales.

The trend in the number of threatened species describes the populations of species in danger to go extinct due to changes in agricultural practices. Since the highest numbers of threatened species are found in dry meadows, the indicator describes the species diversity of open farmland habitats. The indicator shows the trend in the number of threatened species in butterflies (Lepidoptera), beetles (Coleoptera), hymenopterans (Hymenoptera), vascular plants and macro-fungi. Three comprehensive evaluations of threatened species have been conducted in 1985, 1991 and 2000 (see Rassi et al. 2001).

Population trends of farmland birds indicate primarily species response to the change in the landscape structure and to some extent to changes in the cropping practices of specific habitats. Farmland birds can be classified into four categories in regard to their habitat requirements: species breeding on fields, field verge and bush species, farmyard and small village species, and farmland species breeding in forest edges or interiors (Tiainen & Pakkala 2001). The indicator captures the yearly change in the abundance of the previous four categories. Data on the population trends of farmland birds have been collected yearly since 1978.

Population trends of farmland butterflies indicate primarily species response to the changes in the landscape structure as well as the area and the management of semi-natural farmland habitats. Butterflies can be classified into three categories in regard to their primary habitat type: field margins and farmyards, meadows, and forest verges and clearings. The indicator shows the change in the butterfly abundance of the previous three categories. Data on the population trends of farmland butterflies up to 1987 are available from three sources: Atlas of the Finnish Macrolepidoptera (Huldén et al. 2000), from 1991 onward the national butterfly recording scheme in Finland (NAFI) (Marttila et al. 2001) and from 1999 onward the transect counting data on agricultural landscapes (Kuussaari et al. 2001). The indicator requires the development of the population change index based on the previous three data sets.

The trend in the abundance and number of species of vascular plants of arable land indicates the response of species to the effects of management of arable land, e.g. use of herbicides. The indicator of arable land shows the trend in the species number and abundance of the about 30 most abundant plant species of spring cereal fields. Data on the vascular plants of arable land (spring cereal fields) have been collected in 1961-1964, 1982-1984 and in 1997-1999 (Mukula et al. 1969, Erviö & Salonen 1987, Salonen et al. 2001).

Several organisations are responsible for the biodiversity data**.** Collation of the data on the threatened species is co-ordinated by the Ministry of Environment and the Finnish Environment Institute (SYKE). The butterfly data are gathered by the Finnish Museum of Natural History, the Allergy and Environmental Institute of South Karelia and the Finnish Environment Institute. The bird monitoring data are gathered by the Finnish Museum of Natural History. Plant Production Research of MTT Agrifood Research Finland collects the data on vascular plants of arable land.

Presentation of the results

Threatened species: a bar diagram on the number of threatened species in each species group in 1985, 1991 and 2000. *Birds*: a line diagram on the population change index by habitat requirement category. *Butterflies*: a bar or line diagram on the population change index of butterfly species classified by habitat requirement category. *Plants*: a bar diagram on the average (with SD or SEM) species number and average number of individuals per square meter by decade, 1960s, 1980s and 1990s.

Theme 8 Landscape

Definition and purpose

Landscape indicators are a subset, which addresses the patterns and trends as well as the rates of change of the structure in rural land-use. These may be used or specifically developed for assessment of quantitative processes like, e.g. erosion, nutrient leaching, or trends in species diversity of natural flora or fauna, as well as for assessment of qualitative aspects like scenic beauty of an agricultural area (OECD 2001).

The Finnish Ministry of Agriculture and Forestry defines close connection between agricultural landscape management and biodiversity management at different scales, gene, species and habitats (Ministry of Agriculture and Forestry 2001b). Management of traditional agricultural biotopes has been prioritised to management of ordinary agricultural landscapes. At the same time as the areas of traditional biotopes have decreased, ordinary agricultural landscapes have been homogenised. Large ordinary rural areas have lost a number of their agri-historical features such as field margins, barn areas and clumps of trees and bushes within the fields.

In this work, agricultural landscape management has been defined according to clear three distinct value judgements, which are compatible with the OECD landscape work (2001), but main stress here is on the Finnish agricultural landscape scale:

Ecological value: Agricultural landscapes, especially with the field margins and the semi-natural habitats (meadows, clumps of trees and bushes within the fields) lying close to cultivated areas maintain many species. One of the most important changes in the Finnish agricultural landscape since the 1950s has been the decline in the number of linear elements (Ruuska & Helenius 1996, Hietala-Koivu 1999); the decrease has been especially dramatic in the numbers of open field ditches and their margins. Over 420 m/ha of open ditches have been replaced by sub-surface drainage in Finland in the course of time. Ditch boundaries locating closest the fields are suggested to be of great importance in maintaining species diversity in the ordinary agricultural landscapes.

Cultural value: Agricultural landscapes with open and managed fields and rural settlements are an important part of Finnish rural culture. Maintaining the openness of agricultural landscapes is one of the objectives of the Finnish Agri-Environmental Programme. In Finland the share of agricultural land is only 8 % from the total land area and, therefore the Agri-Environmental Programme obligates the farmers to cultivate their fields according to good local agricultural practices. Visual diversity of agricultural landscapes depends on multidimensional aspects of scenery, e.g. sounds, odours, colours and heights of plants and placing of construction areas within a landscape. Openness as an indicator measures possibility to view scenery in agricultural areas. It varies a lot spatially in Finland because of the different nature conditions. In order to compare the temporal and spatial changes the openness of agricultural landscapes has to be measured separately in each Finnish agricultural region.

Amenity value: Agricultural landscapes are places for food and fibre production, but also areas for recreation and gaining rural experiences and other public commodities. In recent years multi-functionality in agriculture (ecological entrepreneurship, rural tourism etc.) has proved to be one way for many farmers to get additional income. According to the Agricultural Census, in 2000 about three thousand Finnish farms had additional income from tourism, accommodation and recreation services and two thirds of those farms reported that line of business as a more important income source than practising agriculture (Ministry of Agriculture and Forestry 2001b).

Evaluation of current indicators

In the first indicator work of Ministry there was one ecosystem level indicator, which consisted of diversity index (H), landscape quality (LQ) and the share of semi-natural grasslands and cultivated fields (ha) (Ministry of Agriculture and Forestry 1999a). The weakness of the diversity and landscape quality indices is the time-consuming data collecting in case areas. Third indicator, the share of semi-natural areas and fields, is more ready for use, as the agricultural authorities collect yearly data at national and EU-level.

The earlier indicator work of Ministry presented also three indicators concerning cultural landscapes and their amenity values: share of cultural and traditional landscapes; number of regional cultural programmes; landscape preferences (Ministry of Agriculture and Forestry 1999a). The share of cultural and traditional landscapes presumably does not vary yearly and, therefore, does not describe any evident change during the past few years. The number of regional cultural programmes is easily measured, but the interpretation of the implementing stage of the programmes has been ignored. Landscape preference indicator has proved to be one of the useful measures, with which amenity values of the landscapes could be measured quantitatively.

Method and data requirements

The aim of this work is to improve or to maintain the above mentioned value judgements, and the following indicators are suggested:

1) Ecological value: *Edge density of fields (km/100 ha per TE-Centre regions)*. The edge density measures total edge lengths i.e. perimeters of field parcels. This index indicates the abundance of the ditch boundaries between field and the other land use and describes the habitat diversity in an agricultural landscape. Data are available from the Information Centre of Ministry of Agriculture and Forestry: Integrated Administration Control System (IACS)

2) Cultural, visual value: *Openness in agricultural landscape* (ha per TE-Centre regions), which is expressed as the share of cultivated land inclusive managed fallow. Data are available from the Information Centre of Ministry

of Agriculture and Forestry: Integrated Administration Control System (IACS).

3) Amenity value of agricultural landscape: *Utilisation rate of accommodation in farm tourism in Finland.* Data availability: Statistics of the Rural Policy Committee/Rural Tourism Working Group collects the data by yearly questionnaires and keeps the statistics on the capacity of rural tourism in Finland (Rural Policy Committee 2001a, 2001b).

Presentation of the results

Graphs of edge density and openness indicators in two thematic maps covering the TE-Centre regions. Bar graphs of the utilisation rate of accommodation in farm tourism during 1998-2001.

Theme 9 Animal welfare

Definition and purpose

Farm animal welfare is a complex issue that originates increasingly from consumers' concern for the animal housing conditions and handling practises. As research domain, farm animal welfare is a quite new issue and there are different opinions as how to define the animal welfare. Therefore, many definitions exist. One definition covers animal's mental and physical health so that the animal is in harmony with its environment. The other defines that welfare is the state of an animal in regard to its attempts to cope with its environment. Third definition says that welfare is the absence of suffering. It can also be said that the welfare of farm animals is on acceptable level if "The Five Freedoms" are fulfilled. "The Five Freedoms" are: 1) freedom from hunger and thirst, 2) freedom from discomfort, 3) freedom from pain, injury and disease, 4) freedom to express normal species-specific behaviour, and 5) freedom from fear and distress (Brambell 1965).

An indicator for animal welfare has to be measurable. Data should also be available from several years retroactively, and also in the future. Data collection method should be as similar as possible through all the years. Until now positive welfare indicators do not exist. One possible and probably the most realistic strategy at the beginning is to identify incidences/signs of poor welfare. Everyone agrees that suffering is not welfare. Considering the various farm animals in numbers of individuals Finland, most of the potential suffering individuals are among the poultry (about 13 million individuals in the year 2000). The second largest number of individuals is the fur animals - minks and foxes. The following are the pigs and cattle. Welfare indicators should cover these most important species and groups of production animals. Therefore, two possible indicators are presented here. One is the amount of condemned carcasses in the Finnish slaughterhouses, and the other is the yearly number of sentences for prohibited animal rearing in Finland.

Method and data requirements

Data on the amount of condemned carcasses are available for the poultry, pigs and cattle for ten years retroactively. This indicator reflects the welfare of the farm animals either on farm conditions or during transportation to the slaughterhouse. Majority of the pig carcasses is rejected because of arthritis and abscesses. Arthritis is quite common for quick-growing pigs and the abscesses usually originate from tail biting. Tail biting may reflect poor environmental conditions during growing period. This indicator may also reflect animals' poor nutrition. The disadvantage of this indicator is that it does not tell anything about the welfare of the fur animals. The condemnation practices of the various slaughterhouses probably also vary, and the condemnation practises have also changed in the course of time. However, this is a good indicator, which covers almost all farm animals that are reared for food production

The Finnish National Veterinary and Food Research Institute (EELA) has collected the condemnation data from the slaughterhouses since 1994. Before that Ministry of Agriculture and Forestry collected these data. EELA publishes yearly the condemnation data in their Annual Report; the data are public and available from the Internet (Finnish National Veterinary and Food Research Institute 2001).

The number of sentences for prohibited animal rearing reflects poor welfare and precisely poor handling and rearing of animals. Majority (85 %) of these injunctions for prohibited animal rearing concerns farm animals, the rest (15 %) concerns pets. The injunction for prohibited animal rearing can be permanent or the prohibition time can be limited. The present animal welfare law in Finland was implemented in 1996. This new legislation had an effect on the number of sentences for prohibited animal rearing. Therefore, it is recommended that the indicator be not applied to the data before the year 1997. For example the police officers have been gradually trained to animal protection work. The advantage of this indicator is that it covers all animal 'groups' and species.

The data on the number of sentences for prohibited animal rearing comes from the courts. The information is forwarded to the Finnish Ministry of Agriculture and Forestry, where the data are stored and available on request.

Possible indicators in the future

EU COST-Action 846 project "Measuring and monitoring farm animal welfare" started at 2001 and it will last until the year 2005. The aim of this

COST project is to find a way to measure reliably and to monitor the farm animal welfare on the farms. Finland takes also part to the project.

Comparing the farm animal welfare between various countries is very complex. The aim to have an indicator, which shows the situation of animal welfare state in Finland as compared to that e.g. in other EU countries cannot be reached with the existing measures. There are no possibilities to compare reliably the countries with each other, because animal welfare data from different countries are different. The production may also be focused to different species in different countries. Veterinarians do randomised inspections on the farms to verify that animal protection regulations in Finland are fulfilled. This material should be evaluated to see, whether it could be used as a welfare indicator in the future. There is also another possible indicator, which is suitable, in addition to the farm animals, also for the pets. The Ministry of Agriculture and Forestry keeps summarised data on the number of animal protection inspections in Finland that have been undertaken, if violations of the animal protection law are suspected. The yearly number of immediate actions as a consequence of these inspections could be used as an overall animal welfare indicator. It should be also noted, that the needs of the various farm animals are not identical. Different indicators are, therefore, probably needed for poultry, fur animals, pigs and cattle.

Presentation of the results

The *amount of condemned carcasses in Finnish slaughterhouses* for poultry, pigs and cattle, and the *yearly number of sentences for prohibited animal rearing* in Finland will be presented as figures and/or tables.

Theme 10 Regional structure of agricultural production

Definition and purpose

The production patterns of agriculture differ regionally: the crop cultivation is mostly concentrated to southern and western Finland, whereas the cattle farms are mainly in central Finland. In regional terms, also the importance of agriculture varies markedly because, in the South, there are more opportunities for additional income. Furthermore, the natural circumstances for cultivation as well as the socio-economic circumstances e.g. farm sizes and market distances vary regionally.

Usually the main arguments for differences in location of the production lines are the climatic conditions and the farm operational environment. By describing the development of the main production lines in agriculture the picture of the production intensity and of the role of agriculture are clarified.

Ecologically it is favourable to maintain the regional balance between animal and plant production. Diversified production is an essential condition for managing the quality of agricultural soils, for handling the manure and for maintaining the biological and landscape diversity. Economically the issue is not that simple. In principle, the efficiency of the production increases with specialisation, and this is opposite to the goal of maintaining the diversity. However, diversity reduces long-term risks of the production, and therefore it may be beneficial also economically. This kind of scrutiny also assists to predict the future changes of agriculture.

Evaluation of current indicators

OECD monitors the changes in the number and size of the farms, but has not investigated the production structures more closely (OECD 2001). In Finland, for example the Pellervo Economic Research Institute (PTT) has studied how the structural change in agriculture has affected the income development in Finland (Pyykkönen 1996, 1999). Also, the role of agriculture in regional economy has been studied (Knuuttila 2001).

Method and data requirements

This proposed indicator illustrates the distribution of the main production lines in Finland. Required data are obtained from the annually published Farm Register.

Presentation of the results

The indicator is presented with the following figures: 1) *Distribution of the production lines arranged by the Employment and Economic Development Centres (TE-keskus).* 2) *General distribution of the production lines in Finland.*

Theme 11 Income changes in agriculture

Definition and purpose

The financial and economic conditions for agricultural production can be evaluated by describing agricultural income and profitability of the enterprises. Financial security is vital for the farmer, for example, in the long term planning. Profitable farms can also better afford to take the environment into account in their management decisions.

The importance of additional income in agriculture has emerged, but the opportunities to achieve it vary regionally. An interesting point would be to study the connections between the farm profitability and the commitment to the farm. An employment problem arises, if profitability of the production decreases while, at the same time, the commitment to the farm is increasing.

This is always the case in the areas with limited opportunities for employment.

Evaluation of current indicators

Economic Research of MTT Agrifood Research Finland monitors the farm income development of agricultural and horticultural producers. This follow-up system is based on the annual money flows within the sector. Statistics Finland uses the result in agriculture per agricultural holding practising production as an indicator. The differences between these two indicators are minor. Here the general development in farm income is first described, and then the wages and salaries in two different sectors are compared.

The operating environment in the agricultural sector is changing rapidly, which is reflected, for example, in the emergence of new entrepreneurial activities on farms. Therefore, the calculation framework and the data sources need continuous development and revision (Aakkula et al 2001). Indicators published by the OECD examine the net farm income, which is defined as the difference between the value of the gross output and of all the expenses, including depreciation from agricultural activities at the farm level (OECD 2001).

Method and data requirements

Farm income presentation is based on the total calculation of agriculture published annually by Economic Research of MTT Agrifood Research Finland. To calculate the farm income, first the gross return at market prices is summed. Secondly, to the gross return total the subsidies, income from rents and compensations for stock and crop damages are added. Thirdly, the total costs are subtracted from the gross return total.

The required data are obtained from Economic Research of MTT Agrifood Research Finland and from the Agricultural Enterprise and Income Statistics published annually by the Statistics Finland. In addition, material from the Statistical Yearbook of Finland published by Statistics Finland and Finland’s Farm Accountancy Data Network (FADN) of EU is used. The changes in the structure of the income flows, including the additional income, in farm enterprises are illustrated with the data of the Agricultural Enterprise and Income Statistics.

In addition, the wages and salaries of agriculture are compared to those of manufacturing industry. The profitability description is integrated into the income representation. Comparison of wages and salaries and the profitability scrutiny support the description of farm income changes, which is the main indicator in this connection.

Presentation of the results

The main indicator, *the income changes in agriculture and the structure of total farm incomes,* is graphically presented. In addition, comparison of wages and salaries and the profitability scrutiny are made.

Theme 12 Continuation of farming: investments and generation transfers

Definition and purpose

The decisions of farmers and their families are essential for the continuation of the agricultural production. In deciding about the investments the farmer compares the alternative plans and their profitability expectations with their effects on the working conditions. An investment decision represents the farmer's trust on the positive development of agricultural product prices on the market and on the overall future of the production. Usually an investment forces the farmer to practise his profession with a chosen production structure for years or for decades ahead.

The future perspectives of the farmers may be investigated also through the generation transfers within agriculture. The development has been alarming in the 1990's, when the amount of the generation transfers collapsed. Most of the changes in the ownership occur close to the cities, where the risks of the consequences of the decisions may be minimised (Pyykkönen 2001).

Evaluation of current indicators

To use investments as an indicator has not been recognised in any of the OECD indicator publications. However, entrepreneur's investments and the investment behaviour have been studied to some extent. EC has suggested the generation transfers within agriculture as an indicator (OECD 2001, CEC 2001b).

Method and data requirements

The indicator illustrates a farm's investments. Investments concern the buildings for animal and crop production, machinery, soil improvement and extension of production etc.

Farm investments are presented as regional grouping. The indicator describes the variation in total investments between the various regions in Finland. The necessary data come from the Information Centre of the Ministry of Agriculture and Forestry. It is also possible to use to some extent the results from annual farm barometer of the Ministry of Agriculture and Forestry.

The rates of the change of generation are recorded in the statistics. However, data only on those producers whose main income is from agriculture are found in the records. In addition, the changes in the enterprise forms are described. This is considered as important because of the current political debate, which concerns the tradition of the family farm structure and its preservation. The question is relevant both at national and at European level.

Presentation of the results

The indicator presents 1) *total investments in agriculture* and 2) *the rate of generation transfers* arranged by the Employment and Economic Development Centres.

Theme 13 Quality management and assurance

Definition and purpose

Quality management and quality assurance are an essential part of the development project Agri-Food Chain in Finland today, the main objective of which is to maintain the market position of the domestically produced foodstuffs. The Ministry of Agriculture and Forestry has outlined the national quality strategy in order to implement the quality work within the Finnish agri-food chain. The objective of the national quality strategy is to implement to all Finnish farms by the year 2007 quality systems, which meet the requirements of the ISO 9001 standard (Ministry of Agriculture and Forestry 1999c). In these management systems, the principles that guide the quality of the activities and products are established. According to these principles, every enterprise defines it's own quality and environmental goals, implements them and evaluates the efficiency of the actions. The number of implemented systems within a sector describes the interest and activity on the quality and environmental issues.

Evaluation of current indicators

Quality aspects are discussed in several indicator works, but the overall problem is how to measure such a diversified field. Quality should be examined in each group of agricultural products and in each phase of the production. The Finnish national quality strategy for the food sector is internationally unique.

Method and data requirements

Here an approach considering the quality management in three dimensions is adopted with the focus 1) on the product's quality, 2) on the quality of farm activities and production principles and 3) on the environmental quality. Each of the presented three aspects needs its' own analysis. Currently, the necessary data are not available.

In this indicator report it is, therefore, scrutinised how the quality of farm activities and procedures are secured. To describe this, three sources of information are used: 1) farms that have been certified according to the ISO 9001 quality standard, 2) number of farms that have participated quality education or courses and 3) share of quality contracts between farms and food industry. The data are collected from the Rural Advisory Centre and from the food industry.

In future, quality assessment should cover the whole agri-food chain and attention should be paid also to the quality of the products. An approach dealing with the overall environmental quality of the products needs to be developed.

Presentation of the results

The figures illustrate 1) the number of certified farms committed to the quality and the environmental quality work of the agricultural sector 2) the number of farms educated in the quality work and principles and 3) the share of quality contracts between farms and food industry in Finland.

3.3 Proposed indicators for rural areas

Relationship between the primary sectors using the rural natural resources and the overall rural development has changed over time. In the beginning of the 19th century the whole Finnish society was agriculturally dominated. Natural resources of rural areas played economically and culturally important role in the society. As a consequence of new technologies, the total number of people employed within primary production has fallen drastically. Along with that, the overall economic and cultural importance of the rural areas has diminished. In the present technologically oriented information society, traditional rural issues have experienced cultural and economic inflation. Also citizens are loosing their familiarity with the origin of the food and wood products.

Possibly, the deepest depression of interest in rural issues has already been passed. There are even signs that infuse faith to viable future viability of the rural areas. For the first, appreciation of food and domestic food production has increased, at least partly as a consequence of the recent food crises in Europe. Secondly, the traffic and information communications have been improved, which relieves the negative impact of rural remoteness. Thirdly, environmental consumer awareness is increasing. Environmental goals emphasise the need to replace non-renewable resources with renewable ones. The development trend is shifting gradually from the materials consumption towards consumption of services. The environmental concerns have also awoken interest towards local production. All this provides new possibilities for the rural areas.

Primary production - agriculture and forestry - has a key role in managing rural natural resources and producing renewable raw materials for the processing industries. In doing this, it also creates economic wealth and employment to the countryside. The significance of agriculture and forestry extends far beyond their share from the GDP, because these resources are essential for the well-being of the society. Those sectors are also responsible for managing the rural landscape and environment.

Use of natural resources and the overall rural development are integrated also in the social sense as the farmers, forest owners and fishermen and their families live in rural communities and share the local culture. The major challenge of the rural societies is to re-orientate according to the constantly changing needs of the rest of the society and to adapt the activities to the new technology.

In selecting the rural indicators the topics of the Ministry's strategy were first outlined. As with the agricultural indicators the currently used national and international indicators were studied by paying attention to availability and quality of the data and to the costs of data collecting.

The proposed indicators do not cover the whole spectrum of rural development. The focus is on the use of natural resources and on those rural socio-economic circumstances that have an impact on the resources use. An effort is made to describe the rural development in holistic sense. The Ministry's strategy goals for rural development, relevant themes and the proposed indicators are given in Table 4.

Table 4. Proposal for assessment themes and their indicators on rural development.

Strategy goals	**Themes and indicators**
Availability of domestic food and raw materials Compensation of non-renewable products with renewable Recreational use of countryside	**1. Use of rural products and services** - changes in use of rural products and services - self-sufficiency in food products (milk, eggs, fish, meat)
Maintenance of rural settlement Quality of life in countryside	**2. Regional development and welfare of rural areas** - BTV- indicator describing the changes in population, employment and production (GNP) - share of primary section from total production and employment
Promoting the entrepreneurship based on rural resources	**3. Rural entrepreneurship** - corporate structure and volumes
Feasibility of rural infrastructures	**4. Rural infrastructure and services**

	- accessibility to key services in case study areas (15 communities)
Endogenous development of rural areas Social capital, networking Education Cultural identity	**5. Human resources in rural communities** - preliminary description of human, social and cultural capital
Consumer oriented developing of agriculture Rural and environmental education Social and cultural acceptability of resource use Recreational use of countryside	**6. Consumer awareness** - description of consumer attitudes and awareness concerning rural natural resources on the base of available surveys
Developing planning and administration procedures (adaptive management) Participation and transparency of production Focusing the research	**7. Information management** - description of implementation of the strategy goals

Theme 1 Use of the rural products and services

Changes in the use of rural products and services

Definition and purpose

Sustainable rural development contributes to the economic and social well-being of all citizens. The countryside is intimately connected to the rest of the society by providing the basic needs, food, raw materials for construction and the renewable energy as well as the immaterial public commodities. To subordinate the rural areas to the role of raw materials producer definitively does not support sustainable rural development. Because it increases the rural-urban controversy, it also contradicts the egalitarian strivings and threatens, therefore, also the overall sustainability of the society.

By diversifying the production and service structure of the rural areas, the interaction between the rural and urban areas is promoted. The interplay is further strengthened by the recreational use of the rural areas. This is reflected in the extent of the summer cottage settlement, recreational fishing and hunting as well as in the everyman's right entitling the citizens to hike and to gather the wild. The everyman's right is a deeply rooted right originating from the ancient times, the active enforcement of which shows how tightly the Finnish way of life is still bound to the countryside. The extent of the use of the everyman’s right is difficult to estimate, because there is no way to keep track on the hikers and most of the gathered wild goes into own consumption. However, some idea about the importance of the outdoor life maybe obtained by considering the number of visitors on the state land

and the amount of wild berries and mushrooms, which ends up into whole sale and retail.

Evaluation of the current indicators

So far this theme has been addressed in the sustainability context only vaguely. Currently there are no indicators that have been used to explicitly describe the urban rural-relationship from the sustainability point of view.

Methods and data requirements

Time series data comprise the market supply of horticultural products and the number of the farm tourism enterprises. These data are available from the Finnish register of enterprises, which is up-dated by the Statistics Finland, and from the register of horticultural enterprises (Ministry of Agriculture and Forestry 1998). The Finnish Forestry Research Institute (METLA) publishes yearly data on the market supply of wild berries and edible mushrooms, on the amount of bags of game and of catches from recreational fishing as well as on the number of visits on the State land (Finnish Forestry Research Institute 1998). In addition to the actual amount in weight or in numbers, the data are often given also on the monetary basis.

Presentation of the results

The results are presented as a time series graph, in which the changes in the use of the chosen rural products and services are shown. The data from the various categories are made commensurate by relating the yearly figures from each category to the figure of the reference year within that category. Because the changes are considered relative to a given reference year, very different type of data can be viewed simultaneously within the same graph.

Food self sufficiency

Definition and purpose: In Finland about 720 kg of food products are consumed per capita each year (National Public Health Institute 1998). The food self-sufficiency ensures an adequate supply of basic food products, it safeguards the livelihood and well-being of agricultural and agri-food workers and their families. Agriculture and food production have the key roles in providing the rest of the society with the public commodities such as comfortable environment and the cultural landscapes.

Globally the food production has to be increased to improve the nutritional status of the present day world population and to meet the needs of the growing population. This implies that even in Finland the extent of the food production remains roughly equivalent to the national demand. The self-sufficiency in food supply is one of the strategic goals of the Finnish government and to sustain the national agriculture has been stated also as a major goal in the Ministry's natural resource use strategy. According to the rural policy work group, the domestic food production has to be dimensioned so that the food supply is secured over at least two weak seasons.

The food security in times of crisis is important from the strategic point of view, but a regards the food there is also another aspect that affects the everyday life of the citizens. Food safety means that the food is produced in an environmentally friendly and ethically just way, and that it can be consumed without the risks to human health. The food supply chain from field to table is a complex system, which involves several actors in various stages. The further the food production and consumption are distanced from each other, the more difficult it is to trace back the origin, to control what is produced and how it is produced.

Because of the remote location and cold climate, and also because of the increasingly targeted cultivation measures, the production environment in Finland is comparatively pure. Also the occurrence of the animal diseases is low. Finland has good possibilities to produce safe and high-quality food. Food quality is, therefore, a competitive advantage in the increasingly global food markets.

Evaluation of the current indicators

The food self-sufficiency was also one of the indicators in the Ministry's earlier indicator compilation (Ministry of Agriculture and Forestry 1999a). In the international indicator works this theme has not been specifically addressed, but it was chosen as one of the four indicators in defining the sustainability space of the Swiss agriculture (Binder & Wiek 2001).

Methods and data requirements

The basic food products on which data on self-sufficiency are available comprise pork, beef, eggs, milk and milk products, bread grain and sugar. Information Centre of the Ministry of Agriculture and Forestry (e.g. Ministry of Agriculture and Forestry 1997c) publishes the data yearly.

Presentation of the results

The results are presented as a time series graph, in which the degree of self-sufficiency as to the basic food products is expressed in per cent.

Theme 2 Regional development and the welfare of rural areas

Definition and purpose

The future potentials of the rural areas are tightly bound to the social and economic development at regional, national and international level. The welfare of the rural communities and their residents is dictated by the basic socio-economic circumstances of the region.

The possibilities of the rural communities to promote their own well-being are distinctly different already simply because of the differences in the natural resources base. The economic growth coupled with the on-going centralisation process further accentuates the differences between the various areas. For example, the capital of Helsinki is growing at the expense of depopulation of eastern and northern Finland.

The cumulative economic forces, which probably are difficult to change, drive the centralisation of the society's structures. Economic growth concentrated to the urban areas provides employment, and in chase after employment people move into the growing urban areas. Centralisation brings about many efficiency effects, but it causes also major disadvantages. The knowledge how to use the natural resources is deeply rooted in the countryside. One of the reasons to slow down the on-going development is the desire to preserve this knowledge and to transfer it to next generations. In addition, rural tourism and small-scale manufacturing of farm products are essentially local in character. Traditionally, also the processing industry for primary products has located in the rural areas, although these ties are now loosening as a consequence of the economic and technological development. It should be also noted that regionally balanced development of the society is the objective of regional development policy of the Finnish government as well one of the policy goals of EU.

Evaluation of current indicators

Commission of European Communities has addressed these issues in their preliminary report for agriculture and rural development. Balanced development between rural and urban areas and equity over space is strongly recommended (CEC 2001b). The socio-economic indicators have been further studied within the PAIS-project (Proposal on Agri-Environmental Indicators). Obtaining indicators for these issues at European level is difficult. The usefulness of rural socio-economic indicators is fundamentally constrained by the configuration of the boundaries within the regional hierarchy and by the availability of data at a suitable aggregation level (Bryden et al. 2000). Especially descriptive indicators that provide an overall framework to assess rural development and to highlight the special characteristics of rurality need to be developed.

In Finland, there are abundantly data available on rural development (Statistics Finland 1999b, Remahl 2000, Kainulainen et al. 2001, Sinisalo et al. 2001). The rural areas are here identified on the basis of the statistical classification of municipalities into 5 categories: 1) urban centres, 2) semi-urban municipalities, 3) rural areas near cities, 4) other rural areas and 5) sparsely populated areas. Regional development is continuously monitored by various organisations, such as Statistics Finland, Association of Finnish Local and Regional Authorities and Ministry of Interior. For example, Statistics Finland has recently started a statistical monitoring programme on the development of rural areas. The programme comprises 112 socio-economic parameters on population and migration, employment, economy and land use. The programme is funded by the Ministry of Agriculture and Forestry (Statistics Finland 1999b). National Research and Development Centre for Welfare and Health (STAKES) for example, uses information on economy, health, housing, education, working life, crime and other social problems (Kainulainen et al. 2001). Statistics Finland has concentrated the research on six basic dimensions: population, employment, municipal economics, capacity of skills and structures of livelihood.

Selecting the parameters and making the assumptions for the weighing procedures affects, of course, the results. Thus, in this context the indexes as such are not suitable. Neither is it possible to describe thoroughly the various aspects of rural development. Instead, rural areas are here described within the general framework of regional development.

The Association of Finnish Local and Regional Authorities (Kuntaliitto) has developed the BTV-indicator. This is a composite indicator, and as such it has advantages compared to the aggregated single parameter indexes.

Method and data requirements

(Sinisalo et al. 2001) illustrates the changes in employment, population and production (GDP) by comparing regions relative to each other. However, the key trends should be described also qualitatively and the share of primary sections from total employment and from GNP should be examined more closely.

In future, more comprehensive studies on rural welfare are probably needed. It has turned out that towards the end of the 1990 the psycho-social problems have exacerbated in periphery, the sparsely populated countryside (Rehmal 2000, Kainulainen et al, 2001). Social problems should be highlighted with the available statistics. Also surveys like the Social Barometer, could offer deeper insight into the rural reality and could uncover the needs of different interest groups (Eronen et al. 2001).

Presentation of the results

The overall differences between the regions will be illustrated graphically with the BTV-indicator. The population change, employment and production are further described qualitatively from the communities' viewpoint.

Theme 3 Rural entrepreneurship

Definition and purpose:

About one third of the Finnish population lives in rural areas, and thus the rural industries have an important societal impact in Finland. Here the attention is on the small rural enterprises, with no more than 20 employees (Rantamäki-Lahtinen 1999 and 2000). Farm enterprises practising rural industries can be divided into three groups: farms engaged in basic agricultural production, rural enterprises and pluriactive farms.

Evaluation of current indicators

The OECD report recognises rural viability but there is no clearly stated indicator in use. In the PAIS-project attention has been paid especially to diversification of farm activities as well as to structure and performance of rural business. New business formation rate, number of business per population as well as the innovativeness of business have been used as indicators (Bryden 2001).

Method and data requirements

The current *corporate structure* and *development in turnover* illustrate diversity or monotony of industries in rural areas. It also shows what kind of industries are strengthening or weakening.

The data are obtained from the register that has been recently developed at the Economic Research of MTT Agrifood Research Finland. Rural Business Register is a combination of two existing registers, the Business Register of Statistics Finland and the Farm Register of Information Centre of the Ministry of Agriculture and Forestry, and it is updated annually (Rantamäki-Lahtinen 1999, 2000).

Regional corporate structure illustrates also the relative importance of farming enterprises and the employment created by the agricultural sector. These issues are also illustrated in the BTV-indicator (Theme 2). The development trends in corporate structure show the changes in agricultural production lines and the shift to other occupations. The changes in the structure of rural industries will be analysed regionally by the Employment and Economic Development Centres.

Presentation of the results

Results are presented in the form of a map.

Theme 4 Rural infrastructure and services

Definition and purpose

The availability of services and maintenance of rural infrastructure are among the key issues that promote rural viability. In recent decennia, the basic services in the rural areas have declined drastically. As the countryside population is constantly decreasing and the age-structure of the remaining population is growing older, there is an urgent need to develop new and cost-effective models that secure the rural services (Mäntylä 2001).

The attention to these issues has probably suffered from the lack of adequate information. Currently it is not known to what extent the supply of services is in balance with the demand or what are the most deprived services and regions. This kind of information is essential in policy context, and it interests also individual entrepreneurs.

The availability of services should be considered both from the enterprises' as well as the rural families' point of the view. The institutions, which rural entrepreneurs value mostly are post, bank, store, school, health services and public transportation. Among the most important services are also the services for economic development and employment, the maintenance of road network, information connections as well as library and pharmacy.

Evaluation of current indicators

The availability of services was suggested as an indicator already in the earlier indicator report of the Ministry (Ministry of Agriculture and Forestry 1999a). The access to key rural services represented by the retail, recreational, education, health and transport services is also suggested by the PAIS-project (Bryden 2001).

In Sweden, the accessibility to key rural services (post offices, pharmacies, banks, petrol stations etc.) is assessed by using GIS-technology, and the database is already in use. The programme calculates accessibility to services from start to destination. The database is kept and up-dated by the Swedish National Rural Development Agency and the National Consumer Agency.

In Finland, the Association of Finnish Local and Regional Authorities have also started to develop a system of assessing the basic services. The question has been approached by considering the overall quality of services. It was suggested that evaluation should cover at least the following aspects: 1) management and personnel, 2) processes and structures for services, 3) customer satisfaction, 4) functional effectiveness and 5) economical efficiency (Association of Finnish Local and Regional Authorities 2001).

Method and data requirements

It is suggested that the assessment of rural services is started with a preliminary case study on accessibility to key rural services. Case studies should include accessibility to services that are important both for the rural residents and the rural enterprises. Both public and private services should be highlighted and attention should also be paid to new innovative forms of rural services. Case study areas are chosen so that they represent the different Employment and Economic Development Centres, altogether 15 rural municipalities.

On the basis of the results a more profound system to monitor the availability and quality of services in rural communities is planned and initialised.

Presentation of the results

The accessibility to key rural services in 15 rural communities is shown in a graph.

Theme 5 Human resources in rural communities

Definition and purpose

People's self-reliance and the capability to promote their own standard of living is a necessary condition for rural development. Also the effectiveness of the policy measures has been found to be the best in those regions, which are capable of self-determined actions (Finnish Government 2000). Because of the rapid and technologically complex production processes human capital is still, and will be also in the future, an essential production factor.

In this sense networking has been strongly promoted. Finnish government has made the decision on foundation of 14 Expertise Centres, the aim of which is to promote interaction between the research organisations and companies. The Centres will be founded during 2000-2006. Networking and co-operation is especially important for the rural enterprises, which are commonly small, with 1,5 employees in average, and have limited economic resources (Rantamäki-Lahtinen 1999).

Evaluation of current indicators

In the international indicator compilations there are several indicators associated with networking, community involvement and empowerment of rural residents. The indicators highlight the human and social capital, education, competitive capacity of the regions and the innovations. In the PAIS- project, human capital was examined in terms of attaining education. The EC has concentrated more specifically on agriculture and highlights the number and the age structure of people employed in agriculture as well their educational level (CEC 2001b).

The Pellervo Economic Research Institute (PTT) has developed a method to describe the variation in regional competitiveness, which actually is found to correlate with the long-term economic development. Explanatory factors include 1) human capital, 2) innovativeness, 3) agglomeration, and 4) accessibility. Human capital is estimated with the number of residents with high educational background, number of (technical) students, size of working age population and the participation rate. Innovativeness is captured with the number of patents, amount of the R&D and the innovative establishments and with the share of high technology sectors (Huovari et al. 2001a, 2001b).

However, these figures are not very suitable in recognising the potentials of the rural areas. In fact, most of the rural areas are ranked as poor with these figures. Resources for rural development have to be described with different approaches, although the basic economic and social forces may be the same.

Method and data requirements

The rural potential is here highlighted with the concepts human, social and cultural capital. S*ocial capital* means community's ability to mutual dialogue and trustworthy relationships. *Human capital* comprises the knowledge and skills, which help to navigate in the difficult situations and to find the relevant solutions. The successful regions rely on vital cultural identity and diversity or the *cultural capital* of the community.

There is no simple way to measure these aspects. It is suggested here that the phenomenon is first captured by examining the structural conditions and activities of the communities. Secondly, the capital in form of innovations is considered (Table 5). Instead of comparing the regions with each other, the aim is rather to recognise the mental capital and to find the key success stories of the rural communities.

Table 5. Examples of indicators.

	Human capital	Social capital	Cultural capital
Rural structures and activities	Amount of working age population activating the human capital. Educational level	Co-operation and networking inside and outside the communities	Regional identity and diversity of cultural values Cultural heritage
Outputs	Innovations		

Presentation of the results

In the first stage, the human, social and cultural capital in few case areas is described. The future monitoring methods are based on these results and on the methodological development at the national and the international level. The data collection could be combined with the appraisal of rural development programmes as it already has been done.

Theme 6 Consumers awareness

Definition and purpose

As the consumers of rural products the citizens are an important group of actors using natural resources. The daily consumption decisions have an effect on what is produced and how it produced. The primary industries have been accused of being too much production-oriented. The Ministry’s strategy states that the production should be adapted to the consumers needs.

This is important, because successful communication between producers and consumers is the prerequisite for the viability of the branches that utilise natural resources. The entrepreneurs need consumers’ support and trust, but they also need information on consumers’ constantly changing needs. In addition, to promote sustainable consumption patterns it is essential to provide the consumers with sufficient and objective information on food production and on management of natural resources. Adequate consumer awareness is also called for when the citizens participate the public discussion concerning the choices of the use of natural resources. More attention should be paid to environmental education of children, who are the future consumers and citizens.

Evaluation of current indicators

In the earlier indicator work of the Ministry (Ministry of Agriculture and Forestry 1999a) it was suggested that the consumer attitudes towards agriculture, forestry, game husbandry, fishery and reindeer husbandry should be monitored. Fishery sector has pioneered in this issue by introducing a comprehensive barometer, with which the changes both in the consumer as well the producer attitudes are regularly assessed (Finnish Game and Fisheries Research Institute 2001). Single surveys have been carried out also in other sectors of natural resources use. For example, the Finnish Forest Association has conducted a survey on the children's and teenagers' attitudes towards the forests (Elintarviketieto 1999, Metsästäjäin keskusjärjestö 2001, Finnish Game and Fisheries Research Institute 2001).

Also within the agri-food sector, there is an increasing interest to recognise the patterns of consumers' behaviour. Finnish Food Information Service (Finfood), which is a government funded but functionally independent association, produces up-to-date information about Finnish agriculture and food production for consumers and for the media. The specific area of interest is the organic production, and Finfood has conducted consumer surveys on the consumption of organic products (Finfood 2001). In 2002 the National Food Agency of Finland will start consumer panels or customer forums in order to find out consumers' wishes and worries concerning food and food control. The third institute active in this area is Statistics Finland. It collects data about the household expenditure including leisure activities, among them farm tourism and number of summer cottages or other leisure residents.

On the European level, the European Commission carries out *Eurobarometer opinion polls* among public and farmers. The aim is to evaluate public perception of the agricultural policy. The polls show that there is an on-going and heated debate about the future direction of the common agricultural policy (CAP). Apparently the debate has been provoked by the recent BSE and foot-and-mouth crises. Accordingly, the consumer expectations are an important contribution to these discussions (CEC 2001c).

In conclusion, at present there is keen interest to better understand consumers' needs and attitudes. However, the activities are highly sectorised and a coherent view about the consumer awareness on rural issues and on the use of natural resources is still missing.

Method and data requirements

It is proposed here, that the Ministry initiates a continuous monitoring of those rural occupations that utilise natural resources. This consumer survey should deal with agriculture, forestry, fishery, reindeer, and game and fur animal husbandry as well as with the sectors that process the primary products. This kind of survey uncovers general consumer attitudes and the extent of consumer awareness about the rural sectors. The survey would, therefore, provide a useful base line for more the detailed surveys.

Planning of the research should be done in co-operation with several organisations associated with utilisation of rural resources. Before the survey, a consumer panel should be organised. This would help to encapsulate the dimensions and concepts that the citizens are mostly concerned about. The results of the panel are used in planning and conducting the survey.

The overall data collection should be concentrated, but the sectoral research organisations should participate planning of the survey and interpretation of the results. To obtain constant, real time, long-term information the surveys should be arranged regularly. The consumer panel arranged every now and then provides a reflective tool for revision of the survey formula.

Fruitful interaction between the producers and consumers calls for close co-operation. It is essential to consider also the processes of sharing information. Special attention should be paid on the children's' environmental education and their familiarity with the food production. Better co-operation between various actors, interest groups, research and advisory organisations, is necessary to promote sustainable consumption and production patterns.

Presentation of the results

In the first monitoring report, which is to be conducted in spring 2002, consumers' attitudes and awareness are described on the basis of the available results on consumer studies. The results are disseminated in close co-operation with the consumer and producer associations. However, for the future a more integrated consumer approach should be developed.

Theme 7 Information management

Definition and purpose

The Ministry's strategy stresses the importance to continuously develop the planning and administration procedures as well to focus the research activities. The sustainable use of the rural natural resources is an adaptive learning process at all levels. Also the importance of participation and transparency of the methods has been emphasized in the strategy.

Evaluation of current indicators

In international context, the institutional conditions for sustainable development have been repeatedly emphasised. For example, the

Commission has suggested that institutional efficiency and availability of regulatory framework and informal steering mechanisms should be assessed. However, the institutional circumstances to guide the resource management vary from country to country, and it is unlikely, that quantitative assessment procedures could be initiated on these issues. Rather they need to be described qualitatively and in a way that is specific to the situation.

Method and data requirements

The management procedures can be evaluated in the context of the Ministry's strategy on the basis of the current administrative systems. The necessary data are produced as a part of the organisations' yearly operational planning.

4 Developing the system approach

The sustainability concept implies a holistic approach to the agricultural system. This requires that both the changes within the system as well the external forces that affect the system dynamics have to be considered. The actions in one part of the system, for example the environmental management activities, have a range of effects in other parts of the system (Fig. 4). The idea of sustainability with all the goals equally accomplished and without any negative feedback is, unfortunately, not possible in reality. To balance and control the development it is, therefore, essential to identify the controversial forces.

The decision-making on the farm level is a practical example of these mutual interactions; the use of all production inputs is dependent on their price, on the availability of the compensating inputs and on the price of the final products. The farmers tend to optimise their actions according the given conditions as any other business does. If energy is cheap, it will be used whenever it is profitable compared to the more expensive production factors. It is, thus, more profitable to use nitrogen fertilisers than to invest into better manure handling systems. This is in spite of the fact that the better manure handling systems would decrease the nitrogen losses into the environment.

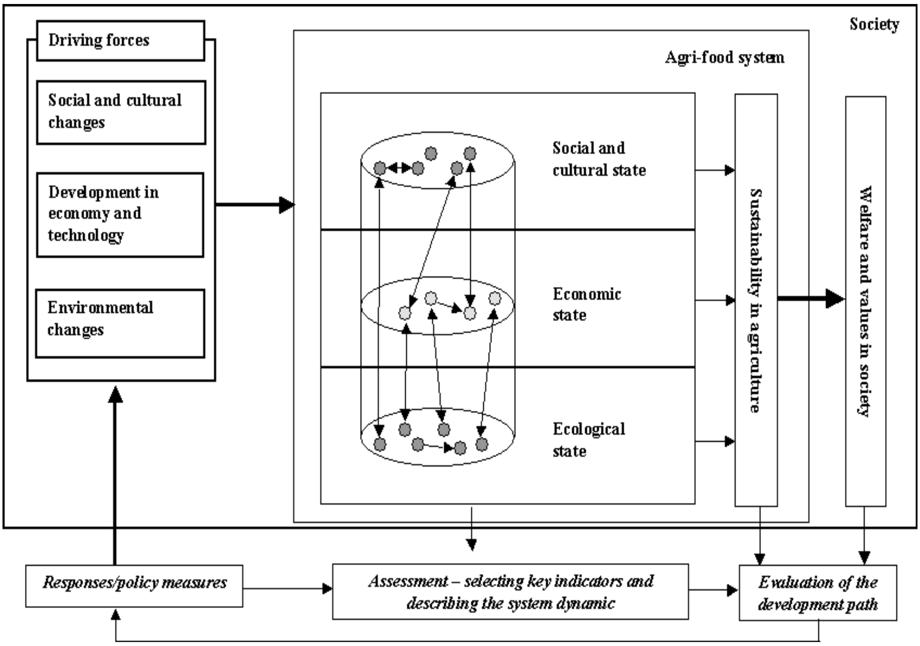

Fig. 4. Conceptual model of managing sustainability of the agri-food system.

The Ministry's strategy highlights the development in the use of the natural resources also in a broader context of countryside. Viability of the rural areas is a necessary condition for sound agricultural development in general but, on the other hand, agriculture is a livelihood, which in a profound manner contributes to the rural development.

Another practical example is the human labour, which is a comparatively expensive production factor. Therefore, the need for human labour tends to be minimised by substituting it with increased use of energy, machinery and chemicals. However, this means increased rural unemployment, which in turn affects local economy and social structures, because there is less money available, and fewer people to maintain the human capital and the social networks.

In the system approach, the first step is to *consider the interactions between the indicators on the systems level* (Table 6). Changes in the state of one indicator may affect one or several other indicators. The impact is either positive or negative, and these effects have to be identified. Below is a brief description of the various interrelations between the indicators that have been identified in setting up the proposed indicator system.

Table 6. Interrelations between the indicators. Possible changes in the chosen topics have number of positive and negative feedback effects on the other parts of the system.

	1. Use of natural resources	2. Use of pesticides	3. Soil quality	4. Loading to watersheds	5. Greenhouse gas emissions	6. Animal welfare	7. Genetic diversity	8. Diversity of wild species	9. Landscape diversity	10. Regional structure of production	11. Income changes in agriculture	12. Continuation of farming	13. Quality management
Agriculture indicators													
1. Use of natural resources		1.2			1.5				1.9				
2. Use of pesticides			2.3	2.4			2.7	2.8					
3. Soil quality				3.4	3.5			3.8		3.10			
4. Loading to watersheds			4.3		4.5							4.12	
5. Greenhouse gas emissions						5.6							
6. Animal welfare				6.4	6.5		6.7		6.9		6.11		6.13
7. Genetic diversity		7.2											
8. Diversity of wild species		8.2											
9. Landscape diversity		9.2	9.3	9.4				9.8					
10. Regional structure of production			10.3	10.4				10.8	10.9				
11. Income changes in agriculture												11.12	
12. Continuation of farming				12.4					12.9				
13. Quality management	13.1												
Rural area indicators													
14. Use of rural products												14.12	
15. Regional development									15.9	15.10			
16. Rural industries										16.10	16.11	16.12	
17. Social capital												17.12	
18. Consumers awareness	18												
19. Institutional information systems	19												

1. Use of natural resources

1.2 The area of agricultural land dedicated to conventional and organic farming affects directly the use of the fertilisers, pesticides and energy.

1.5 Decreasing the use of the non-renewable energy resources decreases the greenhouse gas emissions.

1.9 Agricultural land use has an impact on the landscape diversity. Especially the farms that have ceased with the agricultural activities have a major impact on the rural landscape.

2. Use of pesticides

2.3 Contamination of the agricultural soils depends on the exposure to the pesticides (application rates, spray drift, leaching) as well as on the persistence, solubility and behaviour of the pesticides in soils.

2.4 The toxicity of the pesticides and the extent of their use are critical as regards the usability of the water and the food quality.

2.7 The development and use of the pesticides decrease genetic diversity in two ways. The genetic base of the crop plants has to be known in detail in order to avoid the harmful effects of the pesticides. This requires as homogenous genetic base as possible. The continuously increasing specificity of the pesticides directs agriculture to rely on fewer crops and varieties that are chemically tolerant. By adopting the most efficient production practices agriculture favours fewer varieties

2.8 Application of the pesticides may decrease the species diversity in the agricultural areas by destroying more plants and animals than necessary.

3. Soil quality

3.4 Leaching of the nutrients and erosion of the suspended solids are crucially dependent on the soil quality factors such as soil structure, organic carbon content and soil biota.

3.5 Soil quality affects also the biological and chemical reactions of the soils. For example, the anaerobic conditions in the soil increase the risk for the greenhouse gas emissions. The carbon dioxide and ammonium emissions correlate with the amount of organic matter in the soil.

3.8 Soil quality affects the species diversity of vascular plants on arable land.

3.10 Regional production structure is partly determined by the soil quality.

4. Loading to watersheds

4.3 Increased load of the nutrients and suspended solids into the watersheds weakens the soil quality by diminishing its pool of nutrients and other growing factors.

4.5 High surplus in the nitrogen balance increases the risk of releasing ammonium oxides from the fields. The use of nitrogen fertilisers contributes considerably to the greenhouse gas emissions of agriculture, because the synthesis of fertilisers requires a lot of fossil energy. Thus, the nitrogen balance is also an indicator for the greenhouse gas emissions.
4.12 Agricultural activities are strictly regulated in the areas that have important drinking water reserves. This may risk the continuation of animal husbandry on farms in those areas.

5. Greenhouse gas emissions
5.6 Measures aiming to control greenhouse gas emissions may have an impact on animal welfare by affecting rearing of domestic animals.

6. Animal welfare
6.4 and 6.5 Grazing may increase loading of nutrients into the watersheds and the greenhouse gas emissions.
6.7 Animal welfare and breeding require adequate genetic base.
6.9 Pastures and grazing animals in pastures increase the landscape diversity.
6.11 Measures to maximise economic profits may endanger animal welfare by restricting possibilities of species-specific behaviour. Animal welfare may suffer also from farmers' tight economic situation, because in such circumstances the farmers' ability and motivation to take good care of the animals may be lowered.
6.13 From the citizens' point of view animal welfare is an important issue and it should be included within the quality management.

7. Genetic diversity
7.2 Maintaining genetic diversity helps to reduce the pesticide use, because polygenic resistance against diseases is more persistent than the resistance based on a single gene or on a narrow gene base.

8. Diversity of wild species
8.2 High species diversity of natural enemies decreases plant protection problems, and therefore also the need of pesticides use.

9. Landscape diversity
9.2 Crop rotation is an important factor in decreasing pressure of the diseases on crops. In controlling the weeds and diseases insufficient rotation is substituted with increased pesticide use. Field edges with wild vegetation increase abundance of natural enemies of pest species and thus decrease the need of pesticide use.
9.3 Crop rotation is essential in maintaining the quality of the cultivated soils. Species with abundant biomass and strong roots

contribute essentially to the humus of the soils. The leguminous plants are useful in the crop rotation and in fixing the atmospheric nitrogen.
9.4 Edge density of the fields, e.g. the abundance of the ditch boundaries, affects also loading of watersheds.
9.8 Landscape diversity in form of edge density and openness increases species diversity of some birds and butterflies.

10. Regional structure of production
10.3 Regionally specialised production lowers possibilities to maintain adequate crop rotation and is, therefore, a risk as regards the soil quality.
10.4 Intensive animal husbandry concentrated within a geographically small area may increase nutrient loading into the watersheds because of the excessive amounts of manure.
10.8 Regionally specialised production decreases the species diversity in that area, because the crop rotations become unilateral.
10.9 The regional production structure has a strong impact on the landscape. Animal husbandry with associated buildings and pastures are important elements of the cultural landscape.

11. Income changes in agriculture
11.12 Income changes are a critical factor as regards the continuation of farming. Insufficient income level forces the farmers to give up agriculture and to seek other livelihood.

12. Continuation of farming
12.4 Although the number of farms is decreasing the fields remain usually in production, because other farmers buy or rent them. Loading into the watersheds varies depending on the type of agriculture that remains in a particular area.
12.9 The landscape is changed depending on whether crop or animal husbandry farms stay in operation in a particular area.

13. Quality management
13.1 Quality management affects practically all the other indicators. Better management directs the production to more efficient use of natural resources and other production inputs. This, in turn, decreases the overall environmental impact of the production.

14. Use of rural products
14.12 The use and need of the rural products within the society is the basic driving force for the livelihoods in the countryside. Therefore, continuous demand of rural products is a key factor in keeping countryside populated and in securing vitality of the rural areas.

15. Regional development
15.9 and 15.10 Regional development affects landscape in various ways. Overall societal development directs also regional development of agriculture.

16. Rural industries
16.10, 16.11 and 16.12 Rural industries have a significant role in keeping the countryside populated. They also provide farmers and their families an opportunity for additional income and contribute, therefore, to continuation of farming activity.

17. Social capital
17.12 Social capital has an important role in maintaining the essential infrastructure of the rural areas and, therefore, it secures also the continuation of agriculture.

18. Consumer awareness
18. The consumer awareness has an effect on what is produced and how it is produced. This is because the public concern about the environmental or animal welfare issues is a very strong signal, which cannot be ignored in the production.

19. Institutional information systems
19. Usability of institutional information systems depends on quality and accessibility of the indicator data.

In addition, the system perspective should highlight also the *outside forces that affect the agri-food sector.* Agriculture has evolved in more or less open economy and it has become intimately interwoven with the rest of the society. Therefore, the development of the society's social structures, economy and technology affects directly also agriculture and the food industry.

The constantly changing social framework has created the current technological, economic and human circumstances. Social framework comprises also the social values, which guide the decision-making and the activity of the people. These constitute the operating conditions also for agriculture, which cannot proceed in terms of sustainability unless supported by the prevailing circumstances.

Indicators are needed to describe also these preconditions as well as the development paths of the agricultural production. The indicators are linked to each other in various ways and the changes have to be considered in mutual context simultaneously. The pre- and post-farm agribusiness contributes also to the development of agriculture. They supply, among other things, the technological innovations, determine the production costs and market prices, which all have a major impact on the agricultural production.

Agricultural systems are very complex objects to analyse. This becomes especially obvious when decisions about the political measures to be implemented in agriculture are made. Analysing and modelling require a clearly defined, simplified system, which helps to understand the key characteristics of that system. The model should not be burdened with details that are irrelevant for the matter in question.

In this report the focus is on sustainable use of the natural resources and on the interrelations between the indicators. Even though the number of indicators is moderate, there is not enough research basis to construct a model, which covers all the interactions. Therefore the interactions have been described here only qualitatively. In future, the interactions should be studied more in detail to improve understanding on how the indicators are quantitatively linked with each other and how the various policy measures affect the system.

Apparently, modelling the agro-ecosystems and the agri-food cluster within the society requires consistent and holistic scrutiny. Otherwise the indicators appear as independent variables that are not very informative in describing the development of the whole system, and their value in decision-making remains low.

5 Conclusions

In this research project the main task was to propose for the Ministry of Agriculture and Forestry a set of indicators to monitor the implementation of the Ministry’s strategy for sustainable use of natural resources. In the present compilation the focus is on the assessment of the sustainability of agriculture and rural development.

As the starting point for the proposal a theoretical framework enabling the choice of the indicators was constructed. Altogether, 13 assessing themes for agriculture and 7 themes for rural development have been suggested. Agricultural sustainability is assessed by considering: 1) use of natural resources, 2) pesticide use and risks, 3) soil quality, 4) loading of the watersheds, 5) greenhouse gas and ammonia emissions, 6) genetic diversity, 7) diversity of wild species, 8) landscape, 9) animal welfare, 10) regional structure of agricultural production, 11) income changes, 12) continuation of farming, 13) quality management and assurance.

Resource utilisation from the rural development perspective is assessed by 1) use of rural products and services, 2) regional development and welfare of rural areas, 3) rural entrepreneurship, 4) rural infrastructure and services, 5) human resources in rural communities, 6) consumer awareness and 7) information management (Appendix 2 and 3). It is recommended that the themes are used in future as tools in monitoring the realisation of the strategy.

Methodologically the formulation of the indicators requires that the data are organised and presented in a form that is transparent and comprehensible for the various users. During the past decennium agri-environmental indicators have been actively developed within several international organisations. The indicator sets currently in use provide new insights into the European agriculture, but the data are often fragmentary and of highly varying quality. The comprehensive overview is still lacking. In many cases, conceptually and practically satisfactory agri-environmental indicators are still under development. In addition, the extent to which the piecemeal information actually reflects the many-faceted reality of agriculture in praxis has to be understood.

The indicators proposed here provide an information package for the future decision-making, but two basic conditions have to be fulfilled: 1) the chosen assessment themes have to correspond to the key strategic goals expressed in the Ministry's strategy, and 2) the information provided by the chosen assessment themes and methods has to be based on reliable research data.

As to the first condition, the holistic view comprising the ecological, economic and social aspects of agriculture and rural development requires that due attention be paid to each of these and that the issues are approached from the various perspectives. The proposed set of indicators is a minimum that is necessary to describe the agricultural practices and its consequences in Finland in a coherent and balanced way. The continuing discussion hopefully reveals, whether additional themes eventually should be included within the suggested indicator set.

As to the database of the indicators, its scope and reliability definitively can be improved. Feasible indicators have to be based on profound understanding of the phenomenon at issue and on up-to date monitoring data. At present, this is not always the case. As to the economic issues the situation is fairly good and there are plenty of reliable statistical data available. The research background of the environmental sciences is much younger and the data availability is also more restricted. Areas such as energy consumption and physical and biological properties of agricultural soils lack totally the spatial environmental data. Currently, environmental modelling approaches are under active development; in near future the modelling approach opens new possibilities to produce spatially differentiated data on issues such as loading of the watersheds by agriculture and environmental impact of the pesticide use.

At the other end are the social and cultural indicators that are poorly developed, indeed. In this work, some methodological approaches to assess the social and cultural aspects of agriculture and rural development have been introduced. However, it should be born in mind that the proposed indicators are preliminary and under development; the information provided by them is not very profound nor is it theoretically solid, and the indicators are not spatially differentiated. This is because there are very few statistical data readily available. Moreover, the qualitative phenomena such as quality of rural life, feasibility of rural infrastructure or cultural identity are difficult to describe with simple figures. Developing social and cultural indicators requires on the one hand that the assessment methods be improved, on the other hand that the policy goals are expressed more precisely.

In this work, an appropriate attention has not been paid to the food processing industry or to the food retailing. The scope of the assessment should be extended to comprise the whole food systems. Horticulture and fur animal husbandry are beyond the scope of the present work, and they are mentioned only in passing. This is clearly a shortcoming, since especially the fur animal husbandry is an areally and economically important and societally touchy rural livelihood.

Thus, there is a need to further develop the assessment methods for the various themes. In addition, there is an urgent need to develop indicator approach itself as a tool for decision-making. In this work, the system perspective is specifically stressed. Single, separate indicators do not tell much about the overall development of agriculture or rural areas. Utilising natural resources involves a multidimensional and continuously changing system. Beside the raw materials of the production, natural resources comprise the whole ecosystems as as targets of human measures. The socio-economic network including the farmers, the processing and retailing enterprises, consumers as well as the administrative, research and educational institutions decide upon the natural resources use. Indicators should be developed in such a manner, that they reflect the holistic and dynamic nature of the whole system instead of breaking the system into pieces and considering the pieces apart from each other. This requires that the interest is focused on the most relevant themes. Also, attention must be paid to the clarity of the interpretation and to the visual presentation.

Within the system perspective, one of the key characteristics of sustainability – the integration of the ecological, economic and social knowledge - is embedded. In recent public debate about the societal development in Finland, it has been suggested that the sustained economic growth and competitiveness have to be based on high level of social welfare. This is also the key question as regards sustainable agriculture; the economy and technology driven development has to be decoupled from the increasing environmental and social costs. The prerequisite for this is that the development paths leading to agricultural efficiency without intolerable costs for the environment, the health of the consumers or for the viability of rural communities, are identified.

Indicators will not provide the answers, but they will provide an informative basis for the conversation.

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7 Appendices

Appendix 1. Comparison of international indicators

ECOLOGICAL INDICATORS

Use of natural resources

	OECD: *Agri-environmental indicators* (OECD 2001)	*EU Commission:* *Agricultural indicators* *(*CEC 2001a, CEC 2001b)	*European Centre for Nature Conservation:* *ELISA-project* *(*Wascher 2000)	*Canada:* *Agri-Environmental Indicator Project* (McRae et al 2000)	*UK:* *Towards Sustainable Agriculture* (MAFF 2000)
Land use	Land use -stock of agricultural land -change in agricultural land -agricultural land use	Land use -topographical change -cropping/livestock pattern	Land use intensity - share of irrigated area - yield of cereals -share of farms >50% cereals -share of utilised agricultural area -share of grassland - livestock density		Area of agricultural land Change in land use from agriculture to urban use
Energy use		Energy use by fuel type Production of renewable energy sources Energy efficiency		Energy use	Direct energy consumption by farms Trends in indirect energy inputs to agriculture
Nutrient use	Nitrogen balance Nitrogen efficiency	Fertiliser use by crop and region Soil surface nutrient balance	Nitrate surplus and discharge	Residual nitrogen	Manure management (Phosporus levels in topsoils)
Water use	Water use intensity, efficiency and stress Area under irrigation systems	Water use intensity Water use by sector Ground water abstraction Ground water levels	Ground water level Share of irrigated area		Use of water for irrigation
Agricultural		Quantity of agricultural			Planting of non-food

output/ demand		output in energy terms Food demand (quantity and quality)			crops (hemp, flax, linseed, oilseed rape)

ECOLOGICAL INDICATORS
State of environment

	OECD: Agri-environmental indicators	*EU Commission: Agricultural indicators*	*European Centre for Nature Conservation: ELISA*	*Canada: Agri-Environmental Indicator project*	*UK: Towards Sustainable Agriculture*
Soil quality	Land conservation: -water retaining capacity - soil retaining capacity	Soil quality - agricultural areas where soil capability and actual land-use mismatch	Soil compaction	Soil organic carbon Risk of soil compaction Risk of soil salinisation	Phosporus levels of agricultural topsoils Organic matter content Accumulation of heavy metals
Erosion	Risk of soil erosion by wind and water	Soil erosion -estimation of the losses and erosion risk -land cover and agricultural practices in areas at risk	Water erosion Wind erosion	Risk of water and wind erosion Risk of tillage erosion	
Air	Gross agricultural greenhouse gas emissions	Methane emissions Greenhouse emissions	(Air)	Agricultural greenhouse gas budget	Ammonia emissions Emissions of methane and nitrous oxide
Water quality	Water quality risk and state indicator	Water contamination Nitrates/pesticides in ground and surface water Nitrogen emissions to water	Nitrate in rivers, in groundwaters and in drinking water Pesticides in groundwater and in surface water	Risk of water contamination by nitrogen and phosporus	Nitrate and phosporus losses from agriculture
Pesticides	Pesticide use and risk	Index of pesticide use Classified pesticide use Pesticide soil	Pesticides in soil		Pesticides in rivers and in groundwaters Pesticide residues in food

		contamination			Use of pesticides in active ingredients Area treated with pesticides
Genetic diversity	Genetic diversity	Total number and shares of main crop varities/livestock breeds Number of endangered varities/breeds	Genetic diversity in seminatural agro-ecosystems and in farm species		
Species diversity	Species diversity -wild species -non-native species	Species richness	Flagship species Species richness Species population trends		Population of key farmland birds
Habitat diversity	Intensively-farmed agricultural habitats Semi-natural agricultural habitats Uncultivated natural habitats Habitat matrix	Density of linear elements and diversity of land cover Indices of agricultural diversity Area of high nature value	Spatial complexity Corridors and linkages Size/% of charasteristic habitat types	Availability of wildlife habitat on farmland	Area of semi-natural grassland
Landscape quality (visual charasteristics)	Landscape structures - environmental features and land use patterns - cultural features	Number and diversity of memorable elements	Biophysical adequateness of land use Openness vs. closedness Adequateness of key cultural features Land recognised for its scenic and scientific value		Charasteristic features of farmland

ECOLOGICAL INDICATORS
Farm management/practices

	OECD: Agri-environmental indicators	*EU Commission: Agricultural indicators*	*ELISA: Environmental Indicators for Sustainable Agriculture*	*Canada: Agri-Environmental Indicator project*	*UK: Towards Sustainable Agriculture*
Organic agriculture	Number of farms in organic agriculture	Area under organic farming Number of farms and crops in organic production			Area converted to organic farming
Environmental planning	Environmental whole farm management plans	Farms complying with regional level of good farming practise		Adoption of best management practices for handling nutrients, manure and pesticide	
Nutrient management	Nutrient management - plans and soil tests				Manure management
Pest management	Pest management -use of non-chemical control methods - use of Integrated Pest Management (IPM)	Index of pesticides use Pesticide use classified according to charasteristics	Pesticide use (sales and usage) Pesticide cost per crop Estimated usage data per crop Pesticide risk		
Soil management	Soil and land management -soil cover - land management practices	(Land use management) Land cover change		Soil cover	
Environmental Actions	Landscape management				Area of cereal field margins under environmental management
Animal welfare		Animal welfare			

SOCIO-ECONOMIC INDICATORS
Agriculture in the context of society

	OECD: *Agri-environmental indicators* *(OECD 2001)*	*EU Commission:* *Agricultural indicators* *(CEC 2001b)*	*UK:* *Towards Sustainable Agriculture* *(MAFF 2000)*
Basic information	Number of farms		
Agricultural production (GDP)	Agricultural GDP /Agricultural output	Share of agriculture and food industry in GDP Farm net value added	
Production structures		Intensification and extensification Specialisation and diversification Marginalisation	
Farm income	Farm income (Relative income in agricultural households in relation to other rural households)	Composition of farm household income (farm-related and off-farm) Index of prices paid and received	Total income from farming Average earnings of agricultural workers
Farm employment and the changes	Farm employment Farm age and gender distribution (Entry of new farmers into agriculture)	Change in number of people employed in agriculture and Age structure of agricultural labour Agricultural and food industry employment/total rural employment	Age of farmers Agricultural employment (seasonal, part-time, full-time)
Man-made capital in agricultural production		Fixed assets and stocks in agriculture and outside agriculture Rate of renewal of farm capital Public stocks in quantities and values Change in own resources of farm Financial stress (dept servicing ratio)	Agricultural assets and liabilities Percentage of holdings that are tenanted
Productivity		Capital productivity Labour productivity Land productivity	Agricultural productivity
Environmental	Landscape management costs and benefits		

costs and benefits	(Rural amenities)		
Market signals/prices		Difference between between organic and conventional products Products carrying registered product names	
Quality of agricultural output		Infringements on residues/ contaminants legislation	
Agricultural support	Agricultural support		EU Producer Support Estimate (PSE)
Agri-environmental policies	Agri-environmental expenditure -public and private expenditure -agri-environmental research	Area under agri-environmental support Area under nature protection	Payments to farmers for agri-environmental purposes Area of agricultural land under commitment to environmental conservation
Working conditions		Rural and non-rural working hours and labour conditions	
Human capital/ education	Education level of farmers	Agricultural holder's training level Practical experience Agricultural training yearly Agri-environmental training of farmers Rural and non-rural education level	
Environmental awareness and social activities	Environmental farm management standards	Regional level existing for environmental targets	Adaption of alternative farm management systems Knowledge of codes of good agricultural practices
Institutions and networks	(Social capital)	Institutional efficiency -regulatory framework and steering mechanisms Social capital	

Rural development

	PAIS-project (Bryden et al. 2000)	European Commission: Evaluation of rural development programmes (CEC 2001b)
Population	Demography (density, age structure, vital rates) Migration	Stabilation of overall rural population Age and gender profile of benefiting from assistance Less-favoured areas and areas with environmental restrictions -agricultural land use continues -fair standard of living for farmers -maintenance of sustainable farming -increased implementation of environmental programmes
Rural wellfare	Employment (unemployment, economic activity, employment quality, local business) Income (employment income, social payments) Housing (quality, pressure, homelessness) Regional performance (benchmarking regions) Enterprise (innovation) Human capital (educational attainment) Farm households (income diversification, activity diversification) Tourism (structure, performance) Rural business (structure, performance) Agriculture (structure, performance, labour) Forestry (land use, planting, harvesting, employment) Fisheries (employment, landings) Primary industries (value added)	Rural employment, Rural economy Income level of rural community Diversification of activities contributing to employment Wellfare of the rural population improved by social and cultural activities Improved access to services Social and cultural facilities maintained Access to amenity sites
Regional infra-structures	Infrastructure (transport, peripherality, ICT, land) Access to services (retail, recreational, education/health, transport)	

Appendix 2. Agricultural indicators

Strategy goals	Themes and indicators
- Ecoefficient use of resources - Maintenance of agricultural lands	**1. Use of natural resources in production** -agricultural land use -resource efficiency (TMR) -energy efficiency
- Minimising the risks of pesticide use	**2. Pesticide use and risks** - pesticide sales (kg of active ingredients per hectare) - environmental risk indicator may be later added to monitoring system
- Preserving the soil quality	**3. Soil quality** - nutrient status (P mg l^{-1}) - acidity (pH(H_2O)) - organic matter content (Org C %) - heavy metal content (Cd mg l^{-1}) - indicators of physical and biological soil condition s may be later added on to the indicators
- Minimising the agricultural loading	**4. Loading to watersheds** - nitrogen balance at national and regional levels (kg ha^{-1} $year^{-1}$ of total agricultural land; 1990 to present) - soil P concentration (mg l^{-1}); phosphorus balance will be later added.
- Minimising the emissions	**5. Greenhouse gas and ammonia emissions** - agricultural emissions of nitrous oxide (N_2O), methane (CH_4) and carbon dioxide (CO_2) and total greenhouse gas emissions in carbon dioxide equivalents -agricultural emissions of ammonia
- Preserving the genetic resources - Promotion of domestic species	**6. Genetic diversity** <u>domestic animal diversity:</u> - classification of the breeds and sub-populations within a breed and information on population numbers - estimation of the effective population size of the breeds and genetic distinctiveness of the breeds <u>plant diversity:</u> - total number of crop varieties that have been registered - share of key crop varieties in total marketed production - the number of national crop varieties, that are endangered
- Maintenance of diversity of wild species	**7. Diversity of wild species** <u>threatened species</u>: number of threatened species in each species group in 1985, 1991 and 2001 <u>birds:</u> population change index by habitat requirement category <u>butterflies</u>: population change index by habitat requirement category <u>non-cultivated plants</u>: average species number and average number of individuals per square meter by decade (1960s, 1980s and 1990s)
- Maintenance of diversity of habitats - Care of cultural landscape	**8. Landscape** - habitat level indicator: edge density of fields;km/100ha per Employment and Economic Development Centre. - landscape level indicator: openness in agricultural landscape; ha per Employment and Economic Development Centre.

	- socio-economic landscape indicator: utilisation of farm tourism accommodation in Finland ; %/year or month
- Animal welfare	**9. Animal welfare** - number of sentences for prohibited animal rearing - condemned carcasses in Finnish slaughterhouses
- Regionally diversified production structure	**10. Regional structure of agricultural production** - distribution of main production lines regionally
- Profitability of farming - Equal level of welfare of farmers	**11. Income changes in agriculture** - income changes - structure of total incomes - profitability
- Providing the societal circumstances for the occupation	**12. Continuation of farming** - investments - generation transfers
- Quality and safety of the products - Attention in food chains and traceability - Adopting of quality systems	**13. Quality management and assurance** - number of certified farms (quality & environmental quality) - number of educated farms - number of quality contracts with external clients

Appendix 3. Rural development indicators

Strategy goals	Themes and indicators
Availability of domestic food and raw materials Compensation of non-renewable products with renewable Recreational use of countryside	**1. Use of rural products and services** - changes in use of rural products and services - self-sufficiency in food products (milk, eggs, fish, meat)
Maintenance of rural settlement Quality of life in countryside	**2. Regional development and welfare of rural areas** - BTV- indicator describing the changes in population, employment and production (GNP) - share of primary section from total production and employment
Promoting the entrepreneurship based on rural resources	**3. Rural entrepreneurship** - corporate structure and volumes
Feasibility of rural infrastructures	**4. Rural infrastructure and services** - accessibility to key services in case study areas (15 communities)
Endogenous development of rural areas Social capital, networking Education Cultural identity	**5. Human resources in rural communities** - preliminary description of human, social and cultural capital
Consumer oriented developing of agriculture Rural and environmental education Social and cultural acceptability of resource use Recreational use of countryside	**6. Consumer awareness** - description of consumer attitudes and awareness concerning rural natural resources on the base of available surveys
Developing planning and administration procedures (adaptive management) Participation and transparency of production Focusing the research	**7. Information management** - description of implementation of the strategy goals

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